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Highlights

- Dynamic Voltage Restorer (DVR)
- Improvement of Power Supply
- Electronic Dispute Resolution
- Greenhouses Low-Cost Monitoring

Discovering Thoughts, Inventing Future

VOLUME 20 ISSUE 5 VERSION 1.0

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From the Theory and Design of an Electronic Dispute Resolution Platform in the Field of Consumer Affairs to its Effective Implementation under European and Spanish Law

By Oscar Daniel Franco Conforti
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Introduction- In the field of dispute resolution by electronic means, it is possible to find a wide range of expressions (i.e, distance dispute resolution, online dispute resolution, electronic dispute resolution, and a long etcetera) that situation is due to the rich Spanish language allows to create in an attempt to reproduce the essence of the idea of Online Dispute Resolution (ODR) from the Common Law.

ODRs are a set of methodologies through which a conflict can be resolved through the use of information and communication technology (ICTs), which is thus incorporated as a "fourth part" into the traditional tripartite models of conflict resolution (Katsh and Rifkin 2001).

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From the Theory and Design of an Electronic Dispute Resolution Platform in the Field of Consumer Affairs to its Effective Implementation under European and Spanish Law

Oscar Daniel Franco Conforti

I. Introduction

In the field of dispute resolution by electronic means, it is possible to find a wide range of expressions (i.e, distance dispute resolution, online dispute resolution, electronic dispute resolution, and a long etcetera) that situation is due to the rich Spanish language allows to create in an attempt to reproduce the essence of the idea of *Online Dispute Resolution* (ODR) from the *Common Law*.

ODRs are a set of methodologies through which a conflict can be resolved through the use of information and communication technology (ICTs), which is thus incorporated as a "fourth part" into the traditional tripartite models of conflict resolution (Katsh and Rifkin 2001).

To be more specific, an ODR will be the result of the sum: methodology of conflict resolution plus the technological tools (e-mail, chat, SMS, videoconference, etc.) applied to a specific case, by the parties and the conflict operator (when there is one) who will help them in trying to achieve resolution of the case by themselves (or not) (Comfort 2013).

Two early conclusions can be drawn from this idea and concept of ODRs: (a) the technological tools are transversal and functional to all methods of conflict resolution and, (b) there is no equivalence between the technological tool and the method of conflict resolution applied in the specific case (Conforti 2013, 2017).

Among the possible origins of the ODR are, on the one hand, the theory of the transfer of the methodologies of *alternative* dispute resolution (ADR) from the face-to-face to the virtual scenario promoted by professionals in the field of law who, aware of the opportunities offered by the new communication technologies, decided to take these methods (negotiation, mediation, arbitration, etc.) to the cybernetic environment; and, on the other hand, with the theory that focuses on economic transactions carried out through the Internet, wherein the absence of ways to resolve conflicts derived from purchases and sales that were made in this new scenario (for example, in portals such as Amazon®, eBay® or PayPal® —the undisputed promoters of these methods of conflict resolution derived from their commercial activity—) activated the need to respond to unsatisfied consumers. Their origin should not mislead us, ADR and ODR are not equivalent. There are at least three reasons to argue that there is no correspondence between them: Firstly, because ODR procedures may not necessarily satisfy the "alternative" requirement of ADRs, since the form of ODR includes so-called virtual courts or *cyber courts*; secondly, because the technological component of ODR makes it possible to create different or non-existent procedures in ADRs (Generalitat de Catalunya Departament de Justicia 2009) and, thirdly, because the dialogue and creativity required for an ODR process differs from that of ADR processes since here "*Dialogue is a direct, face-to-face meeting process which should not be confused with endless the orisation and speculation.*" (Bohm 2012) and creativity seeks to avoid "*self-feeding confusion*" (Conforti 2015).

The scientific literature in relation to ODR is truly abundant, however, that does not happen in the pragmatic scenario where there is hardly any literature that explains how to resolve in practice the various issues raised by ODRs, in relation to guaranteeing the identity of the parties, electronic signatures, security, privacy, confidentiality, and data protection, among others.

Perhaps part of the explanation for this disparity in developments is that *a priori,* not all ODR need secure, private, and confidential communications. If this were not the case, B2C (*Business to Consumer)* e-commerce would probably not exist, or at least not in its current development. However, it is no less true that today communications on the Internet have greatly improved in terms of security, privacy and confidentiality; practically all communications can use secure servers (Https) and be encrypted, with various certificates and levels of security.

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Secure, private, and confidential communications are only indispensable when required by the parties to the dispute or by law.

Possibly the Law is the other part of the explanation.

The ODR comes from the *common law* legal system where the legal regulation that has been made of them is —in accordance with tradition in that legal system— almost nil. However, in our legal system of continental law, there is an abundant legal regulation to which we must pay attention, among other things, for the sake of legal security.

Thus, for example, in Spain when we speak of mediation by electronic means, the Law establishes the obligation to avoid impersonation by guaranteeing the identity of the participants in the mediation process (Law 5/2012 art.24.1).

II. Issues Raised by the ODR

Confidentiality, privacy, the identity of the parties, electronic signature, and data protection are undoubtedly the first issues on the agenda when it comes to resolving disputes by electronic means.

From a practical point of view, the challenge must be understood at multiple levels, ranging from avoiding the distortion of the conflict resolution methodology in question to the imperative of compliance with the rules of law, to the technical requirements and guarantees to be met by ODR platforms.

Unlike in *Common Law,* where Ethan Katsh acknowledged that "[...] *we have neglected to design systems to deal with disputes that may arise.*" (Katsh 2014), we in the Continental Law must focus on ensuring legal certainty through the design of ODR platforms that take into account the specificity of this modality of work (Sourdin 2007, Conforti 2018).

There is no doubt that there are more than four parties to an ODR. We are talking about the natural or legal persons that have some degree of connection with the ODR process, which is known as a "fifth party" (Lodder 2010, 79), and I would even go so far as to say that it would be appropriate to split a "sixth party", I am referring to the internet service provider.

It is appropriate to open a brief parenthesis to point out, without going into detail, that as regards access to the Internet, in a way, the United Nations General Assembly (UN) closed the debate that, in the field of the Law on New Technologies, existed when it considered access to the Internet as a Human Right.

There is no need for new human rights standards for the internet because the principles and doctrines in current international law apply in all areas. The same international laws and standards that already exist must be applied in the same way to online media.

By applying this human rights-based approach to facilitating access to the Internet, it is the State's obligation to close the multiple forms of the existing digital divide, by promoting digital literacy, by facilitating access to online information - as an important tool for promoting the right to education - and in the resolution of conflicts by electronic means - which is of particular interest to us -, etc. (United Nations 2016).

Table 1: Parties at ODR Own elaboration

Part 1, 2 and 3	Part 4	Part 5	Part 6
Parties to the Conflict	E-mail	Service Provider or ODR Platform (ODRS)	Internet Service Provider
Conflict Operator	Virtual Meeting		
	Provider of ICT tools		

It is clear that while the "fourth part" participates in the ODR process, both the "fifth part" and the "sixth part", which I have just introduced in the table, are not directly involved in the ODR process. It follows that the legal consequences for both are necessarily different.

We must note the need to address the issue of ODR or ODRS (*Online Dispute Resolution Supplier)* platform suppliers, also ODRs. But before we continue, I think it is appropriate to return to at least one of the early conclusions drawn *above* and to point out that the issue deserves preliminary clarification.

A videoconference is not an ODR (Conforti 2013, 2015, 2020) (ADR *Institute of Canada* 2020).

a) Videoconferencing is an ICT (Cloud Computing) tool

A videoconference is a communication established through the Internet in which image and sound are transmitted. People in a video conference can see and hear each other through their computers or devices in real-time (synchronously).

The videoconference is carried out in the cloud over the Internet by a service provider who makes certain *software* available to end-users which may (or may not) need to be downloaded to the customer's computer or mobile device.

This means that the responsibility for managing the key infrastructure, such as storage, security, and

operational features, falls directly on the shoulders of the cloud-based video conferencing service provider. As a general rule, in the free versions, these services are focused solely on production without the additional responsibility of managing the critical ICT infrastructure they offer; in the paid versions, the videoconferencing service provider will assume different levels of responsibility (the specific contract conditions for each of them must be consulted).

Applications such as Zoom, Microsoft Teams, Webex, etc., provide virtualisation solutions over the Internet, only support synchronous communication, and lack the full menu of an ODR that is typical of ODRS platforms.

A videoconference alone, i.e. without an electronic file, without proof of identity, electronic signature, etc., does nothing to actively help the operator of the conflict and the parties to reach a resolution.

b) ODRs are the result of the sum of ICT tools and conflict resolution methodologies

As I explained *above,* ICT tools are in the cloud (*Cloud Computing*) and, when added to conflict resolution methodologies, in the form of ODR platforms, they form a new category or model of *Cloud Computing* service.

ODR's can be developed (in whole or in part) in the cloud, which is why they are included in the *Cloud Computing* category, which can generate some degree of confusion and erroneous assimilation with videoconferencing, however, the differences are notorious.

ODRs provide a space to develop, execute, and manage a wide range of processes. They eliminate the complexity that comes with building and managing all the infrastructure needed to develop and launch protocols for electronic dispute resolution (i.e. for electronic mediation).

By using these developments companies and consumers avoid having to worry about the diversity of devices, operating systems, storage, security, data protection, as the ODRS platform will take care of all this.

ODR platforms are online dispute resolution programs that offer the full range of ODR tools: electronic filing, case management, synchronous and asynchronous communication, reports, etc., using certain *hardware* and *software* ICT tools that have been specially designed and created to develop ODR processes.

On the other hand, ODRS platforms should provide a way to guarantee the confidentiality and privacy of the mediation process and certainty about the identity of the participants, digital signature and personal data protection.

Confusing a videoconference with an ODR platform has led some Justice departments to use software applications and programs that, due to multiple security failures, have been classified as unsafe —i.e: Zoom— (National Cryptologic Centre). The issue is not only a technical problem, because it is also a legal one since different levels of legal protection are being generated for the same rights.

In the attempt to justify the comparison between a videoconference and an ODR platform, it is based (mainly, but not exclusively) on the lack of economic resources to face the implementation of safe *software* and *hardware* applications, and on the urgent need to allocate these economic resources to manage the health emergency caused by the COVID19 Pandemic.

The most immediate consequence of this confusion (fuelled by the videoconference operators themselves, such as Zoom, WhatsApp, Microsoft Teams) is an increase in the digital divide between citizens who receive "access to justice" and later "justice" services in the absence of technical, intellectual, ethical and legal security conditions (National Security Agency USA 2020) and those consumers who use ODR platforms that are in line with Spanish and European legislation.

In addition, "different levels of legal protection are being created for the same rights".

Let's look at some tables that will help avoid confusion regarding the meaning of some terms that are used as synonyms when in fact they are not.

Table 2: Comparison of Web conferencing, Videoconferencing, and Telepresence

	WEBCONFERENCE	VIDEOCONFERENCE	TELEPRESENCE
Desktop software	Yes	Yes	Yes
Hardware	No	No	Yes
Variety of cameras and microphones simultaneously	No	No	Yes
Bandwidth or connectivity requirements	Under	Medium	High

Video image quality, sound, and interactivity	Low image quality (flicker, pixelation), interfering audio, and limited interactivity	High-quality HD video and sound, unlimited interactivity	*High-end* codecs and large displays with Full HD or UHD 4K resolutions, Unlimited interactivity
Access from multiple devices (device compatibility)	Yes *Bring Your Own Device* (BYOD)	Yes *Bring Your Own Device* (BYOD)	No

Own elaboration

Table 3: Comparison between Videoconference and ODR Platform

	VIDEOCONFERENCE	ODR PLATFORM
Software	YES	YES
Hardware	No	YES
Responsibility in the management of critical ICT infrastructure	No	YES
Asynchronous communication	No	YES
Security: end-to-end encryption and data protection	No	YES
Electronic file (direct access to hearings, calendar, time-stamping, recordings, a record of performances, statistical reports, notes)	No	YES
Electronic signature level 2 multifactor	No	YES
Online support within the platform	No	YES

Own elaboration

III. The Fifth Part, the ODR'S

The appearance on the stage of the ODRS responds to this practical approach pursued by this article. In other words, it is a question of establishing: (1) how they should respond and, (2) how they respond to the issues of "confidentiality, privacy, the identity of the parties, electronic signature, and data protection", the ODRS platforms in our legal framework, that is the Continental Law.

a) How should ODRS platforms respond?

Without prejudice to what has been said *above* regarding how the ODRS platforms should respond in relation to Law 5/2012, of 6 July, on mediation in civil and commercial matters; Regulatory Decree 980/2013, of 13 December, which develops certain aspects of Law 5/2012, of 6 July, on mediation in civil and commercial matters; Law 39/2015, of 1 October, on the Common Administrative Procedure of Public Administrations; Organic Law 3/2018, of 5 December, on the Protection of Personal Data and the Guarantee of Digital Rights. It should be noted that the body of law at the European level in relation to the resolution of online consumer disputes is made up of Directive 2013/11/EU and Regulation (EU) No 524/2013, both of the European Parliament and of the Council, of 21 May 2013, on the resolution of online consumer disputes (hereinafter the Directive) (de la Rosa 2020).

The Directive seeks to protect the consumer and has therefore created a way for the out-of-court settlement of disputes on-line through a dispute resolution process which, according to recital 12, is an On-Line Dispute Resolution (ODR).

From a procedural point of view, this ODR excludes negotiation between the parties (argument 23 and Art. 2 e.) and technically, it could be said that it is a facilitation process in which the facilitator can suggest or impose a solution that is binding on the parties.

The principles of this ODR are: the technical quality of the dispute settlement operator (expertise), independence and impartiality, transparency, efficiency and speed, accessibility to the ODR, fairness (not justice), freedom of choice, legality (through the rule of

law), data protection, secure exchange of information and comprehensive, easily accessible and understandable information for the consumer.

Pragmatically, any trader with a website should include an advertisement (similar to cookies) with a text such as: "*The European Commission provides consumers with an online dispute resolution platform for consumer issues which you can access from here: http://ec.europa.eu/consumers/odr*". The same announcement should be made in the e-mails with offers of these on-line services.

The trader must inform the consumer of the alternative dispute resolution body to which he has adhered. The entities do not necessarily have to be registered on the EU platform. In this case, the announcement could be similar to the following: "*We have joined the XXXX online dispute resolution service, you can access it here: XXXX or opt for the ODRS provided by the European Commission to consumers which can be accessed from here: http://ec.europa.eu/consumers/odr*" (Conforti 2016a).

Furthermore, the trader must bear in mind that he is the person responsible for the processing of personal data and must exercise due diligence to ensure, at all times, that the information is processed in accordance with the provisions of Law 3/2018 and the EU's general data protection regulation 2016/679 (GDPR).

To benefit from its advantages, the merchant can opt for an ODR service that uses the cloud to host sensitive information, however, he must bear in mind (as I mentioned earlier than now) that the law places the responsibility on him since it is the merchant who has taken the decision to use such services in the cloud; and therefore it must be he who, in the eyes of the Spanish Data Protection Agency (AEPD,) ensures adequate and secure processing.

The trader is responsible for the file, and as such, the guarantor of the fundamental rights of its customers for the protection of their personal data. When deciding to contract cloud services, in addition to the technical and economic advantages, traders must have a legal assessment that allows them to identify the suitability of the services they intend to contract or join in order to prevent sanctions from the AEPD. To do this, it will be essential to have experts to advise on ODRS platforms.

The doctrine has identified many possibilities for improving the EU platform while respecting the spirit of European law with regard to it, i.e: a prior system of assisted negotiation could have been implemented (de la Rosa 2017a), the admissibility of compulsory consumer mediation (de la Rosa 2017b), an information alert system by which the consumer is informed of the rate of complaints registered for certain services or products (known as *name and share),* some form of measure could have been established in relation to multiple successive and identical complaints (*repeat players)* (Marcone Lo Presti 2020, 94).

Finally, some concern should be expressed regarding the fact that the submission of complaints, their processing, and transmission raise the question of the accreditation of the identity of the parties since the forms of the EU's RLL platform do not show how this is accredited and certified (Valbuena González 2015).

Paraphrasing Andrés Vázquez López, it can be said that in the scenario of ODR, in addition to the regulatory requirements themselves, the principle of transparency imposes a series of conditions on mediation institutions and dispute operators so that they guarantee it by advertising at least the applicable regulations, the identification of the holder providing the service, the identification of the dispute operator, and the identification of the channels of access to the available services, the information necessary for the correct use of the ODR platform and other ICTs used, specifying the navigation structure in the virtual environment of the digital platform and the different sections available, (general description of the mediation procedures, negotiation protocols used by the institutions or the same conflict operator and estimated timetables for the duration of the procedure, description of the electronic means available for carrying out mediations by this means, methods used for sending and receiving documents and description of the electronic communication methods used in the procedure, seeking to facilitate the interoperability of the systems, languages supported, detailed outline of all the phases of the process used for carrying out mediations by electronic means, cost of the ODR process and its criteria for determination, method of payment and, where appropriate, information on the free nature of the service, and information on the legal consequences of the possible agreement in relation to at least the applicable law, the possibility of obtaining an enforcement order and the competent courts in the event of enforcement or challenge of the agreement). In addition, an indication of how to exercise the rights of access, objection, rectification, and cancellation of personal data, with an indication of the level of protection and the mechanisms used to guarantee the security measures available to computer media in accordance with the applicable legislation on personal data protection (Vázquez López 2020).

It is absolutely understandable that in the emergency situation in which we are living due to the pandemic, a significant number of technological tools appear to be available, although it does not seem that all of them will be useful for online conflict resolution (Hu Wu 2020).

In our case the ODRS has to be designed following the parameters of legal security set by local and European laws, specifically taking into account the fundamental critical points already indicated (i.e.

confidentiality, privacy, identity certification, electronic signature, and data protection).

The ODRS thus become formal out-of-court dispute resolution systems in our legal system. The design of ODR systems will require genuine professionals from at least three distinct areas of expertise, I mean

Conflict management: this is a "conflict operator" who is familiar with the various methods of conflict resolution (negotiation, arbitration, conciliation, mediation, etc.) as this is the only way to be able to differentiate between them.

Legal informatics: because it is about the application of informatics in law and not just about informatics.

Law: because the process will need legal certainty and that must translate into the protection of fundamental rights such as the right to privacy, and the protection of personal data.

The design of an ODR Platform must respond not only to the EU's RGPD and other local and related legislation, but also to the Sustainable Development Goals 16 and 17 adopted by the United Nations and of course to the principles of the European Ethical Charter on the use of artificial intelligence in judicial systems and their environment (where relevant): respect for fundamental rights, non-discrimination, quality and safety, transparency, impartiality, and fairness. All this under the maxim "under user control".

To avoid the dangers of choosing a platform, you must choose one that guarantees: "confidentiality, privacy, the identity of parties and data protection".

"*ODR platforms have to produce a positive change in the people who will use them. On the part of the users, the design of the platform requires specific knowledge that must respect the values of the conflict resolution methodologies that can be applied through it and, at the same time, the fundamental rights of the people who use them.* "(Conforti 2020).

On the other hand, it has to be admitted that the generalisation of ODRS will require a combination of (a) training of conflict operators specialised in the online field and, (b) the continuous improvement of platforms (electronic file and collaborative video conference). Only in this way will it be possible to incorporate ethics and transcend the legal framework.

In particular, and focusing on ODR platforms, we must make it clear that not all technology is innovation, but nor it is all innovation technology.
The two pillars on which an ODR Platform is to be built are *ease-use* and *security*.

The design of an ODR platform should respond to the experience of the different types of users, focusing on the specific needs of each one of them, obtaining, as a result, a useful and simple product to be used, which can also be used in all types of devices.

An ODR platform, to be used in the legal system of continental law, will need to shield and provide citizens, professionals, and institutions with intellectual, legal, ethical, and computer security (Conforti 2016b).

b) How does an ODRS platform respond?

Having already made the distinctions and differentiations between a videoconference and an ODR platform (see *ut supra* point II sections 1 and 2) and laid down the principles on which an ODR platform should be designed (see *ut supra* point III section 1), let us move on to the study of the customer's experience.

The concept of "client" in an ODRS is multiple, it can be either a trader, consumer, the operator of the dispute, or the institution that offers the public the platform of dispute resolution. For the customer's experience to be satisfactory we must bear in mind that it will be directly related to their expectations and the outcome of the process, which in turn will be closely linked to the legal security of the process, i.e. the eventual effective enforcement of the agreement, even if it has to be forced (Conforti 2012).

Following Milagros Sanz Parrilla, let's see how the ODR platform of the company Acuerdo Justo SL responds, within our legal framework, to the questions of "confidentiality, privacy, the identity of the parties, electronic signature and data protection". This is the first Spanish platform created in 2008. "*This service has been developed with the collaboration of the Family Mediation Centre of Catalonia of the Department of Justice of the Generalitat de Catalunya and is based in Barcelona*" (Sanz Parrilla 2011, 449-450).

Completely redesigned, the platform has been able to maintain the two hallmarks mentioned *above,* i.e.*ease-use* and *security*. The ODR's Acuerdo Justo platform has updated its image following a modern design respecting the maxims in the design and creation that are recognized.
The design is adaptable to the customer's needs.

It can be installed on local servers, runs on any PC system, is compatible with all modern computers and browsers.

The *framework* under which the platform is programmed, as well as the rest of modern *frameworks,* are based on the ES2015 standard of Javascript (ES6), which is the current standard of modern browsers.

The platform automates a large part of the process of registration and creation of the electronic file of the ODR process.

It applies artificial intelligence in the computer architecture necessary to raise the level of security of the identification of the parties and their electronic signatures in the mediation minutes and agreements to multi-factor [(taking it to level 2 multi-factor inspired by the European directive PSD2 which is the one they apply, for example, European banks and shops to provide greater security to their customers through

enhanced authentication which consists of asking the consumer for two of these three elements: something he has (e.g. his ID card or a bank card), something he knows (the card's PIN), or something he is (the fingerprint or the iris)].

The platform has technical support for non-users and users at two different levels of assistance that even allows video calls from the platform itself to be assisted by an expert in parallel and outside the session that the professional may be carried out synchronously.

With regard to security (the identity of the parties, confidentiality, privacy, and data protection), the platform works with encryption: (a) *secure socket layer* (SSL), (b) *transport layer security* (TLS), and (c) *hypertext transfer protocol secure (*HTTPS), which I will explain later.

Encryption or encoding is the process of making sensitive information unreadable. Once encrypted, the information can only be read by applying a key. It is a security measure that is used to store or transfer sensitive information that should not be accessible to third parties. The platform uses 128-bit SSL security certificates and/or higher, which are distinguished by having the highest encryption capacity in the industry.

Deciphering such encryption could only be done by means of brute-force calculation, which consists of entering all possible variables in a message until the correct one appears. Decoding a 128-bit key, by means of brute-force calculation, would take the attacker a minimum of 149,745,258,842,898 years (Martínez de la Torre, 2016).

1. The platform works on a *secure socket layer* (SSL), i.e. a cryptographic protocol (a set of rules to follow related to security, applying cryptography) used to make secure connections between a client (such as an Internet browser) and a server (such as a computer visiting web pages).
2. It also uses *transport layer security* (TLS), which is a protocol that provides data encryption and application authentication between client and server, and is very useful and necessary, especially when sending messages over insecure networks, such as e-mail.
3. In addition to the hypertext *transfer protocol secure (*HTTPS), which is an internet communication protocol that protects the integrity and confidentiality of user data between their computers and the website. Because users expect a secure and private online experience, the adoption of the HTTPS protocol to protect connections to web sites is the most common and is well known to all users.

Regard to data protection [in accordance with the data protection regulations of Organic Law 15/1999, replaced on 6 December 2018 by the Organic Law on the Protection of Personal Data and the guarantee of digital rights, in accordance with the European regulations of the General Regulations on Data Protection (RGPD), in force since 25 May 2016 and applicable from 25 May 2018], with the differentiation between digital and electronic signatures referring to encrypted coding (and *clickwrap)*, to the use of synchronous or asynchronous systems that can be guaranteed by certification bodies, such as, for example, the notarial online certifications currently performed, as well as services related to PKI (public key infrastructure) and time stamping (*timestamping) and* qualified electronic signatures, are issued in accordance with the requirements of Law 59/2003 of 19 December on Electronic Signatures and Law 5/2012 on Mediation] (Vázquez López 2020) the session that starts in end-to-end SSL encrypted mode.

The login part of the tool is handled with the Cisco Webex Meetings APIs. The password is passed through HTTPS with the certificate created by *LetsEncrypt* for the website, furthermore, it is not stored on the server, it is only stored in the *cookies to* refresh the *token,* thus providing a smooth platform experience for the user.

The password is sent using AES 256 encryption.

SQL database. The MySQL database table is protected with a username and password. And everything is hosted on *Google Cloud Server.* The *Compute Engine*'s control plane exposes its API via GFE, so it takes advantage of infrastructure security features such a denial of service protection (DoS) and centrally managed SSL/TLS support. Customers can obtain similar protections for applications running on their *Compute Engine* virtual machines by choosing to use the optional *Google Cloud Load Balancer* service which is based on GFE and can mitigate many types of DoS attacks.

End-user authentication to the *Compute Engine* control plane API is done through Google's centralised identity service that provides security features such as hijacking detection. Authorisation is done using the central *Cloud* IAM service.

Each virtual machine (VM) runs with an associated virtual machine manager (VMM) service instance. The infrastructure provides these services under two identities. One identity is used by the VMM service instance for its own calls and the other identity is used for the calls that the VMM makes on behalf of the customer's VM. This allows the platform to further segment the trust placed in the calls coming from the VMM.

Compute Engine persistent drives are encrypted at rest using keys protected by the central infrastructure key management system. This allows for automated rotation and central auditing of access to these keys.

The *Compute Engine* is accessed using SSH from the Google cloud platform and finally, the platform uses the traffic from the *Nginx Open Source* server to

control and filter the traffic to the server allowing only https type connections.

The ODR Acuerdo Justo platform is a native Spanish speaker, which is worth highlighting because there is no such thing as a fair agreement in the market. Already available in English, it is intuitive and designed to meet the most stringent specific ODR needs. In addition to reinforcing security in the IT environment and data protection in the digital environment, it guarantees legal certainty in accordance with the European Union's international standards of quality and regulations, from an approach that is in keeping with the intellectual, legal, ethical, and IT security that it is intended to protect.

According to the website's explanations, the ODR Fair Settlement platform will allow the operator to settle disputes:

1. Planning remote sessions from your own platform.
2. Launch the connection of conflict operators to the sessions from that platform.
3. To adapt the communication of the meeting room to the consumers in a totally personalized way and suitable for all types of mobile devices.
4. Access to the statistics and recordings of the sessions from the platform.
5. To have a collaborative environment on the platform that allows operators, with a single click, to access an expert on the ODR subject in question, via chat and video conference.
6. An Expert can add other people to the videoconference session if additional support is needed. This interface is embedded in the platform, it will not be necessary to open a new application (it is done through a *widget*).
7. The *widget* may have an associated *bot which will* allow the expert to be assigned to the user's query.
8. From the point of view of user administration, the platform will also be able to automate the management of licenses associated with users (registration, deletion, etc.).
9. Legal informatics: because it is about the application of informatics in law and not just about informatics.

Sticking to Spanish and European law we can say that the regulations on the computer and legal security are implemented in the ODR platform of Acuerdo Justo.

In other words, to the question *Can ODR processes be carried out with sufficient guarantees of computer and legal security?* the answer is: Yes, at the Acuerdo Justo ODR Platform, it is possible.

Table 4: Comparison between Zoom, Webex (videoconference), and Acuerdo Justo (ODR platform) [1]

ZOOM	WEBEX	ACUERDO JUSTO
—	Security • end-to-end encryption • data protection	Security • end-to-end encryption • data protection
—	—	Electronic file • direct access to audiences • calendar • time-stamping • recordings • record of proceedings • Statistical reports • notes
—	—	Electronic signature • level 2 multifactor
—	—	Online support • by video call within the platform • provided by specialists of recognized experience

Source: Conforti, 2020. [1] Zoom, Webex, and Acuerdo Justo ODR Platform are registered trademarks. The table has been compiled from public information and is available at Google Play Store, Apple App Store, Company Websites, *US Department of Homeland Security CISA Cyber+Infrastruture,* and *National Security Agency USA* reports, cited in the bibliography.

"*Legal, technological, intellectual, and ethical security is a necessity for citizens that we must guarantee from public and private services alike. In it, the ethics of responsibility and conversion co-exist; however, the ethics of responsibility cannot be waived, because only in this way will we achieve authentic justice.*"(Conforti 2020).

IV. Conclusion

Due to the current global circumstances, it is well known for all the reasons for being on the Internet. It is no longer a question of if you arenot on the Internet, you do not exist, but of something much deeper, such as our Democracy.

Reaching citizens through the Internet is a necessity for every State that claims to be in the vanguard.

At least this is clear from Agenda 2030 and the Sustainable Development Goals, in particular ODS 16.

Finally, I propose to take up again the reflections on the obligation of the State to provide "efficient protection". The efficient protection of people's rights does not necessarily refer to the legal system, which also refers to a much broader idea that remodels the concept of Justice by expanding it, *a priori* —but not only— to the area of consumption, which is the subject of this paper.

We speak not only of "effective judicial protection" but also of "effective guardianship", that is, the application of alternative methods of conflict resolution in various fields, such as consumer affairs.

Thus, the need arises to remodel the concept of Justice towards the new paradigm of "Open Justice". Open Justice consists of a series of mechanisms that accredit "to" and "before" the citizenry "in" and "the" fulfilment of its procedures.

The "efficiency" of the Open Justice paradigm requires a transformation that consists of moving —naturally and smoothly— from "access to Justice" to "access to The Justice". Both systems of "protection of rights" coexisting on an equal footing.

One of the greatest challenges facing the Justice system when faced with the inclusion of technology as a means of materialising both judicial and extrajudicial processes is, almost naturally, the concern for programming and applying artificial intelligence algorithms to the sector on the one hand, and intellectual, legal, ethical and computer security on the other.

The traditional arguments of cost reduction, time-saving, incorporating specialised trends, providing resources to citizens in relation to judicial protection, are still valid, however, are not the main reasons why it is advisable to use an ODR platform in the consumer field.

We must bear in mind that ODRS, among other things, seek to overcome the barrier of distance; however, we must not lose sight of the fact that identity accreditation systems and electronic and digital signature certificates are often incompatible between one state and another, which ultimately creates a problem and prevents, *a priori,* their development.

It is no less true that the potential violation of confidentiality or security is not substantially greater in the virtual mode than in the face-to-face one. Therefore, until ICTs allow us to do so, the doctrine favours a minimum regulation that enables self-regulation in these matters, making it clear that this does not mean that anything is worthwhile since as I have mentioned *ut supra,* we must take as a starting point the State's obligation to provide "efficient protection" (Vilalta 2017).

As for the application of artificial intelligence in-justice (predictive justice), there is no doubt about its value; however, we owe it to ourselves to reflect deeply on the programming of the algorithms, because it is not the same to construct them under the parameters of Chinese society as one constructed in Abu Dhabi or another based on the idiosyncrasies of Spanish society.

With regard to the issues of "confidentiality, privacy, the identity of the parties, electronic signature and data protection", it has become clear that in our legal context there is at least one platform that has overcome all the difficulties of intellectual, legal, ethical and IT security and provides a practical solution that has been in operation since 2008.

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Greenhouses Low-Cost Monitoring and Control System

By Carlos Eduardo Bastos, Miguel Grequi & Rafael Galli

Abstract- The cultivation of fruits and vegetables is a fundamental activity for a nation's economic and food sectors. However, this practice exposes the farmer to the damage caused by weather conditions or severe weather changes in the region. Thus, we observe that, when cultivation occurs organically, without the addition of fertilizers or pesticides, there's an intensification of the impacts caused to production. Mitigating this issue is possible through several technologies found on the market for the control of agricultural greenhouses since the cultivation in greenhouses provides better development of production. Although, these devices are usually inaccessible to small rural producers, damaging the family farming sector. Based on these facts, the present study aims to build a low-cost autonomous gadget for controlling and monitoring agricultural greenhouses, making this system efficient and accessible to small rural producers and encouraging the practice of organic cultivation.

Keywords: *electronic system; climate conditions; controlled cultivation.*

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Greenhouses Low-Cost Monitoring and Control System

Carlos Eduardo Bastos [α], Miguel Grequi [σ] & Rafael Galli [ρ]

Abstract- The cultivation of fruits and vegetables is a fundamental activity for a nation's economic and food sectors. However, this practice exposes the farmer to the damage caused by weather conditions or severe weather changes in the region. Thus, we observe that, when cultivation occurs organically, without the addition of fertilizers or pesticides, there's an intensification of the impacts caused to production. Mitigating this issue is possible through several technologies found on the market for the control of agricultural greenhouses since the cultivation in greenhouses provides better development of production. Although, these devices are usually inaccessible to small rural producers, damaging the family farming sector. Based on these facts, the present study aims to build a low-cost autonomous gadget for controlling and monitoring agricultural greenhouses, making this system efficient and accessible to small rural producers and encouraging the practice of organic cultivation. The device acts independently that the user, from his personal computer or smartphone, selects the type of crop to be sown, and the system acts by simulating the best possible microclimate inside the greenhouse. This simulation is possible through an array of sensors that frequently gather climatic data both inside and outside the greenhouse. After reading the sensors, the software compares the values acquired and, if necessary, executing the electric actuators' activation dedicated to modifying specific climatic properties in the greenhouse. So, simulating the microclimate for the best development of production. The device also presents the farmer, based on his climate database, alerts for specific meteorological phenomena, such as dew. Allowing both the producer and the system to prepare themselves to deal with this fact in the best possible way. The equipment is still under development, and a bench-scale prototype will be implemented for analysis purposes and will later be implemented on a pilot scale to ensure its effectiveness.

Keywords: electronic system; climate conditions; controlled cultivation.

Resumen- El cultivo de frutas y verduras es una actividad fundamental para el sector económico y alimentario de una nación. Sin embargo, esta práctica expone al agricultor a graves daños causados por las condiciones climáticas o cambios climáticos severos en la región. Así, se observa que, cuando el cultivo se da de manera orgánica, es decir, sin la adición de fertilizantes o pesticidas, se intensifican los impactos ocasionados a la producción. Para solucionar el problema es posible encontrar en el mercado varias tecnologías para el control de invernaderos agrícolas, ya que el cultivo en invernaderos proporciona un mejor desarrollo de la producción. Sin embargo, estos dispositivos suelen ser inaccesibles para los pequeños productores rurales, dañando el sector de la agricultura familiar. Con base en estos hechos, el presente estudio tiene como objetivo construir un dispositivo autónomo de bajo costo para el control y monitoreo de invernaderos agrícolas, haciendo este sistema más efectivo y accesible a los pequeños productores rurales y fomentando la práctica del cultivo orgánico. El dispositivo actúa independientemente que el usuario, desde su ordenador personal o smartphone, seleccione el tipo de cultivo a sembrar y el sistema actúa simulando el mejor microclima posible dentro del invernadero. Para ello, el dispositivo cuenta con un grupo de sensores que actúan realizando un relevamiento de datos climáticos en tiempo real tanto dentro como fuera del invernadero. Después de leer los sensores, el software compara los valores adquiridos y, si es necesario, ejecuta la activación de los actuadores eléctricos dedicados a modificar determinadas propiedades climáticas en el invernadero. Así, simulando el microclima para el mejor desarrollo de la producción. El dispositivo también presenta al agricultor, basándose en su base de datos climáticos, alertas de fenómenos meteorológicos específicos, como el rocío. De esta forma, permitir que tanto el productor como el sistema se preparen para afrontar este hecho de la mejor forma posible. El equipo aún está en desarrollo y se implementará un prototipo a escala de banco con fines de análisis y luego se implementará a escala piloto para asegurar su efectividad.

Palabras clave: sistema electrónico; condiciones climáticas; cultivo controlado.

I. Introduction

Agriculture is a crucial sector of the Brazilian economy, fundamental to the country's growth. It is an activity highly dependent on climatic factors, whose changes can affect productivity and crop management, in addition to reaching social, economic, and political factors [1].

As reported in some media ways, agriculture is an activity that is subject to losses caused by weather variations. Thus, it may cause a drop in the quality of fresh produce and, consequently, an increase in these products' prices, harming the farmer and the entire consumer population.

The potential adverse impact of climate change on Brazilian agriculture and its livelihoods is an issue on which researchers and producers have paid extraordinary attention. There is a growing concern about the hypothesis that the increase in climate variability negatively impacts agriculture, national economic growth, and related subsistences in Brazil [2].

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There are climatic changes in each region, which causes immense impacts that make cultivation difficult. Any culture suffers due to these variations, especially with the distance between provinces and factors of climate instability that we find today [3].

Considering these facts and that "[...] the ability to control the internal environment of the greenhouse makes the results better than those obtained in the open field" [4]. We developed this project to provide a control and monitoring system for agricultural greenhouses to the small agricultural sector, ensuring a better development of production and consequent reduction in the probability of losses caused by weather conditions to the producer.

The project aims to build a low-cost electronic system that will provide as much as possible the ideal climatic conditions for the cultivation of a given crop in an agricultural greenhouse, ensuring grander safety and quality of production. Through this, the user will be able to define in advance from his personal computer or smartphone the type of cultivation to be sown. Thus, the system will act by monitoring not only the internal environment of the greenhouse but also the external environment comparing the climatic properties of these environments and activating, when necessary, electric actuators inside the greenhouse to control such values.

It is necessary to note the equipment's sustainable characteristics, such as the use of solar energy to recharge the batteries, in addition to saving water used in cultivation, since the plantation will receive only the necessary. Regarding the benefits for the user, the possibility of controlling and monitoring the greenhouse from a distance stands out, which provides the producer with continuous monitoring and a less exhaustive routine since it is not necessary to travel to the production site to be aware of the climatic conditions inside the greenhouse and the drives carried out by the system.

II. Materials and Methods

At first, research was carried out on the components employed in the system. These were chosen to aim at the efficiency and accessibility of the project. Simultaneously, we researched managing horticultural products in agricultural greenhouses and how an electronic system could assist in efficient cultivation. That said, we conclude that, initially, the most relevant climatic factors to obtain the best quality of production in an agricultural greenhouse are: luminosity, the relative soil moisture, relative air humidity, and temperature. Therefore, to carry out the analysis of these parameters, it was necessary to research how to collect data from sensors [5], implement response curves, and ascertain and improve their accuracy.

a) Component search and selection

After choosing the array of sensors, we carried out an analysis of these devices. This phase took place by implementing and testing a circuit with the sensor connected to a microcontroller. This device can act sequentially or combinational, so the system operates by performing the sensor's acquisition, interpretation, and conversion of acquired data, mathematical calculation, storage, comparison, and, finally, if necessary, making a decision [6-7].

As mentioned, the electronic system, through the sensor response, performs mathematical functions to convert the sensor data into units of the sensors; that is, in analog sensors, it converts voltage levels to the corresponding sensor unit, as temperature. However, some sensors used do not have mathematical equations provided by the manufacturer. Therefore, it was necessary to carry out research and tests with these sensors in different environments and soils so that we can ensure that it is making a correct measurement. To perform such tests, we made use of a previously developed device. It is a portable electronic device that contains a programmable microcontroller to perform test steps with the sensors (Figure 1). Thus, facilitating the instrumentation process, since the device is compact, facilitates the test areas' movement. This system also saw implementation in the Substrate and Fertilizer Production from Tree Pruning project, which uses this device to carry out practical classes with students from the technical courses at IFSUL Campus Pelotas [8].

Figure 1: Portable testing electronic device

The realization of most of these studies was in conjunction with the *Production of Substrates and Organic Fertilizers from Tree Pruning for Food and Vegetables Production*, which constitutes a research center directly linked to this work.

We also conducted studies on electric actuators, devices responsible for controlling each climate property analyzed. However, due to our academic environment's financial and physical limitations, we have completed the analysis stage; that is, the system is analyzing everything precisely. Electric actuators demand their power and cost, depending on the physical space available for installation. Therefore, it would be impracticable to install the system in a full-scale greenhouse for the first tests.

b) Sensors instrumentation

Consultation of a wide theoretical basis took place to research climatic properties, establishing the reasons for the contemplated aspects of examination of similar works available through technical reports issued by renowned universities in the country. Thus, the project's theoretical framework has information on variations in weather, climate analysis, irrigation, light, air humidity, ventilation, and temperature. From the theoretical knowledge obtained, the sensors' research phase was initiated, carried out to select the best electronic components to be used in the project. Besides, concepts about the climate were studied, making their practical application in our institution's research laboratories.

With the portable device used to perform tests, we started to examine the relative soil moisture sensor. Based on our research, we have not successfully found an affordable and efficient soil moisture sensor. Therefore, we innovated a conventional sensor that consists of a skewer to measure the soil's electrical conductivity, and that has no equation on the part of the manufacturer. Therefore, we researched the sensor's behavior in a chemistry laboratory in conjunction with the project *Production of Substrates and Fertilizers from Tree Pruning*. Tests were carried out with several types of organic substrates in conjunction with the sensor to discover its different voltage levels and collect as much information as possible to complete this device's mathematical function. For that way, we try to validate a conventional sensor and access to efficient gear for the system.

Next, we examined the Light Dependent Resistor (LDR) brightness sensor. A plant's growth through artificial lighting shows the best result when it receives the correct incidence of a photoperiod [9]. Such phenomena demonstrate that a conventional luminosity sensor such as LDR is necessary due to its practicality of use and its low cost. Although the device has an equation corresponding to its response curve, we couldn't find information on lux analysis applications in the instructional text. The standardization of luminosity measurements is quite complicated due to the lack of a widely accepted measurement system [10]. Given this finding, we sought to develop an LDR device that would meet the minimum precision needs. The LDR has the response curve as a logarithm function (Figure 2); thus, by extracting the appropriate mathematical equations for each interval for calculating the sensor, we were able to analyze this graph.

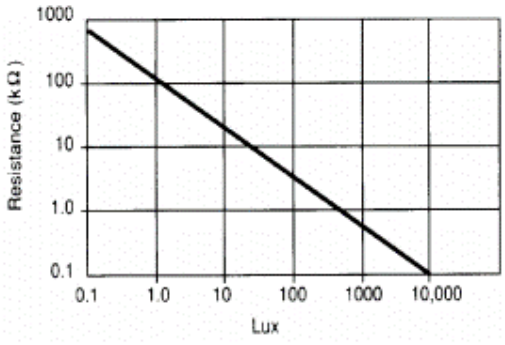

Figure 2: Brightness vs. resistance graph

With the standardization of these measures, we tested the device with a certified professional luximeter. Our system presented a minimal deviation concerning the other device, which is very satisfactory considering that the relevant factor, as mentioned, is the photoperiod in which the plant is subject to, and not the amount of incident lux.

The temperature sensor used was the LM35. This component comprises temperatures up to 150 ^{o}C, with each variation of 1 ^{o}C in its condition, causing a 10mV variation in its output (Figure 3). Also, it has meticulous behavior for the application of our system, making it unnecessary to carry out advanced examinations with the equipment.

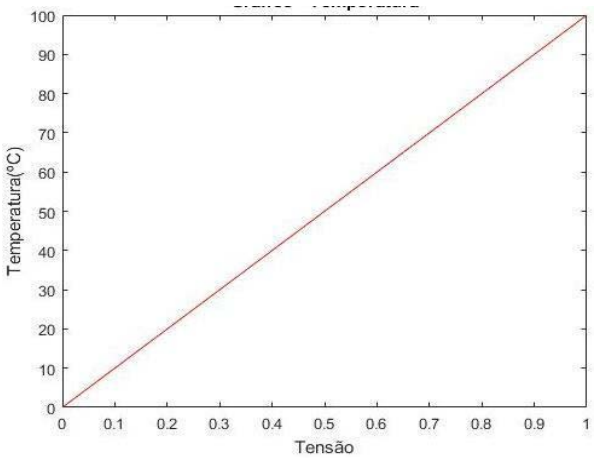

Figure 3: Temperature vs. sensor output voltage graph (LM35)

The sensor designed to acquire the relative humidity is the HIH4000. This sensor also has a

desirable precision for the project and was tested based on our city's climatic comparisons. Where he presented a very satisfactory result, and his response curve, available in his datasheet, can be seen in figure 4.

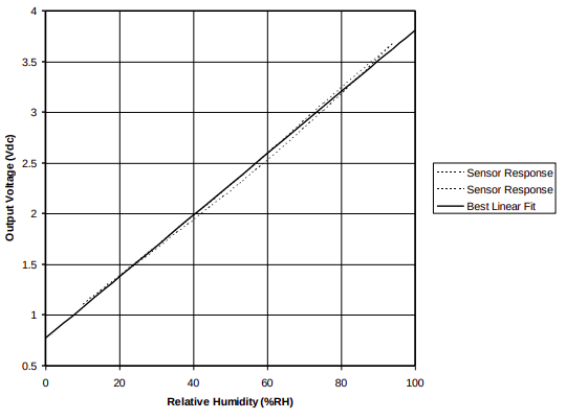

Figure 4: Relative humidity sensor response curve (HIH4000)

The relative soil moisture sensor has not yet shown satisfying behavior and is still under analysis. It is also estimated to carry out several long-term tests with different types of soil and cultivation to carry out the proper calibration of this apparatus.

c) Hardware and software development

After the instrumentation of the sensors, the hardware and software design phase begins. A system was devised, predicting the construction of independent monitoring and control modules. Control of each module happens through an ESP32, which will analyze a small-scale greenhouse or its corresponding area in a large-scale greenhouse. Based on the data gathered and on previous instructions of a master personal computer or smartphone, the module will activate the electric actuators, if necessary, to control specific climatic properties mentioned elsewhere.

Thus, the monitoring and control module consists of a compact and easy to implement device to allow easy installation in any structure of an agricultural greenhouse. This device contains all the prior sensors and will perform all the acquisition of climatic data inside the greenhouse. Specifically, an independent module will perform the climactic analysis of the external environment. Allowing the insertion of modules according to the producer's physical structure, that is, separate modules where each one will control a small greenhouse, or several modules, each being responsible for the analysis of a specific area of a large greenhouse.

After carrying out each analysis cycle and executing the necessary activations, this information, both from the external environment module and from the greenhouses' interior, is sent to a central, where the farmer can view these data and know the internal state of the greenhouse. The plant is still in development. It is estimated, initially, to create a software to carry out wireless communication with the modules for both Windows and Android platforms; that is, the producer will be able to monitor the progress of his production using his personal computer or smartphone. The physical standard of communication is still under study, and as mentioned, there will be the implementation of wireless communication, where this could be Wifi, Bluetooth LE, or ZigBee.

For the software development of the modules, we used the Arduino IDE, formulating specific functions for the various tasks implicit in the system. Initially, to perform the sensors' analysis, each directive is assigned to the sensors containing the entire procedure to deal with the physical pattern of the sensor, interpret, convert, and store the requested data according to the calibrations performed previously. Soon after, we developed procedures to compare the sensor data with the external environment and with the instructions coming from the control panel to activate the electric actuators when necessary [11].

For the system's central software, we conceived an interface where the farmer could start the cultivation, select the type of culture, visualize in real-time the data of the monitoring and control modules, and also receive alerts about specific climatic phenomena such as dew.

d) Prototype development

Execution of the system's first tests will take place in a small greenhouse, where the necessary actuators are easily accessible. Thus, in this greenhouse, it will already be possible to ascertain the system's behavior and have a database of the first errors present. (Figure 5).

Figure 5: Small testing greenhouse

At first, this prototype consists of a bench greenhouse, which contains a monitoring and control module with the appropriate electric actuators to perform the drives. Later, more greenhouses of the same scale, and more modules will be implemented to carry out wireless communication tests.

The structure will initially have a group of electric actuators to control the climatic properties mentioned

elsewhere. The system's ventilation system will be activated at each determined time interval to replace the greenhouse's indoor air. The heating system consists of an electric heater connected to a fan. With cooling activation done by a thermoelectric chip connected to a fan, and irrigation acting through the use of the sprinkling technique [12] composed of humidifying sponges linked to a fan. It is worth mentioning that an irrigation system that consumes little water and that acts efficiently is essential in production to generate benefits for the producer and the environment [13].

With the apparatus built, it is estimated to carry out long-term tests by sowing and cultivating different types of crops and analyzing the system's behavior in distinctive circumstances, such as rainy, humid, hot, and cold days. Simultaneously, we intend to produce the same crop in an open field and a greenhouse of the same scale without implementing the system, so at the end of the experiment, we will have a database of crops produced in the open field, in a conventional agricultural greenhouse, and an autonomously controlled greenhouse.

III. Results and Discussions

Because the project is still in the development stage, it has not yet been possible to test it in a real application. However, we already devised tests and selected the site. This space consists of a rural property in the family farming sector, where the producer has homemade greenhouses for the organic cultivation of fruit and vegetables. In this structure, certain fruits will be grown with different substrates, which were produced with compost in a partner project in the core of governmental, agricultural works. This way, it will be possible to evaluate the project's effectiveness in the field and on a real scale. However, the instrumentation phase of the sensors, hardware, and software development and the theoretical framework addressed to ensure an autonomous electronic system's efficiency for analyzing and controlling agricultural greenhouses. Logically, the smaller the area of a greenhouse for control and monitoring, the lower the cost of operating and installing the system.

IV. Conclusion

The project is still under development, and many steps must be completed to, in fact, fully evaluate its efficiency in a real application. We should note that some improvements have already been observed, such as the implementation of more sensors and electric actuators to expand the system's monitoring and control capabilities. Simultaneously, it is estimated to carry out studies on other factors relevant to cultivation, such as soil pH. Following envisioning an efficient and sustainable apparatus, we plan on studying and developing an adjunct system for capturing solar energy and recharging a battery bank, making the system self-sustainable and accessible to rural properties where electrical connection isn't present to the structure of the agricultural greenhouse. The variety of expansion and application of the project is immense. The studies carried out in the current work ensure the central idea that a low-cost electronic system can autonomously monitor and control an agricultural greenhouse, guaranteeing a better development of production and a less exhaustive work routine for the farmer. It is possible to conclude that controlled cultivation in greenhouses solves weather conditions and provides the farmer and the population with a better quality product [14].

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Improvement of Power Supply at Igbo-Etche Rumoukwurusi Area of Port Harcourt, Rivers State using Dynamic Voltage Restorer (DVR) Method

By Igbinake Osakpamwan, Sepiribo Lucky Braide & Dikio Idoniboyeobu
Rivers State University

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Keywords: power supply, loads, load evaluation, improved performance, igbo-etche rumoukwurusi, port harcourt.

GJRE-F Classification: FOR Code: 090699

Strictly as per the compliance and regulations of:

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I. Introduction

a) Background of the Study

The problem of electricity supply in Nigeria by the Nigerian power sector is as a result of its inability to provide adequate electricity supply to domestic household and industrial producers despite a rapidly growing economy, irrespective of the country's large deposit of natural resources which can be harness and utilize for power generation. This deficiency has adverse effect on agricultural and industrial development which in turns impedes Nigeria's ongoing economic growth.

Power generation and distribution have continue to be problematic in Nigeria for decades in spite of efforts by successive government to improve supply and boost access to energy in Africa's most populous country and ensure viability of investment in the optimum benefits of electricity supply either for domestic usage or industrial production, as a result most households and businesses are left with no choice than to run fueled generators to supplement the intermittent supply which in turns brings about rise in cost of production (Ewald &Mohammad, 2008).

Electrical Power Quality is the degree of any deviation from the nominal values of the voltage magnitude and frequency. Power Quality problems concerning frequency deviation and voltage magnitude deviation is as a result of the presence of harmonics and voltage fluctuations. Other voltage problems are the voltage sags, short interruptions and transient over voltages. The power quality issues such as voltage sags, swells, harmonics, transients and their mitigation techniques that are suitable for different types of voltage sags, filter deign for reducing harmonic distortion and surge arrester sizing for location of transients (Madrigal&Acha,2000).

Any interruption of the power quality would cost the efficiency of the system. In most of the cases, control of the power quality refers to the control of the voltage only. This is because in most cases voltage can be controlled more easily than current. More specifically, the quality of power can be described by some parameters such as continuity of service, variation in voltage magnitude, transient voltages and currents, harmonic content (for AC) etc..To describe the importance of power quality issues, we can say that poor power quality leads to unnecessary wastage of power and economy. It creates financial burden on the suppliers and consumers. Unstable voltage and frequency often creates disturbance in the power flow through transmission line (Pohjanheimo &Lakervi, 2000).

b) Statement of the Problem

The increasing emphasis on all power system has resulted in continued growth in the application of devices such as high efficiency adjustable speed motor drives and shunt capacitors for power factor correction, to reduce losses, resulting in increasing harmonic levels in power systems. The end users have an increased awareness of power quality issues which has led to the following:

1. Voltage fluctuation due to over/under voltage flickering of lightning causes load switching.

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2. Voltage sag due overloading problems, intermittent lock-up causes faults in the system excessive network loading and source voltage variation.
3. Voltage swell due to data loss, damage of equipments causes start/start of heavy loads, inrush current and inadequate wiring.
4. Long time voltage interruption due to malfunction in data processing equipment causes failure of protection devices and insulation failures or control malfunction.

c) Aim of the Study

The research is aimed at Improving the Power Supply at Igbo-Etche Rumoukwurusi Area of Port Harcourt, Rivers State using Dynamic Voltage Restorer (DVR) method.

d) Objective of the Study

The objectives of this research work are:

1. To investigate the suitable mitigation techniques used to improved the power supply using Dynamic Voltage Restorer (DVR) method by determining the following factors:
   a. The capacitive power of the network.
   b. The % reduction in power loss of the network
   c. The cable cross-section of the network
   d. The compensation of the network
   e. The losses in the distribution system of the network
   f. The reduction of voltage drop of the network
   g. The faults behind the transformer of the network
2. Prepare the single-line diagram using Electrical Transient and Analysis Program Software (ETAP version 12.6) use in analyzing the possible solutions to improved power supply.

e) Scope of the Study

The scope of this research work shall be limited to 33kV distribution network in Igbo-Etche Rumoukwurusi area of Port Harcourt, and to find a suitable technical solution to the factors that has adversely affected the reliability and quality of power supply to the distribution system. The scope of this research is limited to areas covered by power supply system at Igbo-Etche Rumoukwurusi Township 33KV distribution network, Rivers State. The study focuses on the Bus input and line input data as well as the power supply capacity of the distribution transformer rating in the Network. The capacity condition on the distribution transformers are needed by the Elelenwo Substation in charge of electrical power distribution in the study zone

f) Significant of the Study

The Significance of the research work are as follows:

1. To investigate the mentioned power quality problems.
2. How they can be mitigated with the custom power device introduced.
3. More details about the mitigation device would also be given, in terms of their composition and design; and also how they will be configured in an electrical system.

II. Literature Review

a) Power Quality Production

Power quality is anything that affects the voltage, current and frequency of power being supplied to the customers. Constant voltage is the prime requirement of the customer because if the voltage is lower than the tolerable limits it will cause over heating of the equipment and less illuminating power to the lighting load. If it is higher than the limit it cause material insulation break down, reduces the life of lighting load etc. Lightening (transient over voltages), switching over voltages (i.e capacitor switching, disconnection of lines), short circuit faults (such as voltage sags) and short interruptions are the main causes for voltage deviations which lead to permanent damage of the equipments. Power system frequency is related to the balance between power generation and the load(Ray, 2001). When this balance changes, small change in frequency occurs. The frequency variations that go beyond acceptable limits for normal steady state operation of power system are normally caused by fault on the transmission lines, large portion of load being disconnected, or a large source of generation being isolated. Drop in frequency could result high magnetizing currents in induction motors and transformers, causing problem of overheating and saturation. Off nominal frequency will cause damage to turbine and generator due to high vibration of turbine blades which causes protection to trip out. Therefore it is essential requirement to maintain frequency of the system within the tolerable limits.

As stated by Wang & Mamishev, (2003), nowadays due to more sensitive nature of loads use of custom power devices/custom controllers (electronics based) to maintain power quality has become essential. As custom power controllers are used for current interruptions and voltage regulations, their utilization in the industry saves its equipments from voltage sags and interruptions which lead to loss of production (Madrigal, & Acha, 2000).

b) Protective Devices

Power systems contain protective devices to prevent injury or damage during failures. The quintessential protective device is the fuse. When the current through a fuse exceeds a certain threshold, the fuse element melts, producing an arc across the resulting gap that is then extinguished, interrupting the circuit. Given that fuses can be built as the weak point of a system, fuses are ideal for protecting circuitry from

damage. Fuses however have two problems: First, after they have functioned, fuses must be replaced as they cannot be reset. This can prove inconvenient if the fuse is at a remote site or a spare fuse is not on hand. And second, fuses are typically inadequate as the sole safety device in most power systems as they allow current flows well in excess of that that would prove lethal to a human or animal (Acha, Agelidis, Anaya-Lara,& Miller, 2001).

c) Power Generation Companies in Nigeria

S/N	Power station	Location	Source	Capacity
1	Kainji power station	Niger	Hydropower	760MW
2	Jebba Power station	Niger	Hydro power	576.8MW
3	Shiroro Power station	Niger	Hydro power	600MW
4	Egbin Power Plant	Lagos	Gas Steam	1320MW
5	Sapele Power station	Delta	Gas Steam	1020MW
6	Trancorp Ughelli Power Station	Delta	Gas Steam	972MW
7	Afam I-V Power Plant	Rivers	Gas Turbine	977MW
8	Geregu I power station	Kogi	Gas Turbine	414MW
9	Omotosho I power station	Ondo	Gas turbine	335MW
10	Papalanto (Olorunsogo) power station	Ogun	Gas turbine	335MW
11	Kwale Okpai power station	Delta	Gas turbine	480MW
12	Afam VI	Rivers	Gas turbine	642MW
13	Ibom Power Station	Akwa Ibom	Gas turbine	190MW
14	AES Barge	Lagos	Gas turbine	270MW
15	Omoku Power plant	Rivers	Gas turbine	150MW
16	Trans-Amadi Power plant	Rivers	Gas turbine	136MW
17	Rivers Power plant	Rivers	Gas turbine	180MW
18	Aba power generator	Abia	Gas turbine	140MW
19	Geregu II power plant	Kogi	Gas turbine	434MW
20	Sapele power station	Delta	Gas turbine	450MW
21	Olorunsogo power plant	Ogun	Gas turbine	675MW
22	Egbema power generator	Imo	Gas turbine	338MW
23	Calabar power station	Cross river	Gas turbine	561MW
24	Ihovbor power station	Edo	Gas turbine	450MW
25	Azura power plant	Edo	Gas turbine	450MW

d) Overhead Transmission

High voltage overhead conductors are not covered by insulation. The conductor material is nearly always an aluminum alloy, made into several strands and possibly reinforced with steel strands. Copper was sometimes used for overhead transmission, but aluminum is lighter, yields only marginally reduced performance and costs much less. Overhead conductors are a commodity supplied by several companies worldwide. Improved conductor material and shapes are regularly used to allow increased capacity and modernize transmission circuits. Conductor sizes range from 12 mm^2 to 750mm^2 with varying resistance and current-carrying capacity. Thicker wires would lead to a relatively small increase in capacity due to the skin effect (which causes most of the current to flow close to the surface of the wire). Because of this current limitation, multiple parallel cables (called bundle conductors) are used when higher capacity is needed. Bundle conductors are also used at high voltages to reduce energy loss caused by corona discharge.

Today, transmission level voltages are usually considered to be 132 kV and above. Lower voltages, such as 66 kV and 33 kV, are usually considered sub-transmission voltages, but are occasionally used on long lines with light loads. Voltages less than 33 kV are usually used for distribution. Voltages above 765 kV are considered extra high voltage and require different designs compared to equipment used at lower voltages (Guarnieri, 2013).

Since overhead transmission wires depend on air for insulation, the design of these lines requires minimum clearances to be observed to maintain safety. Adverse weather conditions, such as high wind and low temperatures, can lead to power outages. Wind speeds as low as 23 knots (43 km/h) can permit conductors to encroach operating clearances, resulting in a flashover and loss of supply. Oscillatory motion of the physical line can be termed gallop or flutter depending on the frequency and amplitude of oscillation.

e) Voltage Sag

IEEE definition of voltage sag is sudden and short duration reduction in RMS value of the voltage at the point of electrical system between 0.1 to 0.9 Pu with duration from 0.5 cycles to 1 minute. The amplitude of voltage sag is the remaining value of the voltage during sag. Voltage sags are considered the most severe

disturbances to industrial equipment (Acha et al., 2001). In case of semiconductor industry, voltage sag of 75% (of the nominal voltage) with duration shorter than 100ms results in material loss in the range of thousands of U.S dollars (Wang& Mamishev, 2003).

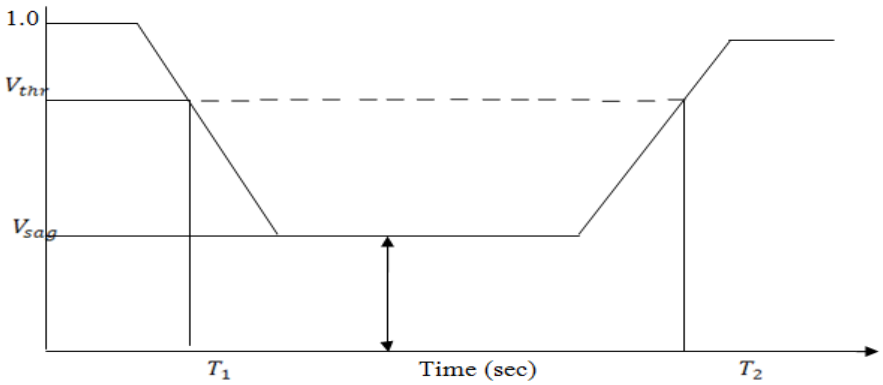

Figure 2.1: Voltage sag

Figure 2.1 shows an rms representation of the voltage sag; sag starts when the voltage falls below the threshold voltage V_{thr} (0.9 Pu) at T_1. Sag continues to T_2 at which the voltage reaches to a value above the threshold value. Duration of the sag is $(T_2 - T_1)$ and its magnitude is V_{sag}.

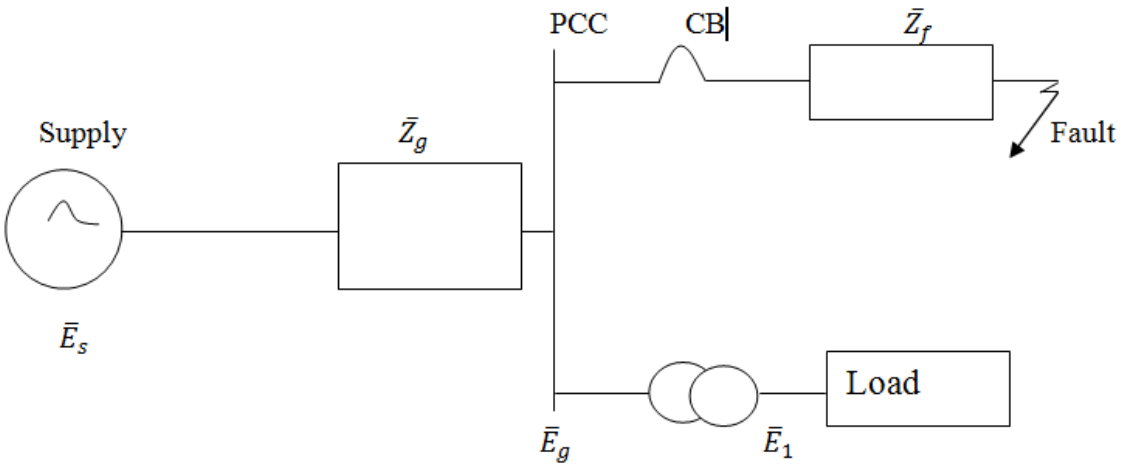

Figure 2.2: Faults on parallel feeder causing voltage sag

Voltage divider model as shown in figure 2.2, is used for the calculation of voltage sag magnitude in case of sag due faults at the point of common coupling (PCC) in the radial system.

III. Materials and Methods

This chapter explained the various procedures and techniques adopted in carrying out this research work.

a) Materials Used in the Analysis

1. Injection transformer
2. Harmonic/Passive filter
3. Storage devices/Energy storage systems
4. Voltage source converter
5. DC charging set
6. Nominal rating of distribution transformers.
7. Electrical Transient and Analysis Program (ETAP Version 12.6)
8. Igbo-Etche Rumoukwurusi Road load data from Port Harcourt Electricity Distribution Total Energy Limited (PHED).
9. Igbo-Etche Rumoukwurusi Road Distribution Network single line diagram

b) Description of Igbo-EtcheRumoukwurusi Road 33kV Distribution Network

The Igbo-Etche Rumoukwurusi distribution network is fed by Elelenwo Substation (132KV/33KV), the substation consists of two 60MVA transformers (2 x 60MVA transformer).

The substation is fed by Afam 132KV power line from Afam generation station, Afam, Rivers state. Presently only one of the two 60MVA transformer is in use while the other one is on SOAK, which is powered without being loaded.

The 132KV/33KV substation station has six feeders viz:

1. Onne Feeder
2. Bori Feeder
3. RST Feeder
4. Timber Feeder
5. Igbo-Etchee Feeder
6. Old Oyigbo Feeder

Two sets of incoming 132KV power lines from Afam Power Generation Station are fed through the Red, Yellow and Blue Jumper Drop into the Isolator – circuit breaker Isolator combination which is then transferred into the Main Bus. The power from the main bus is fed into a 60MVA transformer which steps the voltage to 33KV. The power is then fed into 33KV bus from which six different load feeders tap.

In the process the surge impedance loading of 132KV and 33KV lines was calculated and it was use to estimate the maximum power that can be transfer by the transmission line.

Starting from the generating station to the end users, voltage is needed to be stepped up and down several times in various substations, this ensures efficient transmission of power and minimizes the power losses.

At the substation, power factor is corrected and voltage is stepped down to 33KV which is then transferred to the distribution system (feeders). (TCN 2019).

c) *Operating Principle of Dynamic Voltage Restorer method (DVR)*

The single phase DVR is employed for low power loads while three phase DVR is employed for all practical high power applications as in industrial loads and domestic loads. The basic function of the DVR is to inject a dynamically controlled voltage VDVR generated by a force commutated converter in series to the bus voltage by means of a boost transformer. The momentary amplitudes of the three injected phase voltages are controlled such as to eliminate any detrimental effects of a bus fault to the load voltage V_L. This means that any differential voltages caused by transient disturbances in the ac feeder will be compensated by an equivalent voltage generated by the converter and injected on the medium voltage level through the boost transformer. The DVR works independently of the type of fault or any event that happens in the system, provided that the whole system remains connected to the supply grid, i.e. the line breaker does not trip. For most practical cases, a more economical design can be achieved by only compensating the positive and negative sequence components of the voltage disturbance seen at the input of the DVR. This option is reasonable because for a typical distribution bus configuration, the zero sequence part of a disturbance will not pass through the step down transformer because of infinite impedance for this component. The DVR has two modes of operation which are: standby mode and boost mode. In standby mode(VDVR=0), the boost transformer's low voltage winding is shorted through the converter. No switching of semiconductors occurs in this mode of operation, because the individual converter legs are triggered such as to establish a short-circuit path for the transformer connection. Therefore, only the comparatively low conduction losses of the semiconductors in this current loop contribute to the losses. The DVR will be most of the time in this mode. In boost mode(VDVR>0), the DVR is injecting a compensation voltage through the booster transformer due to a detection of supply voltage disturbance.

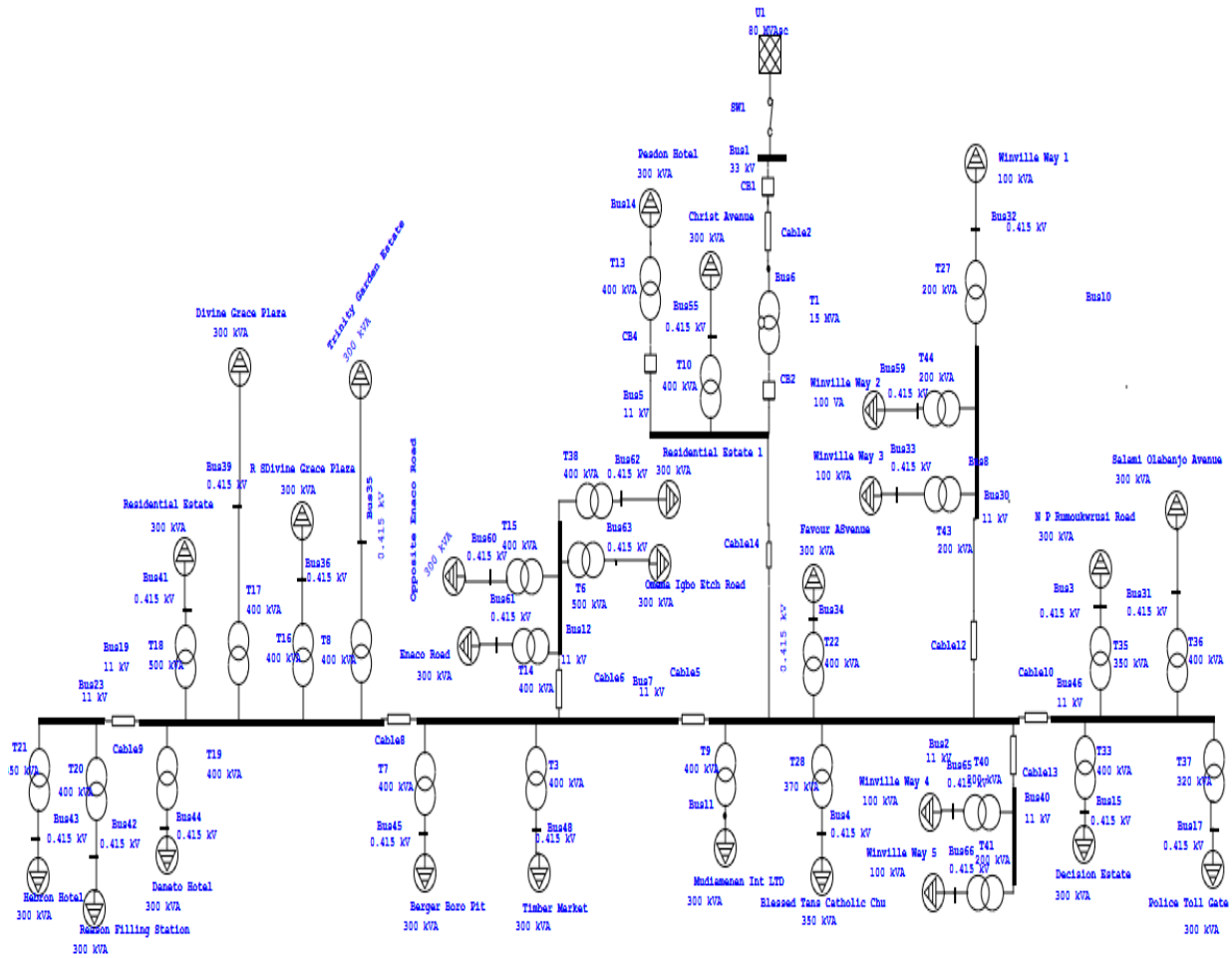

Figure 3.1: Single Line Diagram ofpower supply at Igbo-Etche Rumoukwurusi Area of Port Harcourt, Distribution Network

d) Case Study of Different Feeder

Scenario 1: To Determine the Capacitive Power of the Network

A load has an effective power of P = 4250kW at 415V and the power factor is to be compensated from cos φ_1 = 0.84 to cos φ_2 = 0.91.

The capacitive power can be determinate when the power and current before and after compensation is required:

The power and current before compensation are:

$$S_1 = \frac{P}{Cos\varphi_1} = \frac{4250kW}{0.84} = 5059.52kVA$$

$$I_1 = \frac{S_1}{\sqrt{3}.U_n} = \frac{5059.52kVA}{\sqrt{3}\times 415} = 7.04\ A$$

The power and current after compensation are:

$$S_2 = \frac{P}{Cos\varphi_2} = \frac{4250kW}{0.91} = 4670.33kVA$$

$$I_2 = \frac{S_2}{\sqrt{3}.U_n} = \frac{4670.33kVA}{\sqrt{3}\times 415} = 6.50\ A$$

Therefore, the capacitive power is calculated as:

$$Q_c = P(\tan\varphi_2 - \tan\varphi_1)$$

$$= 4250\ (tan\ 0.91 - tan\ 0.84)$$

$$= 4250kW\ (0.016 - 0.015) = 4.25kVar$$

Where:

P = Effective power

pf = Power factor is to be compensated from cos φ_1 = 0.84 to cos φ_2 = 0.91.

S_1 = Power before compensation

I_1 = current before compensation

S_2 = Power before compensation

I_2 = current before compensation

$Cos\varphi_1$ = Before power factor

$cos\varphi_2$ = After power factor

Q_c =Capacitive power

Scenario 2: To Determine the % Reduction in Power Loss of the Network

% Reduction in power loss

$$= \left(1 - \left[\frac{Before\ \ Power\ \ Factor}{After\ \ Power\ \ Factor}\right]^2\right) \times 100$$

$$= \left(1 - \left[\frac{0.84}{0.91}\right]^2\right) \times 100$$

$$= (1 - 0.8521) \times 100$$

$$= 0.148 \times 100 = 14.8$$

Scenario 3: To Determine the Cable Cross-Section of the Network

A three phase power of 4250kW, with U_n = 415V, at 50 H_Z is to be transmitted over a cable 80m in length, the voltage drop must not exceed 4% = 16.6V. The power factor is to be increased from cosφ_1 = 0.84 tocosφ_2 = 0.91.

$$P = \sqrt{3}.U_n I\, cos\varphi$$

Where:

P = Effective Power
U_n = Rated Voltage
F- Frequency
I_1 =Current consumption before compensation
I_2 =current consumption after compensation
$cos\varphi$ = Power factor

The current consumption before compensation is:

$$I_1 = \frac{P}{\sqrt{3}.U_n cos\,\varphi_1} = \frac{4250\,kW}{\sqrt{3} \times 415 \times 0.84} = 7.04A$$

The current consumption after compensation is:

$$I_2 = \frac{P}{\sqrt{3}.U_n cos\,\varphi_2} = \frac{4250\,kW}{\sqrt{3} \times 415 \times 0.91} = 6.49A$$

The effective resistance per unit length before compensation for 7.04 A is

$$(R_L cos\varphi + X_L sin\varphi) = \frac{\Delta U_n}{\sqrt{3}}$$

$$= \frac{16.6V}{\sqrt{3} \times 7.04A \times 0.08km} = 16.94\Omega/\text{km}$$

The effective resistance per unit length after compensation for 6.49 A is

$$(R_L cos\varphi + X_L sin\varphi) = \frac{\Delta U_n}{\sqrt{3}}$$

$$= \frac{16.6V}{\sqrt{3} \times 6.49A \times 0.08km} = 18.44\Omega/\text{km}$$

e) Voltage Divider Model

Voltage divider model is used for the calculation of voltage sag magnitude in case of sag due faults at the point of common coupling (PCC) in the radial system. In this case voltage $\overline{E_g}$ during fault can be expressed as;

$$\left|\overline{E_g}\right| = \frac{|\overline{Z_f}|}{|\overline{Z_g}| + |\overline{Z_f}|} |\overline{E_s}| \quad (3.1)$$

Where:

$\overline{Z_g}$ is the impedance of the grid
$\overline{Z_f}$ is the impedance between the PCC and the fault including fault and line impedances
$\overline{E_s}$ is the supply voltage

Voltage sag is also related to the changes in voltage phase angle. This change in phase angle is also called as phase angle jump (i.e the phase angle between during sag and pre-sag voltages) and is obtained by taking argument of the complex of voltage E_g.

Assuming the load voltage and current in pre-fault conditions equal to 1 Pu, the injected power by the device during voltage sag mitigation is equal to

$$\overline{S_{inj}} = \overline{E_c}\,\overline{I_1^*} = \left(\overline{E_c} - \overline{E_{g,sag}}\right)\overline{I_1^*} = \left(1 - \overline{E_{g,sag}}\, e^{j\emptyset}\right)e^{j\varphi} \quad (3.2)$$

The Euler identity can be written as $e^{j\varphi} = cos\varphi + jsin\varphi$, applying to (3.2) we get

$$\overline{S_{inj}} = cos\varphi + jsin\varphi - E_{g,sag}(\varphi + \emptyset) - jE_{g,sag}\, Sin\,(\varphi + \emptyset)$$

$$\overline{S_{inj}} = \left(Cos\emptyset - (\varphi + \emptyset)\right) + j\left(Sin\emptyset - E_{g,sag} Sin(\varphi + \emptyset)\right) \quad (3.3)$$

Power absorbed by the load will be given by

$$\overline{S_{load}} = P_{load} + JQ_{load} = \bar{E}_1 \bar{I}_1 = e^{j\varphi} = Cos\,\varphi + jSin\,\varphi \quad (3.4)$$

Therefore, active and reactive power injected by DVR are given by

$$P_{inj} = \left[1 - \frac{E_{g,sag}\, Cos\,(\emptyset + \varphi)}{Cos\,\varphi}\right] P_{load} \quad (3.5)$$

$$P_{inj} = \left[1 - \frac{E_{g,sag}\, Cos\,(\emptyset + \varphi)}{Cos\,\varphi}\right] P_{load} \quad (3.6)$$

The purpose of showing equations (3.5) and (3.6) is to show the dependency of active and reactive power injection by DVR on certain factors. These equations show that these powers depends on sag depth, phase angle jump, load angle and load active and reactive powers.

f) Voltage Controller

In this section the outer loop proportional voltage controller will be derived. Some basic assumptions before deriving is that the injected voltage is equal to the voltage across the capacitors of the VSC output filter, i.e. the injection transformer is considered ideal with a 1:1 turn ratio, therefore

$$e_{inj,a}(t) = e_{c,a}(t) \quad (3.7)$$

$$i_{inj,a}(t) = i_{g,a}(t) \quad (3.8)$$

and is the same for other two phases

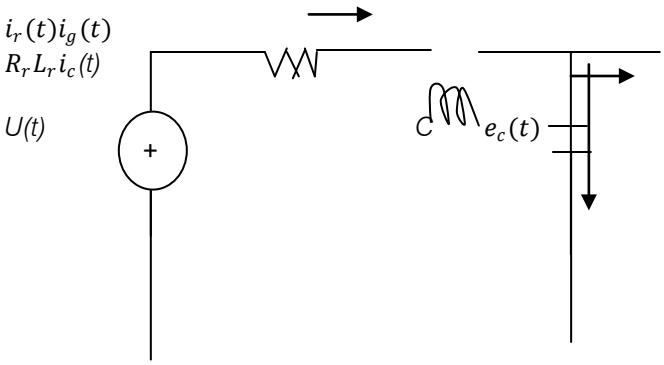

Figure 3.2: Single line View of LC filter and ideal VSC

Now by applying Kirchhoff's Current Law to the LC filter in figure 3.3, we get the following differential equations in 3- phase.

$$i_{r,a}(t) = i_{c,a}(t) + i_{g,a}(t) = C\frac{d}{dt}e_{c,a}(t) + i_{g,a}(t) \quad (3.9)$$

$$i_{r,b}(t) = i_{c,b}(t) + i_{g,b}(t) = C\frac{d}{dt}e_{c,b}(t) + i_{g,b}(t) \quad (3.10)$$

$$i_{r,c}(t) = i_{c,c}(t) + i_{g,c}(t) = C\frac{d}{dt}e_{c,c}(t) + i_{g,c}(t) \quad (3.11)$$

By applying Clarke's transformation we can transform these 3-phase equations (3.9), (3.10) and (3.11) into 2-phase ***αβ−coordinate System*** without any loss of information. Only off course under the assumption that there is no zero sequence component.

$$\frac{d}{dt}e_c^{\alpha\beta}(t) = \frac{1}{C}i_r^{\alpha\beta}(t) - \frac{1}{C}i_g^{\alpha\beta}(t) \quad (3.12)$$

With a PLL synchronized with the grid voltage vector we can transform from ***αβ*** *to dq* coordinate system, which will give us the dc values in steady state andthus easier to implement a control system. This is the basic tool of vector control.

$$\frac{d}{dt}e_c^{dq}(t) + jwe_c^{dq}(t) = \frac{1}{C}i_r^{dq}(t) - \frac{1}{C}i_g^{dq}(t) \quad (3.13)$$

$$\frac{d}{dt}e_c^{dq}(t) = \frac{1}{C}i_r^{dq}(t) - \frac{1}{C}i_g^{dq}(t) - jwe_c^{dq}(t) \quad (3.14)$$

$$i_r^{dq}(t) - C\frac{d}{dt}e_c^{dq}(t) + i_g^{dq}(t) + jwe_c^{dq}(t) \quad (3.15)$$

Now taking Laplace transform of equation (3.15) and removing the cross coupling '$jwe_c^{dq}(t)$'and the feed forward' $i_g^{dq}(t)$'terms because they can be added later, we can have an expressionto be used for voltage controller.

$$i_r^{dq}(s) = sCe_c^{dq}(t) \quad (3.16)$$

We get the equation (3.16) that is the plant for which we want to design a controller. As the plant is a first order system, so we will use first order Low Pass Filter (LPF) response for the design of the voltage controller.

g) An unbalanced 3-phase system

An unbalanced 3-phase system consists of positive, negative, and zero sequence fundamental and harmonic components. The system voltage can be expressed as in equation (3.17):

$$V_s(t) = V_{s+}(t) + V_{s-}(t) + V_{s0}(t) + \sum V_{sh}(t) \quad (3.17)$$

Here subscripts $+$, $-$, and 0 represent positive, negativeand zero sequence components respectively. The seriesconverter compensates for the following components ofvoltage:

$$V_o(t) = V_L(t) - V_s(t) \quad (3.18)$$

Control system automatically controls the series converter so that the output converter voltage is V0(t). The nonlinear load current (equation (3.9)) with distortion can be expressed as:

$$I_L(t) = I_{L+}(t) + I_{L-}(t) + I_{L0}(t) + \sum I_{Ih}(t) \quad (3.19)$$

The shunt converter provides compensation of the load harmonic currents to reduce voltage distortion. Output current with harmonic, negative and zero sequence currents controls the shunt converter so that load current distortions can be nullified. The current component which is compensated by the shunt converter is given by equation (3.20),

$$I_0(t) = I_L(t) - I_S(t) \quad (3.20)$$

Equation (3.18) and equation (3.20) establish the basic principles of an ideal Unified Power Quality Controller (UPQC).

h) Determination of power and current after compensation

The power and current after compensation are:

$$S_2 = \frac{P}{Cos\varphi_2} \quad (3.21)$$

$$I_2 = \frac{S_2}{\sqrt{3}.U_n} \quad (3.22)$$

The required capacitive power is:

$$Q_c = P(\tan\varphi_2 - \tan\varphi_1) \quad (3.23)$$

where;

P = effective power
pf =power factor is to be compensated
S_1 = power before compensation
I_1 = current before compensation
S_2 = power before compensation
I_2 = current before compensation
$Cos\varphi_1$ = Before power factor
$cos\varphi_2$ = After power factor
Q_c =capacitive power

% Reduction in power loss =

$$\left(1 - \left[\frac{Before\ \ Power\ \ Factor}{After\ \ Powe\ r\ Factor}\right]^2\right) \times 100 \quad (3.24)$$

Determination of cable cross-section

A three phase power is given with in respect of the rated voltage, frequency is to be transmitted over a cable with different length, the voltage drop is given and must not exceed some percentage level. The power factor is to be increased between the existing pf and improved pf.

The power is expressed mathematically;

$$P = \sqrt{3}.U_n I\, cos\varphi \tag{3.25}$$

Where:

P = effective power

U_n = Rated Voltage

The current consumption before compensation is:

$$I = \frac{P}{\sqrt{3}.U_n cos\,\varphi_1} \tag{3.26}$$

The current consumption after compensation is:

$$I = \frac{P}{\sqrt{3}.U_n cos\,\varphi_2} \tag{3.27}$$

The effective resistance per unit length before and after compensation is expressed as,

$$(R_L cos\varphi + X_L sin\varphi) = \frac{\Delta U_n}{\sqrt{3}} \tag{3.28}$$

A single phase load is fed from an AC supply with an Input AC of a given voltage with frequency in Hz and a base impedance. It is to be realized as a unity power factor load on the AC supply system using shut connected lossless passive element (L or C).

The load current before compensation is given as the supply voltage per load impedance, which is expressed mathematically,

$$I_{Sold} = \frac{\text{supply voltage}}{\text{Load impedance}} \tag{3.29}$$

$$I_{Sold} = \frac{V_s}{Z_L} \tag{3.30}$$

The reactive current is

$$I_r = I_{Sold}\, Sin\theta = I_{Sold}\, \frac{X_L}{Z_L} \tag{3.31}$$

Where:

θ = power factor angle of the load.

The compensating capacitor should supply the same reactive current as the load, hence,

$$I_c = I_r \tag{3.32}$$

i) How Installing Power Capacitors Improve System Operating Characteristics (Reduce Line Losses)

Improving Pf at the load point shall relieve the system of transmitting reactive current. Less current shall mean lower losses in the distribution system of the facility since losses are proportional to the square of the current. Therefore, the fewer kW-hr needed to be purchased from the utility.

An estimation of the power losses can be made using the following:

$$\%\text{ reduction in power losses} = \left[1 - \left(\frac{Original\ \ Pf}{Improved\ \ Pf}\right)^2\right] \times 100 \tag{3.33}$$

The value of the capacitor for power factor correction is expressed as;

$$C = \frac{I_c}{(V_w)} \tag{3.34}$$

The supply current after compensation is expressed as;

$$I_{snew} = I_{sold}\, Cos\theta \Big\}$$

$$= I_{sold}\, \frac{R_L}{Z_L} = I_a \tag{3.35}$$

The equivalent resistance of the compensated load is expressed as;

$$R_{eq} = \frac{V}{I_{snew}} \tag{3.36}$$

Determination of Losses in the Distribution System

A single phase AC Voltage controller is used to control the heating of packing element in a machine at a given power with respect to voltage which is fed from a single-phase AC mains at a frequency of 50Hz. Feeder conductors have the resistance of where is fed from the network.

Determination of Reduction of Voltage Drop

The drop of the line-line voltage in $3\emptyset - phase$

$$\text{Reduction of Voltage Drop} = \sqrt{3}\, I\, (R\cos\varphi + X\sin\varphi) \tag{3.38}$$

$$= \frac{P}{U_n}(R + X\, tang\, \varphi) \tag{3.39}$$

Where;

R = Resistance of the line

X = Reactance of the line

P = Active Power

U_n = Supply voltage

φ = Power factor before correction

The load resistance is

$$R_L = \frac{V_{LS}^2}{P} \tag{3.40}$$

The rms voltage across the load is

$$V_{LS} = I_S R_L \tag{3.41}$$

The supply rms current is

$$I_S = \sqrt{\left(\frac{P}{P_L}\right)} = \frac{V_{LS}}{R_L} \tag{3.42}$$

Losses in the distribution system are

$$P_{Loss} = 2I_s^2 R_s \tag{3.43}$$

Ratio of losses without and with a compensator is

$$\frac{P_{Loss}}{P_{Lossc}} \tag{3.44}$$

Determination of active power component of load current

After the compensation, the Pf is corrected to unity of the AC mains by a shunt compensator.

The new supply current is the rms value of the fundamental active power component of load current,

$$I_{sc} = I_{s/a} = \frac{P}{V_s} \quad (3.45)$$

Determination of Voltage Divider Model for a Voltage Sag

Voltage divider model for a voltages ag

$$V_{sag} = \frac{Z_F}{Z_S + Z_F} \quad (3.46)$$

Where it has been assumed that the pre-event voltage is exactly 1 pu, thus $E = 1$.We see from equation (3.46) the sag becomes deeper for faults electrically closer to the customer (when $Z_F$becomessmaller), and for systems with a smaller fault level (when $Z_S$becomes larger).

Equation (3.47) can be used to calculate the sag magnitude as a function of the distance to the fault. Therefore we have to write $Z_F = z \times l$, with z the impedance of the feeder per unit length and l the distance between thefault and the pee, leading to:

$$V_{sag} = \frac{zl}{Z_S + zl} \quad (3.47)$$

Determination of Fault Levels

It is possible to calculate the sag magnitude from the fault levels at the p_{cc} and at the fault position. Let S_{FLT}be the fault level at the fault position and S_{pcc} at thepoint-of-common coupling. For a rated voltage $V_n$therelations between fault level and source impedance are as follows:

$$S_{FLT} = \frac{v_n^2}{Z_S + Z_F} \quad (3.48)$$

$$S_{pcc} = \frac{v_n^2}{Z_S} \quad (3.49)$$

with equation (3.47) the voltage at the pcc can be written as:

$$V_{sag} = 1 - \frac{S_{FLT}}{S_{pcc}} \quad (3.50)$$

j) Newton-Raphson Power Flow Technique (N-R)

Newton-Raphson technique is used for solving power flow solution. The technique uses Taylor series expansion with terms limited to first approximation. The technique was used in this research due to its powerful convergence characteristics compared to other techniques.

Complex power at the *ith* node on the distribution line is given by

$$S_i = V_i I_i^* = P_i + jQ_i \quad (3.51)$$

$$I_i = \left(\frac{S_i}{V_i}\right)^* = \frac{P_i - jQ_i}{V_i^*} \quad (3.52)$$

$$I_i = \frac{\sqrt{P_i^2 + Q_i^2}}{|V_i|} \frac{\angle \tan^{-1}\left(-\frac{Q_i}{P_i}\right)}{\angle -\delta_i} \quad (3.53)$$

$$|I_i| = \frac{\sqrt{P_i^2 + Q_i^2}}{|V_i|} \quad (3.54)$$

$$\emptyset_i = \delta - \tan^{-1}\left(\frac{Q_i}{P_i}\right) \quad (3.55)$$

$$I_i = |I_i| \angle - \emptyset_i \quad (3.56)$$

$$I_i = I_i(\cos\phi_i - j\sin\phi_i) \quad (3.57)$$

Where:

i is node 1,2,3,4,5,6,7+….. on the distribution line

P_i is real power injected in the i^{th} node

Q_i is reactive power injected in the i^{th} node

$\emptyset_i$ is power factor angle for the load current in the i^{th} node

Determination of Injected Real and Reactive Power

From (3.52) the current entering the power system is giving by

$$I_i = \frac{P_i - jQ_i}{V_i^*} = \sum_{k=1}^{n} Y_{ik} V_k \quad (3.58)$$

$$P_i - jQ_i = V_i^* \left(\sum_{k=1}^{n} Y_{ik} V_k\right) \quad (3.59)$$

Let $V_i^* = V_i\angle - \delta_i, V_k = V_k\angle\delta_k$ and $Y_{ik} = Y_{ik}\angle\theta_{ik}$

$$P_i - jQ_i = V_i^* \left(\sum_{k=1}^{n} Y_{ik} V_k \angle\delta_k + \theta_{ik} - \delta_i\right) \quad (3.60)$$

$$P_i - jQ_i = \sum_{k=1}^{n} |Y_{ik}||V_i||V_k| [\cos(\delta_k + \theta_{ik} - \delta i + j\sin\delta k + \theta ik - \delta i \quad (3.61)$$

Separating (3.62) into real and imaginary parts we have,

$$P_i = \sum_{k=1}^{n} |Y_{ik}||V_i||V_k| \cos(\delta_k + \theta_{ik} - \delta_i) \quad (3.62)$$

$$Q_i = -\sum_{k=1}^{n} |Y_{ik}||V_i||V_k| \sin(\delta_k + \theta_{ik} - \delta_i) \quad (3.63)$$

Where:

Y_{ik} is the admittance matrix

P_i is the injected real power

Q_i is the injected reactive power.

IV. Results and Discussion

a) Description of the Research Work

This chapter analyses the performance of the Dynamic Voltage Restorer (DVR) with different techniques by determining the capacitive power of the network, % reduction in power loss of the network, cable cross-section of the network, compensation of the network, losses in the distribution system of the network, reduction of voltage drop of the network, faults behind the transformer of the network. The different techniques were analyzed in tabular form and bar chart was used to discuss results of the scenarios. The use of Electrical Transient and Analysis Program Software (ETAP version 12.6) was used in analyzing the possible solutions to improved power supply.

b) Post-Upgrade Network Simulation

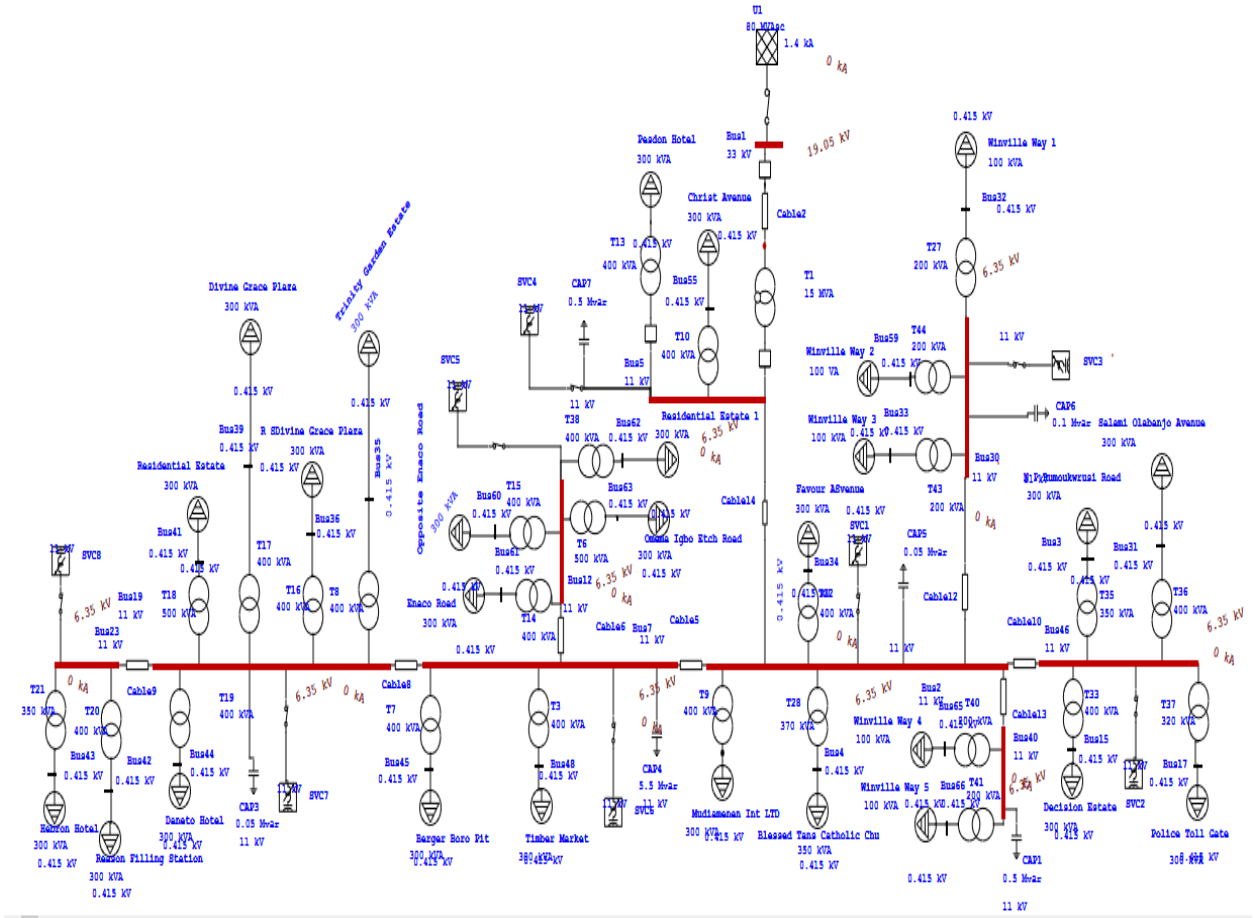

Figure 4.1(a): Simulation of Improved power supply at Igbo-EtcheRumoukwurusi Area of Port Harcourt, Distribution Network

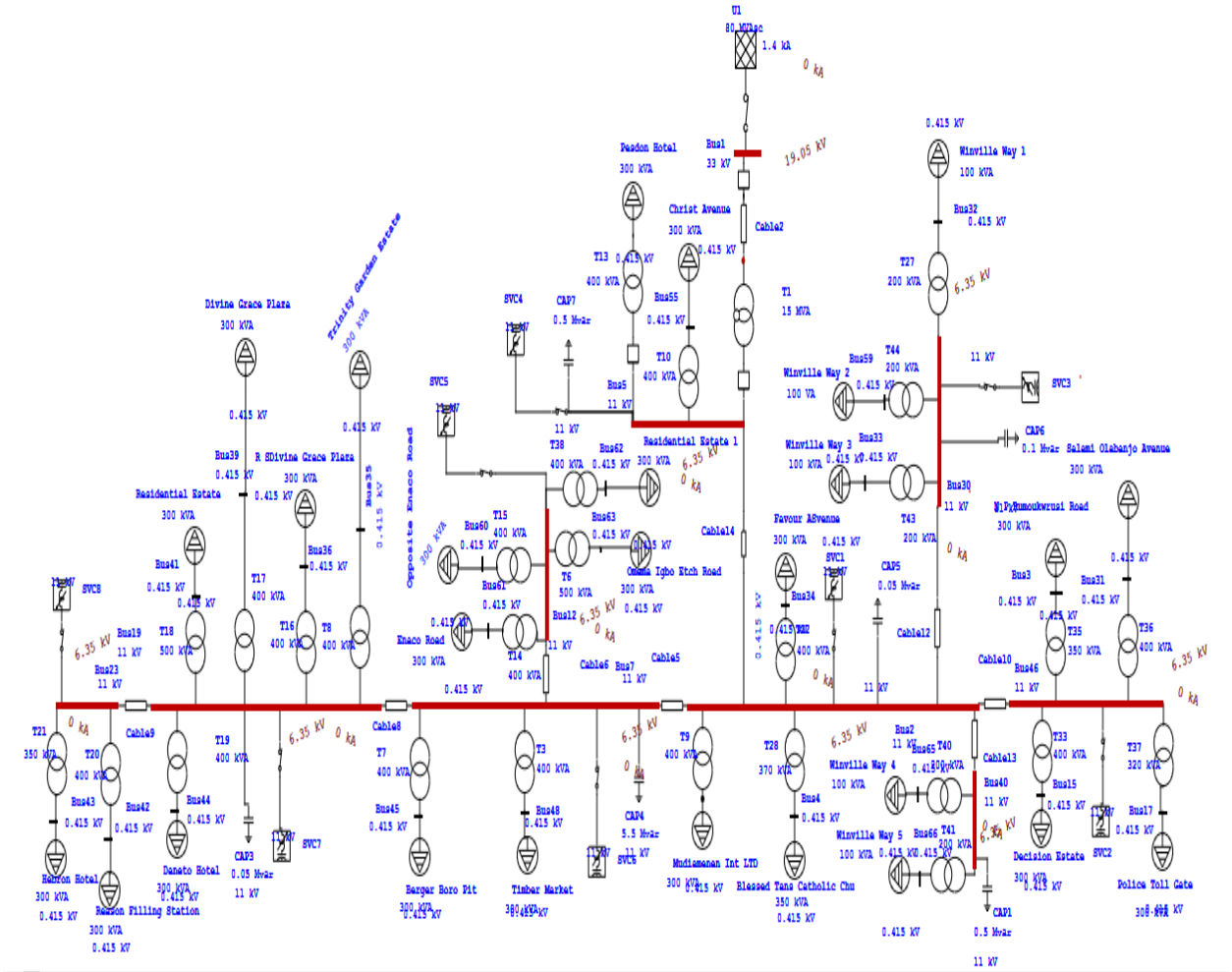

Figure 4.1(b): Simulation of Improved power supply at Igbo-Etche Rumoukwurusi Area of Port Harcourt, Distribution Network

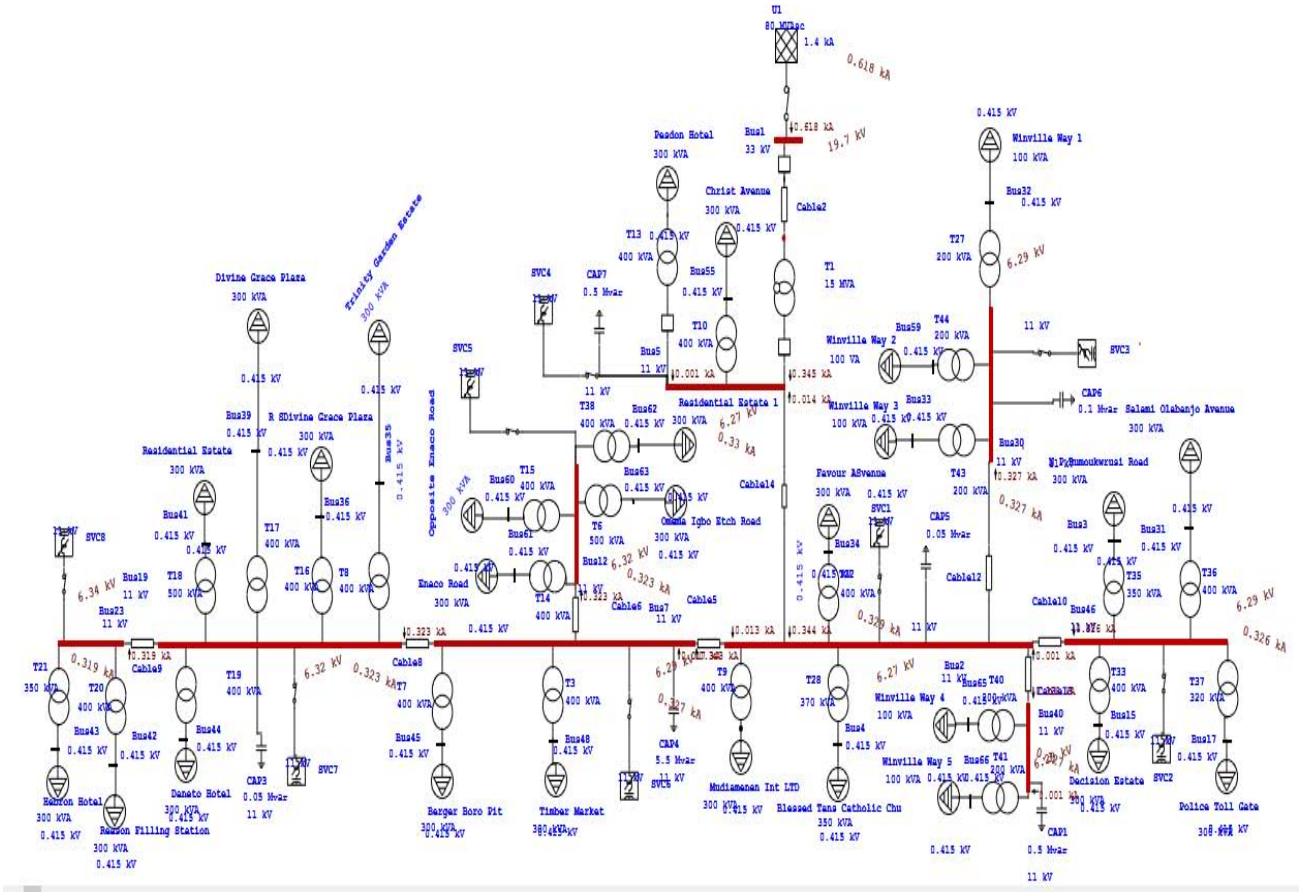

Figure 4.1(c): Simulation of Improved power supply at Igbo-EtcheRumoukwurusi Area of Port Harcourt, Distribution Network

c) *Discussion of Tables and Interpretation of the Results*

This section discusses the tables and interpretation of the results in a concise ways by showing the full details through bar-charts.

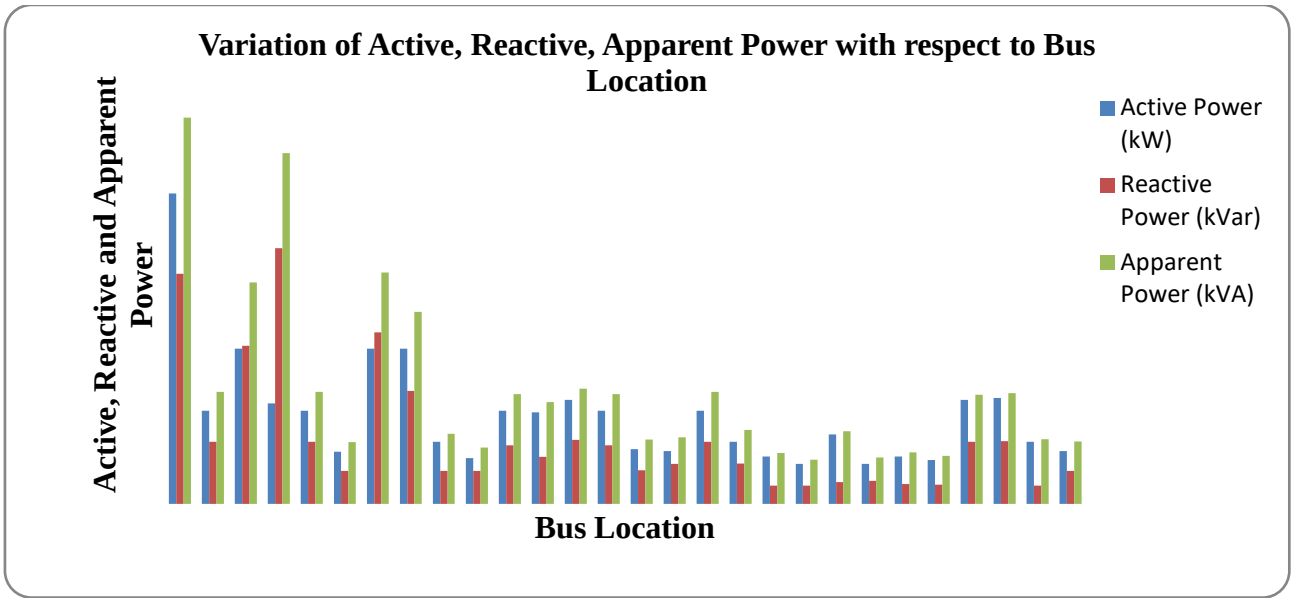

Figure 4:2: Indicates the variation of active, reactive and apparent power with respect to Bus location.

The figure indicates the variation of active, reactive and apparent power with respect to Bus location. For active power, Total Energy Limited has the highest value of the active power of 4250 kW, followed by Dane to Hotel with active power of 2125 kW. While Winderville 1 and Winderville 3 have the lowest values of 550kW respectively.

For the reactive power, Residential Estate I has the highest value of the active power of 3500 kVAR, followed by Total Energy Limited with active power of 3150 kVAR. While Favour Avenue has the lowest values of 250.50kVAR.

For the apparent power, Total Energy Limited has the highest value of the active power of 5290.09 kVA, followed by Residential Estate I with active power of 4803.33kVA.WhileWinderville 1 has the lowest values of 604.38kVA.

Therefore for active power Winderville 1 and Winderville 3 should be upgraded and the active power should be increased.

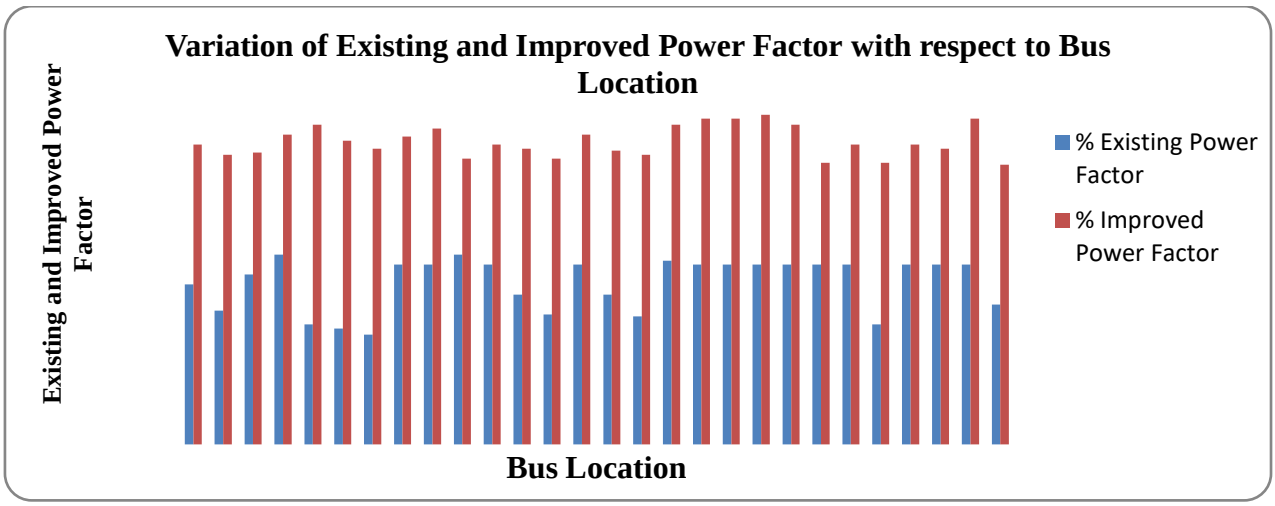

Figure 4:3: Indicates the existing and improved power factor with respect to Bus location

The figure indicates the variation of the existing and improved power factor with respect to Bus location. For existing power factor, Residential Estate I and Mudiamenen International Limited have the highest value of 85.5 respectively. Followed by Blessed Tansi Catholic Church with the value of 85.2.While Mecho Estate / Trinity Garden Estate has lowest value of 81.5.

For improved power factor, Winderville 1 has the highest value of 92.5. Followed by New Pipeline Rumoukwurusi, Favour Avenue and Ngre Oil Filling Station with the value of 92.3 respectively. While Mecho Estate / Trinity Garden Estate and Police Toll Gate have lowest value of 90 respectively.

Mecho Estate/Trinity Garden Estate should be upgrade to the standard power factor as 85.0 since it is a residence area.

V. Conclusion and Recommendations

a) Conclusion

This research work critically examined the improvement of power supply at Igbo-Etche Rumoukwurusi Area of Port Harcourt, Rivers State using Dynamic Voltage Restorer (DVR) method.

Based on the results obtained, it can be concluded that load flow analysis is very vital for understanding the operational nature of a network and the following area were considered vigorously; the capacitive power, power before compensation, power after compensation, current before and after compensation, % reduction in power loss, voltage drop, current consumption before and after compensation, load current before compensation, reactive current, capacitive for pf correction, current after compensated load and resistance of the compensated load, Supply r ms Current, Voltage across the load, Load Resistance, Supply current after compensation, Losses(fixed) in the distribution system, Losses(variable) in the distribution system and Ratio of losses without and with a compensator.

Similarly, distance between the fault, source impedance, transformer impedance, rated voltage, fault level at the fault position, point of common coupling and the voltage sag with respect to Bus Location were considered.

However, the use of Electrical Transient and Analysis Program (ETAP Version 12.6) and was used for simulation of the case study.Post-upgrade simulation was conducted on the network to ascertain the improvement of power supply on the network and the results were significantly positive.

b) Contribution to Knowledge

While other works focused on various power quality problems faced by the utilities such as harmonic distortion and different disturbances, other devices like D-STATCOM (distribution static compensator) which is represented by FACTS devices is used in power system as power electronic shunt device that absorbs and provides reactive power to solve power quality problems in power distribution systems, this work has considered the Power quality is the combination of voltage quality and current quality. Power quality is the set of limits of electrical properties that allows electrical systems to function in their intended manner without significant loss of performance or life.

c) Recommendations

Based on the findings of this work, the following recommendations are made to ensure the overall improvement in the operation of the network:

1. Mecho Estate/Trinity Garden Estate should be upgrade to the standard power factor as 85.0 since it is a residence area.
2. New Pipeline Rumoukwurusi current and capacitive power should be compensated and upgraded while Winderville 1 percentage (%) reduction in power loss should be upgraded.
3. Total Energy Limited has the highest value of voltage drop of 4.12V, it should be upgraded and reduced to the barest value since it is a construction company.

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Electro-electronic Project of an Articulated Electric Vehicle

By Lucas Herrmann, Luiz Antônio Pereira Machado, Luiz Otávio Victória, Arthur Barcellos Galli & Rafael Galli

Abstract- In this work, we present the electro-electronic project of an articulated electric vehicle developed, initially for a user, with electric steering and an articulated center that allows the vehicle and user to enter elevators. The purpose is to allow older adults or people with special needs to obtain greater mobility and comfort on urban and residential roads. The main part of the electronic system is a complete bridge inverter controlled by a microcontroller system. The vehicle features two battery banks, monitored by a control system that defines the best bank to be used, placing the other bank under load through a solar panel. The mechanical structure was constructed from materials that are easily accessible on the market, and materials for reuse to recycle them.

Keywords: *electric vehicle, power inverter, special needs.*

GJRE-F Classification: *FOR Code: 290903p*

Strictly as per the compliance and regulations of:

Electro-electronic Project of an Articulated Electric Vehicle

Lucas Herrmann [α], Luiz Antônio Pereira Machado [σ], Luiz Otávio Victória [ρ], Arthur Barcellos Galli [ω] & Rafael Galli [¥]

Abstract- **In this work, we present the electro-electronic project of an articulated electric vehicle developed, initially for a user, with electric steering and an articulated center that allows the vehicle and user to enter elevators. The purpose is to allow older adults or people with special needs to obtain greater mobility and comfort on urban and residential roads. The main part of the electronic system is a complete bridge inverter controlled by a microcontroller system. The vehicle features two battery banks, monitored by a control system that defines the best bank to be used, placing the other bank under load through a solar panel. The mechanical structure was constructed from materials that are easily accessible on the market, and materials for reuse to recycle them.**

Keywords: electric vehicle, power inverter, special needs.

I. Introduction

Each year, there is an increase in earth temperature attributed, in large part, to human action. One of the factors that contribute to this increase is the emission of greenhouse gases into the atmosphere, for example, carbon dioxide. This problem causes public and private agencies to seek to research and develop new forms of transport to reduce C02 emission, making great use of renewable energies.

Electric vehicles are not an innovation since they appeared in 1830, and at the turn of the 20th century, about 90% of the taxi fleet that ran in New York was powered by batteries (SUPERINTERESSANTE, 2007).

The evolution of oil refining and the consequent reduction in the cost of gasoline, combined with problems with batteries and chargers for electric vehicles, made combustion vehicles more economical, thus causing the "end" of electric vehicles.

With the resumption of research, to develop new batteries and solar panels for the American space program, as well as the evolution of electric motors, new hybrid vehicles - electric and combustion - or simply electric, as efficient as current combustion vehicles, now having the advantage of reducing pollution and the possibility of using energy from the sun, looking forward to reaching a new market place for, to serve a more conscious and demanding consumer about to environmental issues.

Thus, the challenge of the project is to develop a low-cost Electric Vehicle (E.V.) prototype, using the maximum of components on the market, such as motorcycle parts for the chassis, brakes, and bicycle parts. These mechanical components, in conjunction with electronic control boards.

Based on the data previously exposed and seeking to provide people with mobility difficulties, an ally to improve their day-to-day lives, the project has the objective to develop a vehicle for individual transportation that moves around urban centers and indoor environments such as public offices, restaurants, and hospitals. Therefore, it seeks to bring greater mobility and freedom to the user and also contribute to the reduction of CO2 emissions.

II. Motivation

The purpose of the work is to promote a spirit of research among students, seeking interaction between practice and theory, building a didactic transposition that seeks to make the pedagogical methods more attractive to the student body.

There is also a concern to develop ecological and social awareness in students, seeking to show the importance of reusing materials in developing their projects, searching for alternative solutions.

The challenge proposed here is teaching-learning based on the principles of education theorists, which knowledge is developed during the construction of the object (Maria Montessori, 2014).

We must highlightthat the development of this project has been done by students from the Technical Course in Electronics and Bachelor of Design, enabling the exchange of knowledge acquired during the courses, with the support of employees, students, and colleagues of the Bachelor of Electrical Engineering Course, among others.

III. Desenvolvimentodo Projeto

The first step of the project consisted by disigning a chassis using tubes existing in the locksmiths of the Federal Institute of Rio Grande do Sul - Câmpus Pelotas, and some bicycle components, according to figures 1 and 2, together with two 24V

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750W GPA DC motors that generate the power needed to drive it.

Figure 1: Chassis designed by the students

Figure 2: Chassis designed by the students

Figure 3 shows A block diagram of the vehicle control system. The Control Board is responsible for generating the PWM - "Pulse Width Modulation"- for the Power Stage and generating the signals for the Protection Board. When the Protection Board receives signals from the Control Board, it releases power to the Power Stage. The Bank Control Board analyzes which battery bank has the highest load and releases it to the Power Stage through the Protection Board.

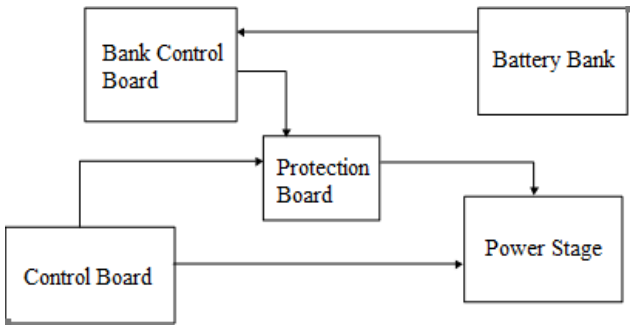

Figure 3: Block diagram

a) Control Board

In the control circuit, Figure 4, is located the PIC 18F4550 Microcontroller that has amid its functions, the generation of the PWM, and analysis of the vehicle's basic system, that is, to analyze the initial conditions of the vehicle, such as battery voltage and condition of the accelerator, and after, if everything is in order, it releases the same to transit.

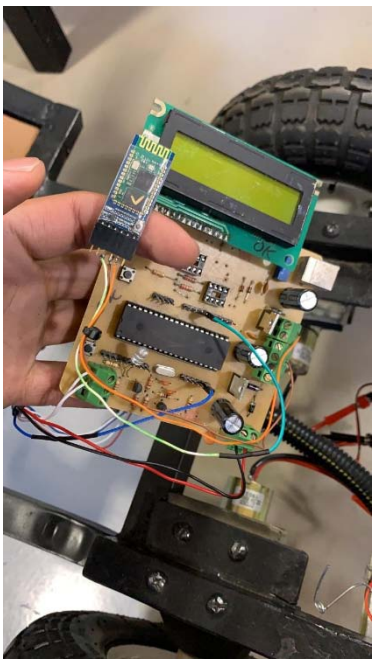

Figure 4: Control circuit

In addition to the digital protection circuit, there is an analog circuit, Figure 5, that prevents the inversion of the batteries and controls the vehicle lights.

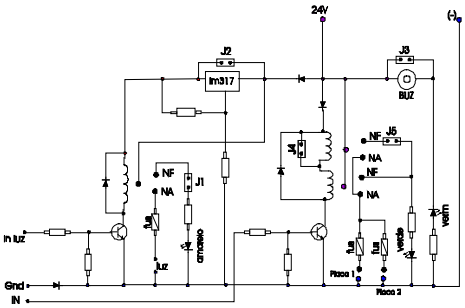

Figure 5: Analog protection circuit

b) Battery Reading Circuit

The battery analysis or reading circuit, shown in Figure 6, has the function to select the battery bank. The vehicle has two battery banks. The control board analyzes the bank with the highest load and switches it to use, keeping the other in charge, through solar panels.

When the bank reaches a certain value, the circuit analyzes the banks again and automatically switches over to the one with the highest load.

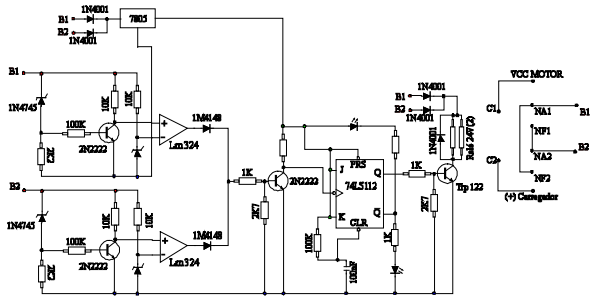

Figure 6: Battery comparator circuit

c) *Power Stage*

The vehicle has two identical power stages:Controlling electric steering, another for controlling fuze, responsible for opening and closing the car, and a more powerful one for propelling.

The full-bridge inverter, implemented with IR2184 and IR 2110, wasbased on a full-bridge. Such integrated circuits are a trigger drive for half a bridge; the complete schematic circuit is shown in Figure 7 and the PCB in Figure 8 end Figure 9, the prototype board Mosfets.

In the case of the main engine's power plate, these CI's control two IGBT's modules and, in the others, power MOSFET.

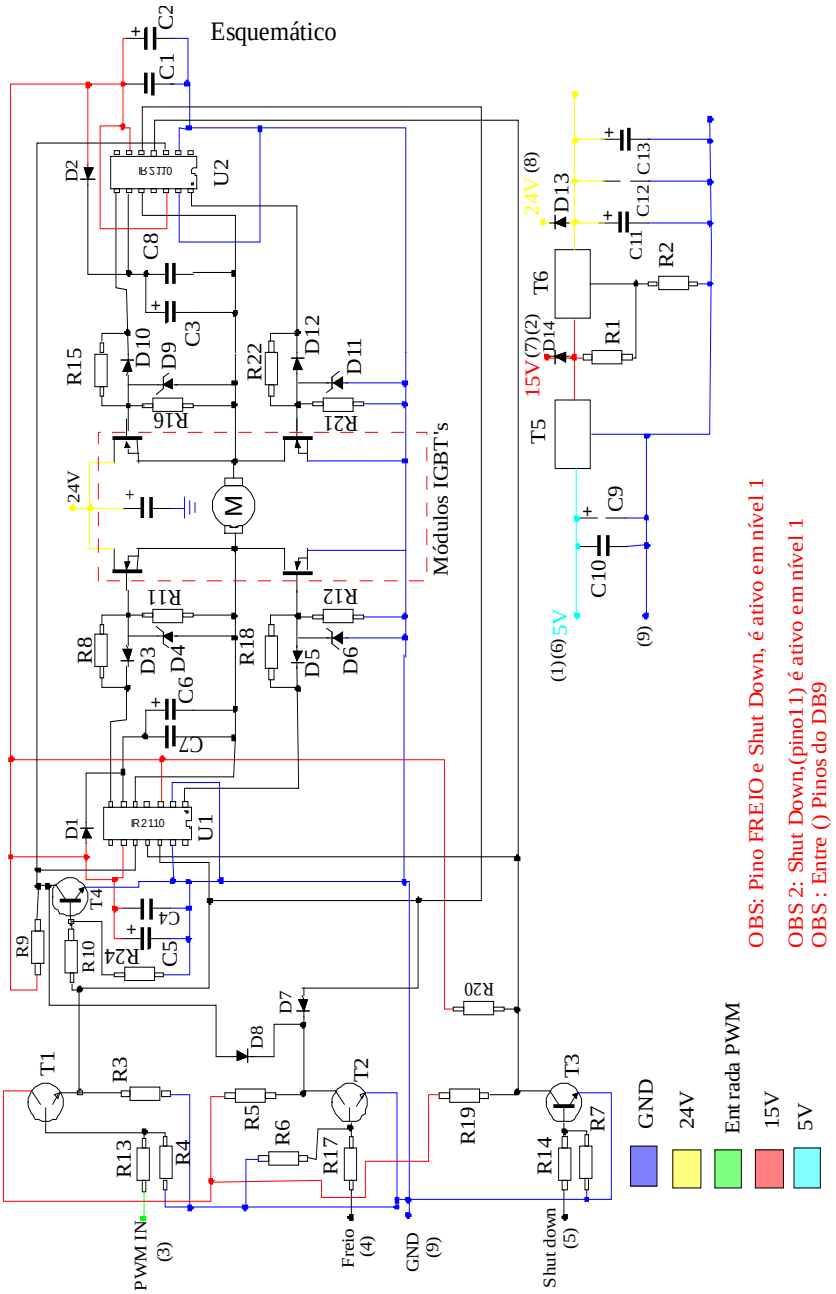

Figure 7: Power stage

The circuits power with IGBT's can be seen in figures 10 and 11.

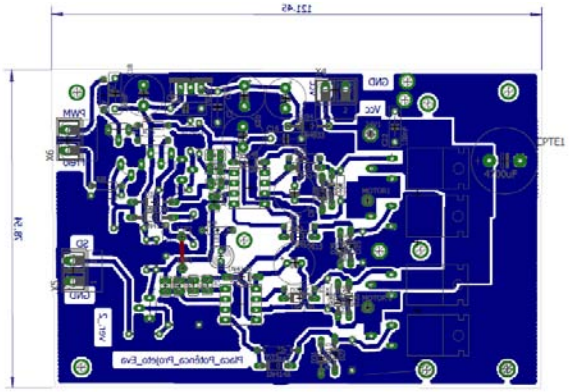

Figure 8: Power PCB board with MOSFETs

Figure 9: IR 2184 control circuit to mosfets

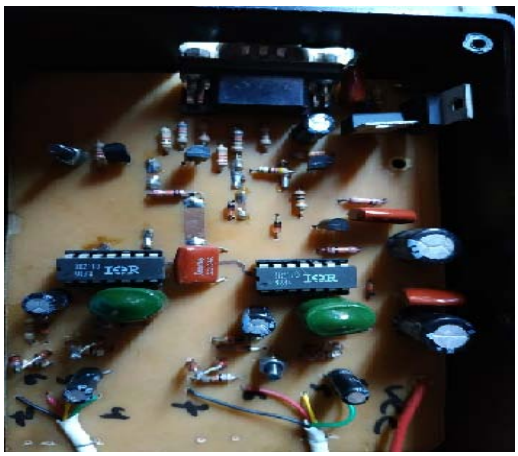

Figure 10: IR 2110 control circuit

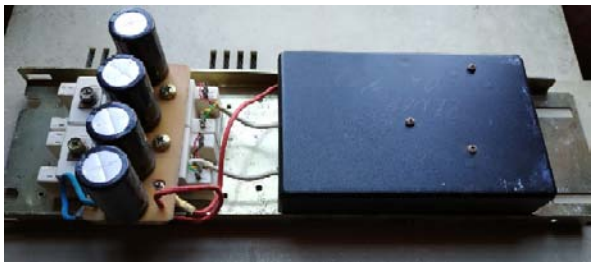

Figure 11: IR2110 circuit assembled with IGBT's.

IV. Results and Discussion

During the development of the prototype, built with recycled materials (Figures 1 and 2), some problems arrived in the mechanical and in the circuits. The shock absorbers were badly damaged hindering cornering vehicle stability. To solve this problem, a new structure with four wheels, shown in Figures 12 and 13, was built.

Figure 12: New open structure

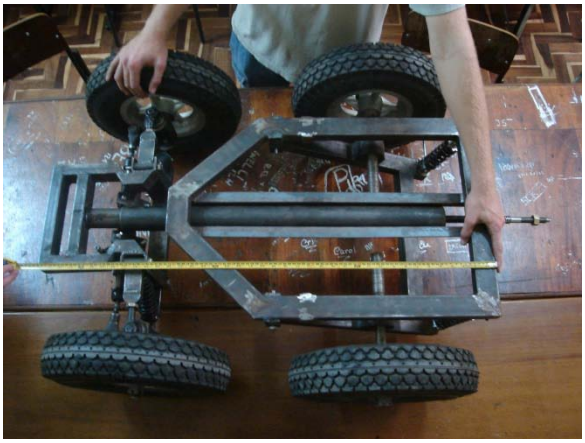

Figure 13: New closed structure

In the electronics part, the battery comparator circuit showed instability. The solution found was the addition of a Schmitt Trigger between the transistor and the flip-flop that stabilized the input pulses.

In preliminary tests, observations in the new structure, showed that the vehicle reached a speed of 35 km / h and reached a distance of 5 km in uneven terrain.

The tests with the charge of the battery banks presented satisfactory results, being in the implantation phase in the prototype.

With the addition of a Bachelor of Design student, it was possible to implement a new chassis, as seen in figures 14 and 15, in partnership with the Universidad Autónoma de Ciudad Juárez, Mexico, which allowed a considerable reduction in the vehicle's

weight, allowing the replacement of 750W motors by 350W motors, and the replacement of IGBT's with power MOSFETs, reducing the number of plates, significantly reducing the cost of the vehicle.

Figure 14: Final chassis side view

Figure 15: Final chassis front view

The power phases with MosFet's performed better than expected, showing stable signals, as shown in figures 16 and 17. The results were obtained mesuring the powers steps by using a Tektronix Oscilloscope TDS 2022B and the Open Choice PC Communication software from Tektronix.

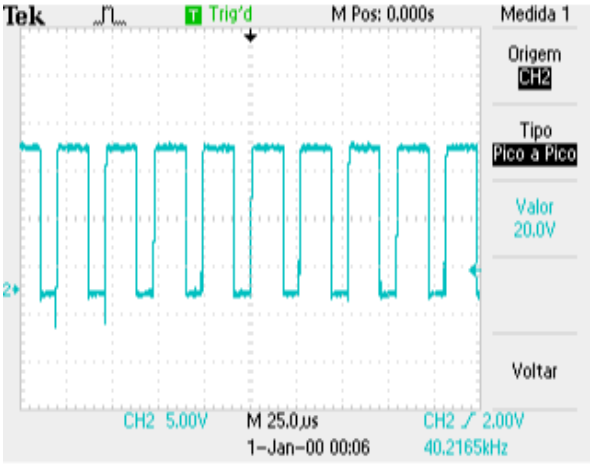

Figure 16: PWM at the entrance to IR 2184

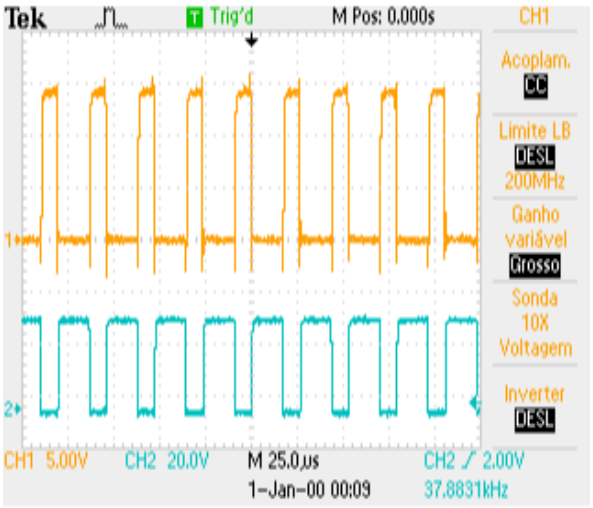

Figure 17: IR 2184 outputs

V. Conclusion

This work presented the development of a project for the creation of an ecologically correct electric vehicleto enable greater mobility for people with special needs and the elderly.

The work proved to be very useful. Given the suggested pedagogical proposal, it was the act of doing to learn, starting from the student's curiosity and desire, besides promoting interdisciplinarity.

There was great interest from those involved in the project, as the teaching methodology was motivating and differentiated in the school routine. The project proved to be a reference for the developing other projects such as Design that generated a modern and efficient chassis and a vision of the future final prototype shown in Figure 18. The design of this project in fact derived the Master's degree from student Luiz Antonio Pereira Machado Júnior, from the Bachelor of Design course at the Federal Institute of Rio Grande do Sul, at the Universidad Autónoma de Ciudad Juárez, México.

Figure 18: Conceptual drawing

And in the control stage, a telemetry system, where over long distances, we can collect and analyze the main signals of the vehicle, such as engine and inverter temperature.

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Analysis and Development of Adaptive Protection Scheme for Meshed Distribution Network

By Modu Abba Gana, Ganiyu Ayinde Bakare & Usman Otaru Aliyu
University of Maiduguri

Abstract- Integration of Distributed Generations (DGs) at distribution network levels have changed the structure from being radial to mesh; thereby causing fault currents to be fed from all the sources connected to the network. Another operational requirement is that DGs can get disconnected from the network due to disturbances or maintenance requirements leading to new network topology. This research work has, therefore, proposed an adaptive protection scheme that relies on modern communication infrastructure for its implementation, after optimally siting and sizing of DG and investigation of impact of DG on the protection system and reliability of the system. Herein, modified particle swarm optimization (MPSO) has been deployed for the optimal relay parameters values (operation time, pick up current and time dial settings). Standard communication protocol (IEC 61850) has been chosen to facilitate the communication amongst the various devices in the adaptive protection framework developed.

Keywords: distributed generation, adaptive protection scheme, reconfiguration, realibility, modified particle swarm optimization, PSCAD and ETAP.

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Analysis and Development of Adaptive Protection Scheme for Meshed Distribution Network

Modu Abba Gana [α], Ganiyu Ayinde Bakare [σ] & Usman Otaru Aliyu [ρ]

Abstract- Integration of Distributed Generations (DGs) at distribution network levels have changed the structure from being radial to mesh; thereby causing fault currents to be fed from all the sources connected to the network. Another operational requirement is that DGs can get disconnected from the network due to disturbances or maintenance requirements leading to new network topology. This research work has, therefore, proposed an adaptive protection scheme that relies on modern communication infrastructure for its implementation, after optimally siting and sizing of DG and investigation of impact of DG on the protection system and reliability of the system. Herein, modified particle swarm optimization (MPSO) has been deployed for the optimal relay parameters values (operation time, pick up current and time dial settings). Standard communication protocol (IEC 61850) has been chosen to facilitate the communication amongst the various devices in the adaptive protection framework developed. Furthermore, the settings of the relays are continually updated using central relaying architecture in accordance with the configuration of the distribution networks. A backup protection scheme has also been developed to operate in case of any critical communication failure that could lead to mal-operation of the adaptive protection scheme. The proposed schemes have been tested extensively within IEEE 33 bus test system. The distribution systems that considered optimally sited DGs (solar power plant) was modelled in ETAP and PSCAD environment and simulated with three different fault types (single phase to ground, double phase to ground and bolted three phase) applied at selected buses. Several far reaching simulation results generated have confirmed that the adaptive protection scheme developed correctly operated the multi directional relays to isolate the faulted sections within the distribution network considered.

Keywords: distributed generation, adaptive protection scheme, reconfiguration, realibility, modified particle swarm optimization, PSCAD and ETAP.

I. Introduction

Distributed Generators (DG) are increasingly connected to distribution systems to meet the load demand and increase the reliability of the system. With the additional connected sources, the system is no longer radial. Moreover, during a fault condition, the fault is fed from all the sources connected to the power system. Therefore, the fault current level is different compared with the radial system. Furthermore, protective relays on the main feeder must see fault currents in forward or reverse directions, and they have to detect the fault direction. Another important problem is that DGs can get disconnected from the grid due to disturbances or for maintenance. [1] Consequently, a new configuration for the system results and, if a fault occurs, a different fault current level flows. Therefore, one setting for the protective relays cannot adequately respond to the continuously changing system configuration. Thus, relays have to be adaptively coordinated for each new system configuration to achieve correct fault clearance operation.

II. DG Installation Problem Formulation

In this work the objective of the placement technique for the DG is to minimize the real power loss and to improve the voltage profile at the distribution level. The real power loss reduction in a distribution system is required for efficient power system operation. The loss in the system can be calculated using (1) in [3], called the 'exact loss formula' given the system operating conditions. The objective of the placement technique is to minimize the total real power loss and improved voltage profile. Mathematically, the objective function can be written as:

$$Minimize\ P_L = \sum_{i=1}^{N} |I_i|^2 R_i \quad (1)$$

Subject to power balance constraints.

$$\sum_{i=1}^{N} P_{DGi} = \sum_{i=1}^{N} P_{Di} + P_L \quad (2)$$

$$Voltge\ Constraints: |V_i|^{min} \leq |V_i| \leq |V_i|^{max}$$

$$Currents\ Limits: |I_{ij}| \leq |I_{ij}|^{max}$$

$$0 \leq P_{DG} \leq 0.3 \sum_{i=1}^{N_L} P_{load}$$

Where *i* is the number of bus,
N is the total number of Buses,
P_L is the real power loss in the system,

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P_{DGi} is the real power generation of DG at bus *i*,
P_{Di} is the power demand at bus *i* ,
I_{ij} is the current between buses *i* and *j*
R_i is the resistance.

The current I_i is determined from the load flow using Hybrid load flow studies Method called Backward – Forward and Newton Raphson. For single source network all the power is supplied by the source but with DG that are optimally placed there is going to be reduction in power loss. [4] This reduction in power loss is determined as the difference of the power loss with DG and without DG. Thus, the new power loss in the network with DG is:

$$P_{l-new} = \sum_{i=1}^{N} |I_i^{new}|^2 R_i \quad (3)$$

Where *j* =*1* for a feeder with DG or else *j* = *0*
Hence, the power loss reduction (P_{lossr}) value for bus *i* with DG is obtained by subtracting (4) from (5) as;

$$P_{lossri} = P_{L-new} - P_L \quad (4)$$

$$P_{lossri} = -\sum_{i=1}^{N} (2JI_iI_{DG}R_i + JI_iI_{DG}^2)R_i \quad (5)$$

The bus that gives the highest value of P_{lossr} is selected as the optimal location of DG. The concern is to place the DG at a location that will give maximum loss reduction. Differentiating equation (5) with respect to $I_{DG}$and equating it to zero, gives the DG current that will give maximum loss reduction, therefore the current is given by equation (6) below.

$$I_{DGi} = -\frac{\sum_{i=1}^{n} I_{ai}R_i}{\sum_{i=1}^{n} R_i} \quad (6)$$

The procedure is repeated for all the buses in order to obtain the highest power loss reduction value as the DG units are singly located. Assuming there is no significant changes in the voltage as DG units are connected, the power that can be generated is;

$$\boldsymbol{P_{DGi} = I_{DG}V_i} \quad (7)$$

Where, Vi is the voltage magnitude of the bus i and the optimum DG size is obtained from equation (7). The optimal location of the DG is bus i for maximum power loss reduction.

III. Protection Coordination Problem Formulation

Protection of power system is typically tuned in such a way that only the faulted part of the system gets removed when a fault occurs. This tuning is called protection coordination and this becomes worse when DGs are connected because they can negatively affect the system coordination. The coordination of overcurrent relays OCRs could be achieved by determining two setting values: the pickup current ($\boldsymbol{I_P}$) and the time dial setting (TDS). The pickup current is the minimum current value for which the relay begins to operate. The TDS adjusts the inverse characteristics of overcurrent device, and hence controls the time delay before relay operates if the fault current reaches a value equal or greater than the pickup current. [2].

The coordination of the relay time settings before the integration of DG was done using eqn. (8), [4].

$$\boldsymbol{t_o = TDS\left[\frac{A}{\left(\frac{I_F}{I_P}\right)^p - 1} + B\right]} \quad (8)$$

Where;
$\boldsymbol{t_o}$ is the relay operating time in second
$\boldsymbol{TDS}$ is the time dial setting of the relay
$\boldsymbol{I_F}$ is the fault current at the point of corresponding relay breaker location,
$\boldsymbol{I_P}$ is the pickup current setting for the relay.
A, B and p are the standard constants based on relay characteristics as shown in Table 1 (Anderson, 1998)

Table 1: Relay Characteristics (IEEE Standard C37, 2002 and IEEE Standard 1366, 2012)

Characteristics	A	B	P
Moderately Inverse	0.00515	0.114	0.02
Very Inverse	19.61	0.491	2.0
Extremely Inverse	28.2	0.1217	2.0

In the coordination of OCRs, the main aim is to determine the optimum relay parameters including the TDS and $\boldsymbol{I_P}$ settings minimizing the total operation time of all protective devices. Therefore, the main objective function can be stated as the minimization of summation of the operating times $\boldsymbol{T_{op}}$of all protective relays given by eqn. (8)

$$\boldsymbol{minimize\ T_{op} = \sum_{k=1}^{n} t_o, z} \quad (9)$$

Where; n is the number of relays in the system and ($\boldsymbol{t_o}$, z) is the operating time of the $\boldsymbol{z^{th}}$relay.

The objective function is subjected to the following set of constraints:

The requirement of selectivity dictates that when a fault occurs, only the primary relay should operate to trip the fault. If the main relay fails to extinct the fault, the backup relay should clear the fault after a pre specified delay time. It is normally set between 0.2 and 0.5s. [7]: In order to satisfy such requirement, the following constraint must be considered.

$$\boldsymbol{T_{backup} - T_{main} \leq CTI} \quad (10)$$

Where;

T_{main} and T_{backup} are the main and backup relays operation time respectively.

CTI is the coordination time interval defined as the minimum time gap in operation between the primary and backup relays. There is always a range for each relay setting, from which feasible solutions are obtained. Therefore other constraint should be considered on the limits of relay parameters including TDS and *Ip* settings that can be expressed as follows.

$$TDS^{min} \leq TDS \leq TDS^{max} \quad (11)$$

$$I_p{}^{min} \leq I_p \leq I_p{}^{max} \quad (12)$$

Where;

TDS^{min} and TDS^{max} are minimum and maximum limits of the time dial settings

$I_p{}^{min}$ and $I_p{}^{max}$ are minimum and maximum limits of the pickup current.

The minimum pickup current setting of the relay usually depends on the maximum load current passing through it, while the maximum pickup current setting can be chosen based on the minimum fault current passing through the coil of the relay.

IV. Feeder Reconfiguration Problem Formulation

The main objective in feeder reconfiguration is to restore as much load as possible by transferring essential load of the out of service area to the nearby healthy feeder. A minimal number of switch operations is required because of switch life expectancy concerns. Under normal operating conditions, distribution Company periodically reconfigure distribution feeders by opening and closing of switches in order to increase network reliability and reduce line losses. The resulting feeders must remain in radial configuration and meet all load requirements. However, in response to a fault, some of the normally closed switches would be opened in order to isolate the faulted network branches. At the same time, a number of normally open switches would be closed in order to transfer part or all of the isolated branches to another feeder or to another branch of the same feeder. All switches would be restored to their normal positions after removal of the fault. A whole feeder or part of a feeder, may be served from another feeder by closing a tie switch linking the two while an appropriate sectionalizing switch must be opened to maintain radial structures. By changing the state of the switches to transfer loads from one feeder to another, the operating conditions of the overall system may be improved significantly.

Feeder reconfiguration is an important operation tool as well as a fault management technique. During normal operating conditions, the networks are reconfigured to reduce the system power loss, and to relieve the network from the overloads. During abnormal condition, the network can be re arranged so that maximum number of customers retains electrical service. To reduce the system real power losses is also referred as network reconfiguration and to relieve overloads is referred as load balancing. The early studies on the network reconfiguration were directed to the planning stage. In planning, the main objective is to minimize the cost of construction. An early work on network reconfiguration for loss reduction was presented by [6]. They have developed branch and bound type optimization technique to determine the minimum loss configuration.

V. Optimal Placement of Switches Problem Formulation

The objective function of the optimum switch number and placement problem is to minimize the sum of interruption and investment costs for distribution feeder. Here, the customers' expected outage cost (ECOST) used as an interruption cost reliability index that should be minimized given by eqn. (36): The optimization problem is formulated as;

$$\text{Minimize Total Cost} = \text{ECOST}\ [(p_1, p_2, p_{3.....}p_{n,}, q_1, q_2, q_{3.....}q_m) + u \times SWH + v \times BRK] \quad (13)$$

Where;

ECOST is the expected interruption cost

$$ECOST = \sum_{k=1}^{NoC} \sum_{j=1}^{NoIL} E_{kj}\, F_{jk(gj)} \alpha_j \$/\text{yr} \quad (14)$$

NoIL is the number of isolated load points due to k^{th} contingency *j*

NoC is the number of contingencies

E_{kj} is the curtailed load at load point *k* due to contingencies

g_j is the average outage time

α_j is the average failure rate

$F_{jk(rj)}$ is the outage cost ($/KW) of loads point k due to outage j with outage duration of r_j

p_i is the ith location where a switch is installed

q_i is the ith location where breaker is installed

u is the number switch

v is the number of breaker

SWH is the cost associated with switch

BRK is the cost associated with breaker

Could be noted that the cost associated with switch and breakers includes capital cost, installation cost and maintenance cost. It is assumed that there are N possible locations for installing switches in the network. The cost function is therefore minimized for the optimum number and locations of switches given that m + n ≥ N. [10]

For adopting this optimization problem in MPSO, N suitable location for installing switches in the network are considered as the swarm dimension. Each

agent of the swarm consist of N particles such that after final optimization, each particle state converges to one final state indicating that a breaker, a switch or none of them should be installed at that position.

VI. Modified PSO

The proposed modification considers the worst position also along with the best positions, so we keep track of particle's worst and global worst positions as we do for the best positions in normal PSO. The worst particle here, will be the particle having maximum function value. In each iteration, S 1 particles are selected and named as "bad particles"; others are "good particles". For these "bad particles", velocity is updated using particle's worst and global worst positions. [10] Other particles will follow the base PSO's velocity update rules. Here particles, going towards worst positions can explore the region nearby the bad function values during the run. There is possibility that these bad particles find good positions during their search. Then they will transform into the good particles and attract the other particle towards them as they are ruled by the best ones.

In this work, particles already performing worse than others were chosen as "bad particles" in each iteration and get velocity update by worst positions. As the particles which are already performing bad, do not participate much into the velocity update of whole swarm.

Equation of velocity update for modified PSO is as follows; for ith particle and jth iteration with total p iterations is

$$\boldsymbol{v_{id}(j+1) = W_{new} * V_{id}(j) + c_1 r_1 k_1 (p_{id}(j) - X_{id}(j)) + c_2 r_2 k_2 (g_{id}(j) - X_{id}(j)) + c_3 r_3 k_3 (p_{iw}(j) - x_{iw}(j)) + c_4 r_4 k_4 (g_{iw}(j) - x_{iw}(j))} \quad (15)$$

$$\boldsymbol{x_{id}(j+1) = x_{id}(j) + v_{id}(j)} \quad (16)$$

$$\boldsymbol{W_{new} = W_{start} - \frac{W_{start} - W_{end}}{iter_{max}} \times iter} \quad (17)$$

Where,

$\boldsymbol{c_1, c_3}$ is the cognitive acceleration coefficient,

c_2, c_4 is the social acceleration coefficient,

g_{id} is the best position vector for the entire swarm consisting of s particles (i.e. Gbest)

g_{iw} is the worst position vector for the entire swarm consisting of s particles (i.e. Gworst),

$j+1$ is the next iteration number,

j is the current iteration number,

$k = [k_1, k_2, k_3, k_4]$ = is switch matrix. In this work, for particles affected by best ones, k = [1, 1, 0, 0], which will switch for bad particles to k = [0, 0, 1, 1].

p_{id} is the best position vector for the ith particle so far (i.e. Pbest of the particle),

p_{iw} is the worst position vector for the ith particle so far (i.e. Pworst of the particle),

r_1, r_2, r_3, r_4 are n –dimensional column vector whose elements are random numbers selected from a uniform distribution [0,1],

x_{id} is the position of ith particle,

v_{id} is the velocity vector of ith particle,

w is the static inertia weight chosen in the interval [0,1]

Positions of particles are randomly initialized between [lb, ub]. Velocities are also initialized such as they lie between [$-V_{min}$,V_{max}] and subsequently trapped in the same velocity interval. Position of the particle will be trapped between [$-X_{min}$,X_{max}].

Where

lb is the lower boundary

ub is the upper boundary

V_{max} is the maximum velocity

V_{min} is the minimum velocity

X_{max} is the maximum particle position

X_{min} is the minimum particle position

Table 2: Optimal MPSO parameter settings for placement and sizing of DG

S/No	Parameter	Value
1.	Maximum iteration	50
2.	Particle size	N
3.	C_1, C_3, is the cognitive acceleration coefficient	2
4.	C_2, C_4 is the social acceleration coefficient	1.5
5.	r_1, r_2, r_3, r_4 are n dimensional Colum vectors	0.8
6	W is the static inertia weight	0.9
7	k_1, k_2, k_3, k_4 matrix for best particle	[1, 1, 0, 0]
8.	k_1, k_2, k_3, k_4 matrix for bad particles	[0, 0, 1, 1]
9.	Maximum inertia weight	1
10.	Minimum inertia weight	0.6

VII. Development of Adaptive Protection Scheme

The developed algorithms in the scheme consist of several functions and each function performs a task in the protection system. The tasks include:

Current and voltage measurement

Fundamental frequency phasors estimation using Fast Fourier Transform (FFT)

Relay coordination using MPSO

Identification of current system topology

Fault detection and Estimation of fault direction using negative-sequence directional element.

In the adaptive protection scheme, communication between the DGs and relays is always performed through a Central Relaying Unit (CRU).

a) Function of each stage

Function of each of the stages in the developed APS are described below.

b) Current and Voltage Measurement

Firstly, current and voltage are measured at each DG to determine the DG's connection status. Then, the DGs connection statuses were received at a CRU through a fiber optic communication channel utilizing the IEC 61850 protocol. The received analog signals were represented by a binary '1' or '0' in case the DG is connected or disconnected respectively.

c) Identification of Current System Configuration

When all the connections signals are received at the CRU, the configuration of the power distribution system is determined. The new system configuration is compared with the old system configuration. If the new configuration is changed, a database containing previously determined minimum and maximum fault currents measured by the relays during system fault analysis was used. The maximum load currents, maximum and minimum fault currents for the existing system configuration are stored in the database. The fixed current transformer (CT) ratios are selected using 125% of the maximum load current at each relay. The tap settings are equally changed based on the system configuration, and are selected using the load current at each relay.

d) Fault Detection and Estimation of Fault Direction

The relays continuously check for fault occurrence. Once a fault is detected, the fault direction is identified using the negative sequence directional element and was implemented in the relays [8]. The relays then send their detected fault direction to the CRU using IEC 61850 protocol. The faulted section is identified when both relays at the beginning and end of that section see the fault in the forward direction.

When the faulted section is identified, the optimal TDS values and tap settings are determined by the CRU for the present system configuration. The optimal settings were determined using previously constructed database. The determined TDS values and tap settings are sent to the relays, using IEC 61850 protocol, to update their protection settings. There is a minimum coordination time of 0.3 s between the closest relay and the upstream relay. The new settings ensured that the closest relay is the fastest acting relay. If there is uncertainty during the faulted section detection, the TDS values and tap settings determined prior to the faulted section identification will be used by the system. The major strong point of Adaptive Protection Scheme (APS) is simplicity of application. [12] Nevertheless, APS has one point of defeat. The protection system does not get updates for any change in the power distribution system's configuration If there is communication system failure between the DGs, relays and CRU. As such, a backup protection scheme without communication system has been proposed. Block diagram representation of the APS is shown in figure 2.

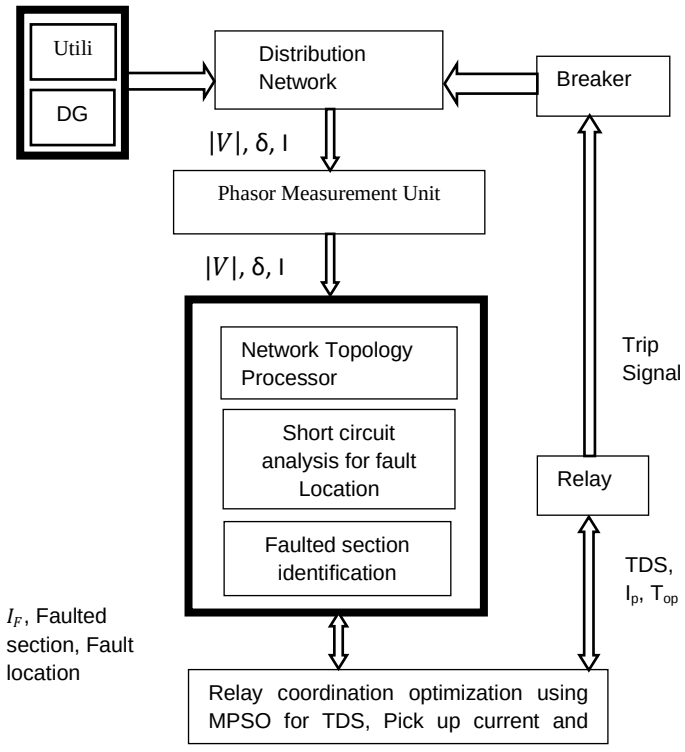

Figure 2: Adaptive Protection Scheme

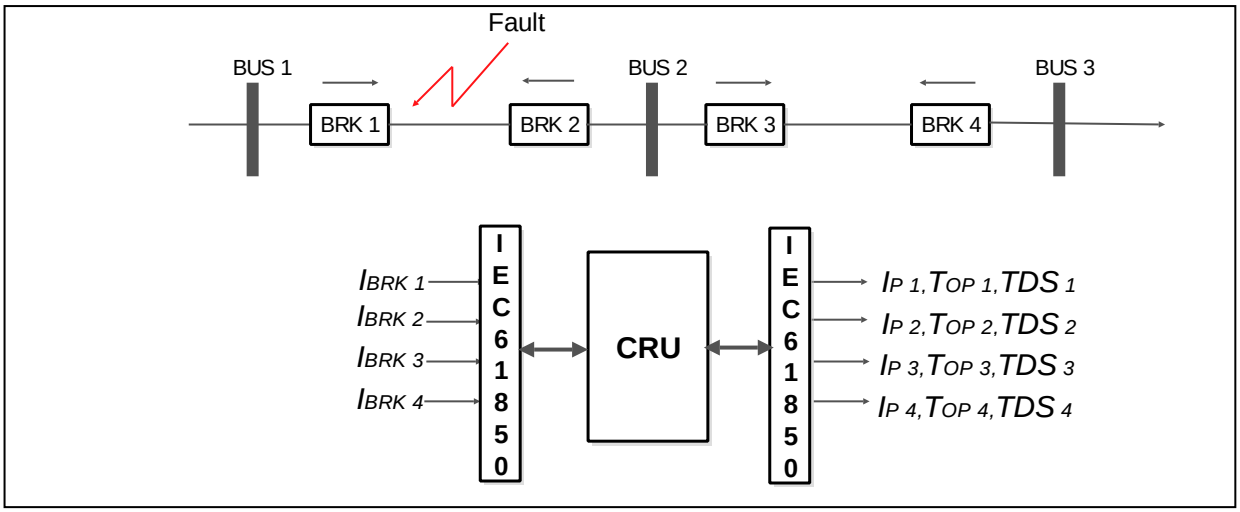

Figure 3: Graphical Representation of the adaptive protection scheme

VIII. Network Modelling using ETAP

Standard IEEE 33 Bus test distribution system was modelled in the ETAP and PSCAD environments with all the components represented. The models are shown in Figures 3 and 4 respectively

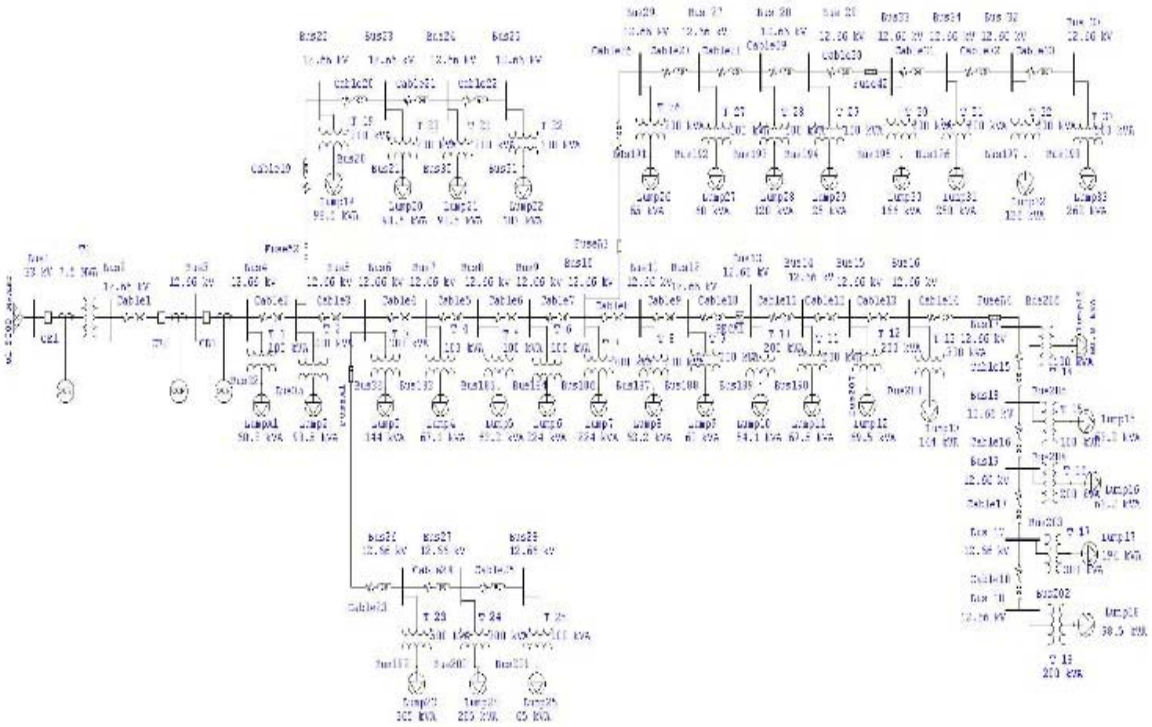

Figure 4: ETAP Model of IEEE 33 Bus test System

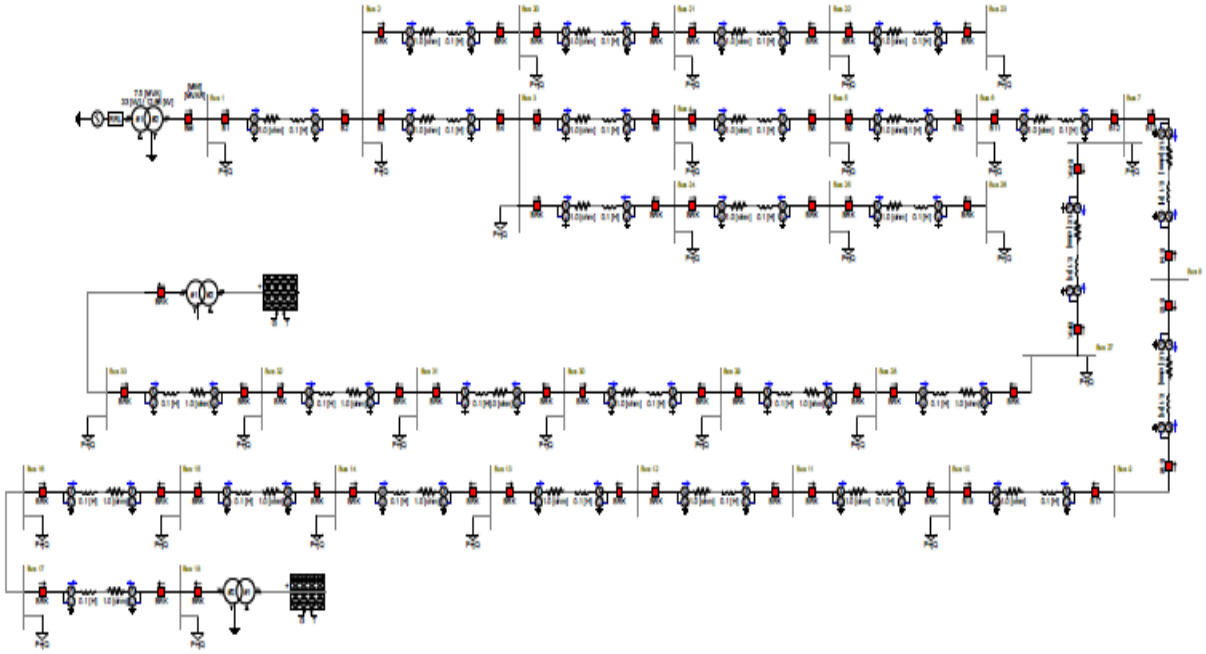

Figure 5: PSCAD Model of IEEE 33 Bus test System

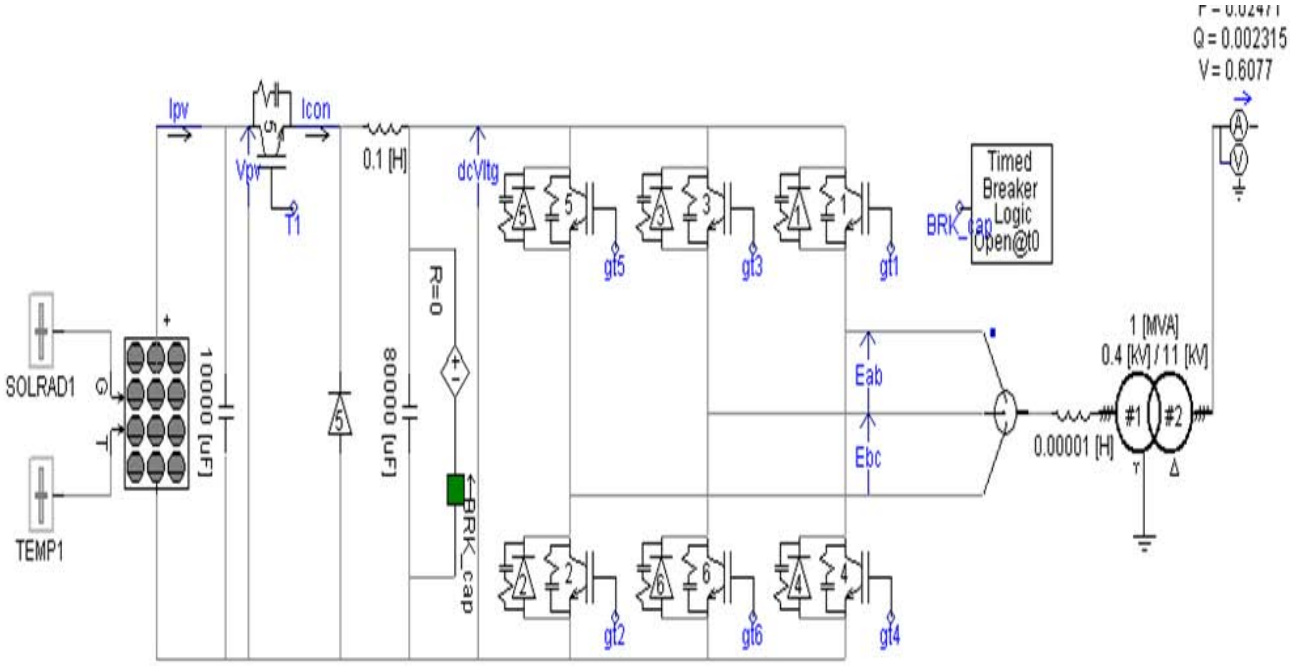

Figure 6: PSCAD Model of Solar PV System

IX. Results for Optimal Placement and Sizing of DG

To verify and validate the effectiveness of the developed MPSO based optimal placement and sizing of DG. Load flow studies were conducted using Hybrid combination of Back ward – Forward sweep with Newton Raphson method to determine power losses in the test system. MPSO was used to determine the optimal location and size of the DG considering two cases to reduce power losses and to improve voltage profile. The results for DG placement are shown in Tables 3.

Table 3: Best placement, Size and Power Losses

S/No	Parameter	Single DG	Two DG
1	Best Location	Bus 28	Bus 18 and 33
2.	DG size (MW)	1.87	1.41 and 0.51
3.	DG Type	Solar	Solar
4.	Initial power loss (kW)	221.43	221.43
5.	Final power loss (kW)	101.1	80.21
6.	% Power loss Reduction	48.85	61.51

Table 4: Bus violating Limit

S/No	Parameter	Without DG	With 1 DG	With 2 DG
1	Bus violating limits	18	5	0
2	Sum of square of voltage error	0.1369	0.02968	0
3	Total number of customers affected	1944	843	0

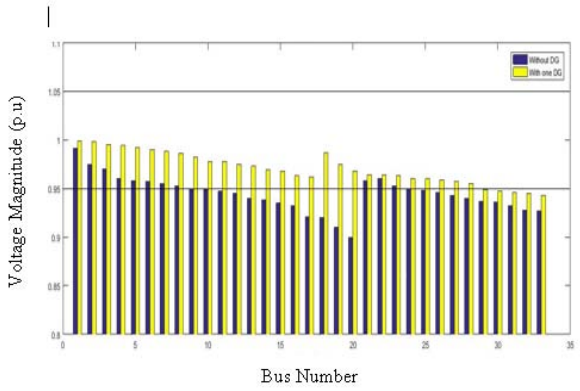

Figure 7: Voltage profile Plot for case 1

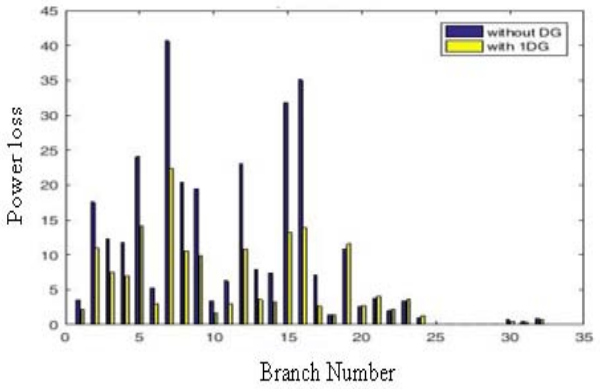

Figure 8: Power loss Plot case 1

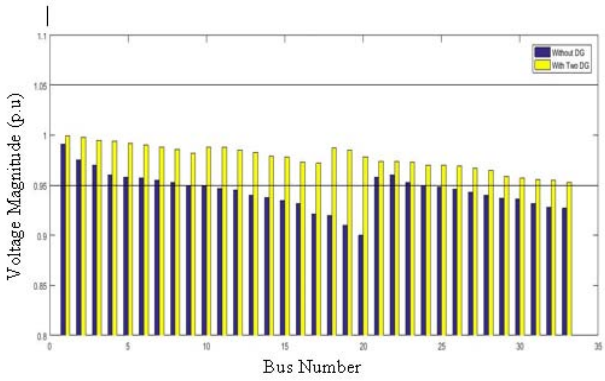

Figure 9: Voltage Profile Plot case 2

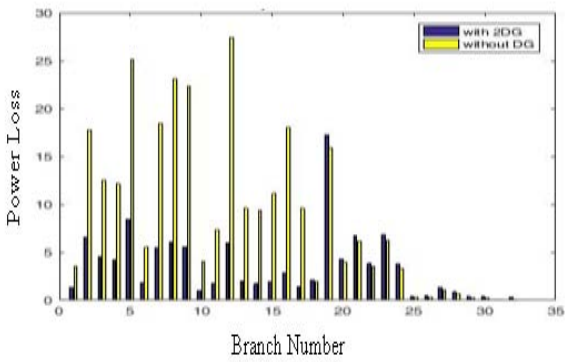

Figure 10: Power loss Plot case 2

X. Results for Short Circuit Current Level Simulation

Solar DG with power rating of 1.874 MW was connected at bus 28 and four different types of fault were created at buses 27 and 29. The magnitude of fault current at different locations are shown in Figures 10 and 11.

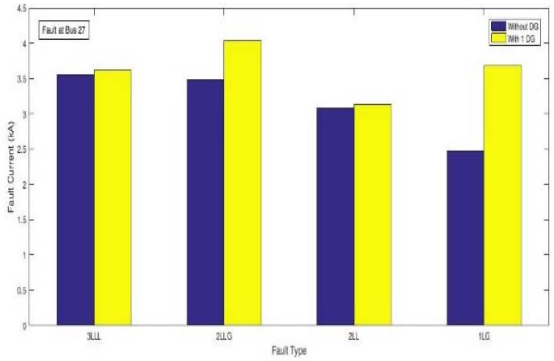

Figure 11: Fault Current for IEEE 33 - Bus Test System with Single DG at Bus 28 and fault at Bus 27

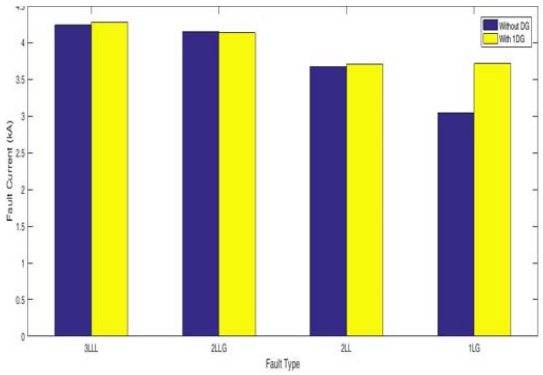

Figure 12: Fault Current for IEEE 33 - Bus Test System with Single DG at Bus 28 and Fault at Bus 29

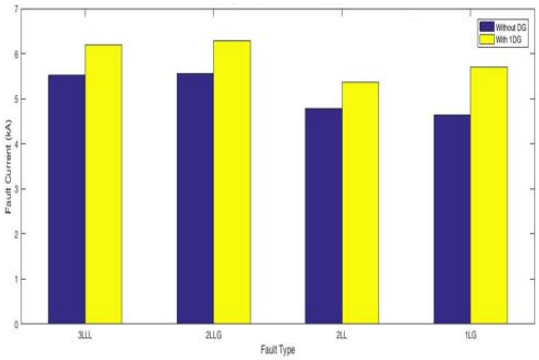

Figure 13: Fault Current for IEEE 33 - Bus Test System with Two DG at Bus 18 and Fault at Bus 17

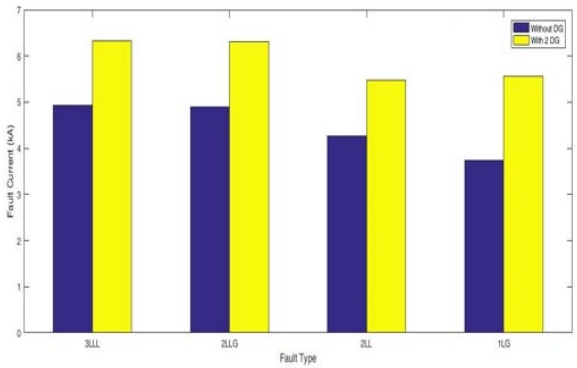

Figure 14: Fault Current for IEEE 33 - Bus Test System with Two DG at Bus 33 and Fault at Bus 32

XI. Coordination Simulation Results

To investigate the impact of DG on protection coordination, the networks were modelled and simulated using ETAP software for three different distribution networks. The sequence of operation of the protective devices for three phase to ground fault is as shown in Table 5.

Table 5: Sequence of Operation of Protective Devices

Number of DG	DG Bus	Fault Bus	Actual tripping		Correct Tripping	
			Primary	Backup	Primary	Back up
One DG	28	29	Fuse 3	DG1 Relay Main Relay	Fuse 3	Lateral Recloser3, Main Relay
Two DG	18 & 33	19	Fuse 4	Lateral Recloser 1, Main Relay	Fuse 4	Lateral Recloser1, Main Relay
Two DG	18 & 33	34	Fuse 3	DG2 Relay, Main Relay	Fuse 3	Lateral Recloser 3, Main Relay

XII. Ferro Resonance Simulation Result

To verify the existence of Ferro resonance in the distribution network when there is circuit breaker or fuse failure, part of the network was simulated using PSCAD. At the 33/11 kV injection substation with 7.5 MVA power transformer, switch was opened on phase B at the time of 0.1s and closed at 0.5s. The bus voltage and the transformer primary and secondary voltages were plotted in Figures 14 and 15.

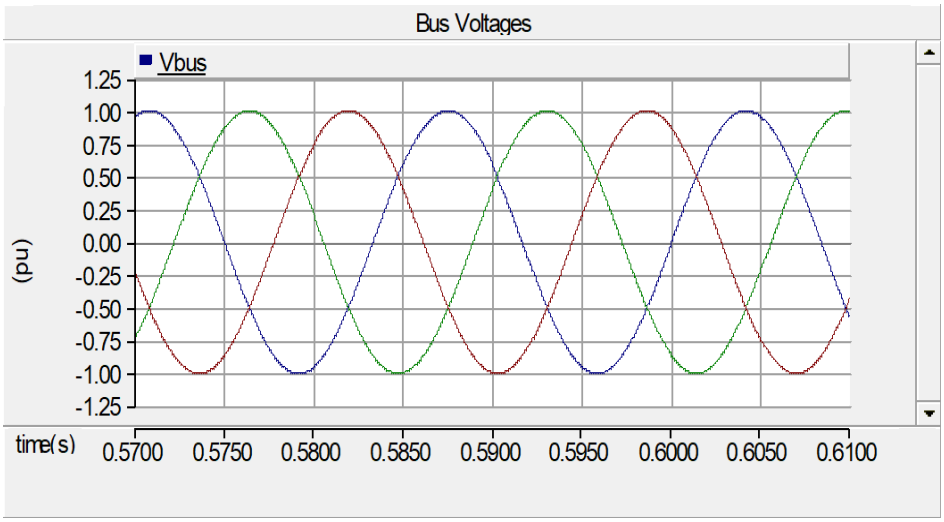

Figure 15: Three-Phase Transformer Bus Voltage

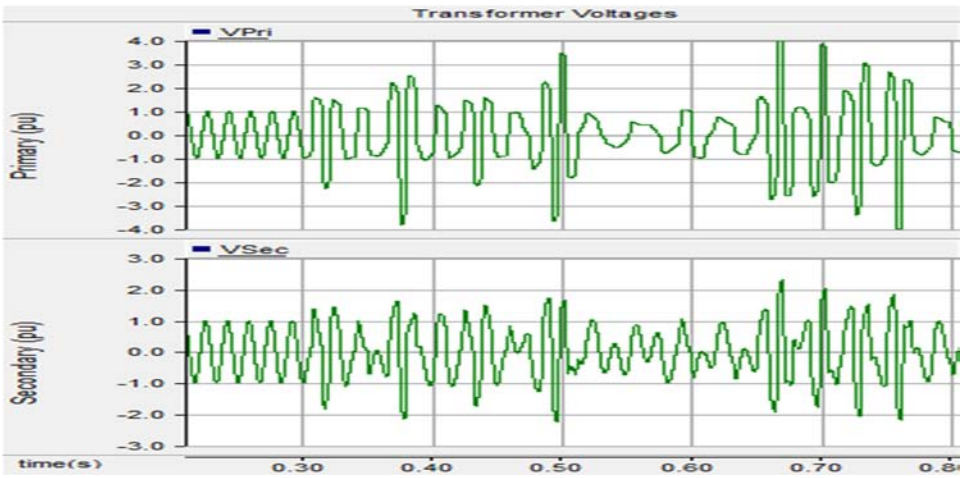

Figure 16: Transformer Primary and Secondary Voltage

XIII. Reliability Evaluation

To investigate the reliability of the system, the following reliability indices of the systems were evaluated using ETAP: System Average Interruption Duration Index. System Average Interruption Frequency Index, Expected Energy Not Supplied and ECOST.

Table 6: Reliability Indices

Parameter	Number of DG		
	Base Case	With One DG	With Two DG
SAIFI	1.8977	0.5231	0.4470
SAIDI	8.2084	3.4424	3.0293
CAIDI	4.326	6.581	6.776
EENS	29.336	16.147	11.211
ECOST	112,970.40	73,976.11	40,872.68
ASAI	0.9991	0.9996	0.9997
ASUI	0.00094	0.00039	0.00035
AENS	0.1424	0.0784	0.0544

XIV. Reconfiguration Results

Optimal number of switches and their locations is presented in Table 7.

Table 7: Number of Switches and their Locations

S/No	Distribution Network	Number of Switches	Switch Locations
1.	IEEE 33 Bus Test System	11	SW2,SW3,SW5,SW6, SW7, SW8, SW10, SW11, SW12, SW14, SW16,

XV. Network Reconfiguration Results for IEEE 33 - Bus Test System with Single DG

One solar power DG with optimal size as suggested by MPSO was connected to the model of the network at the optimal location. As a result of a fault introduced at a bus immediately after the bus with DG, fuse A3 opened after the third operation of the autorecloser at the beginning of the lateral. To reconfigure the network, SW A3 was manually closed. The model of the network used for the simulation, the number of buses isolated as a result of the fault and the corresponding number of customers and the number of buses restored and the corresponding number of customers are presented in Table 8.

XVI. Network Reconfiguration Results for IEEE 33 - Bus Test System with Two DG

Two solar power DGs with optimal sizes as suggested by MPSO was connected to the model of the network at the optimal locations. As a result of a fault introduced at a bus immediately after the buses with DGs, fuse A2 opened after the third operation of the autorecloser at the beginning of the lateral. To reconfigure the network, SW A4 was manually closed. The model of the network used for the simulation, the number of buses isolated as a result of the fault and the corresponding number of customers and the number of buses restored and the corresponding number of customers are presented in Table

Table 8: Number of Buses and Customers Isolated and Restored

Parameters	Number of DG			
	Single DG	Single DG	Two DG	Two DG
Fault Bus	29	29	16	16
Sectionalizing Switches opened	Recloser A3	Recloser A3and Fuse A3	Recloser A3	Recloser A2 and Fuse A2
Tie Switches Closed	-	SW A3	-	SW A4
Number of Buses isolated	8	4	9	4
Number of Buses restored	0	4	0	5
Number of Customers isolated	46	24	1042	621
Number of customers restored	0	22	0	421

XVII. Results on Development of Adaptive Protection Scheme

To validate the models created in PSCAD, the bus voltage at each of the buses were compared with the ones obtained using ETAP. And different simulation cases were performed to test the performance of the proposed adaptive protection schemes. Simulations include relay setting update for system configuration change, faulted section identification and interruption by the appropriate breaker. The simulations cases were performed to test all the three distribution systems as follows: The results for the fault current, breaker interruption and relay settings update are all plotted.

The network was modelled using PSCAD. Three cases were simulated for this network. The fault current seen by the relays, the interruption by breaker and the relay settings update were all plotted in Figures 17 to 22.

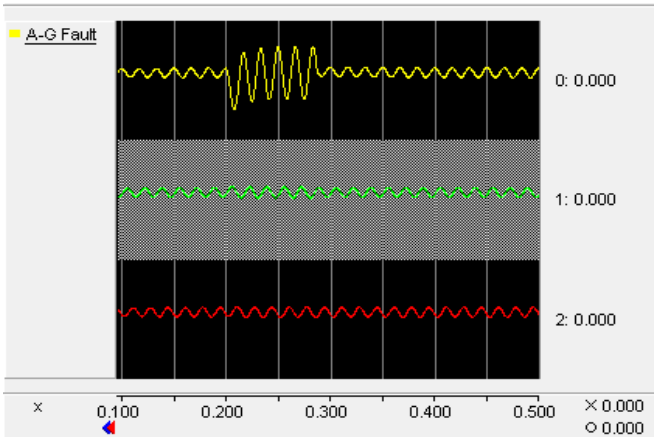

Figure 17: Fault Current Seen by Relay R28

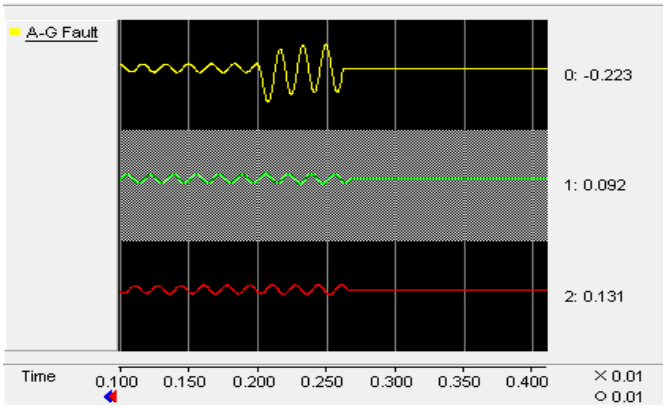

Figure 18: Interruption by Breaker BRKA28 for Case I

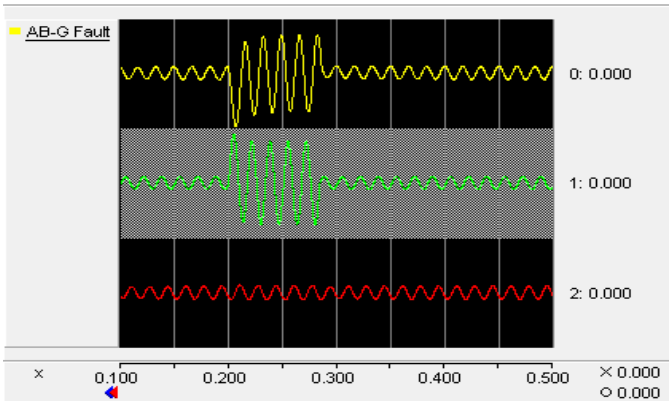

Figure 19: Fault Current Seen by Relay R19

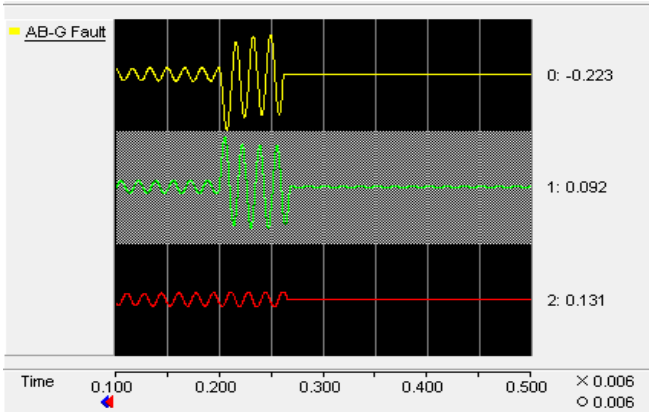

Figure 20: Interruption by Breaker BRKA19 for Case II

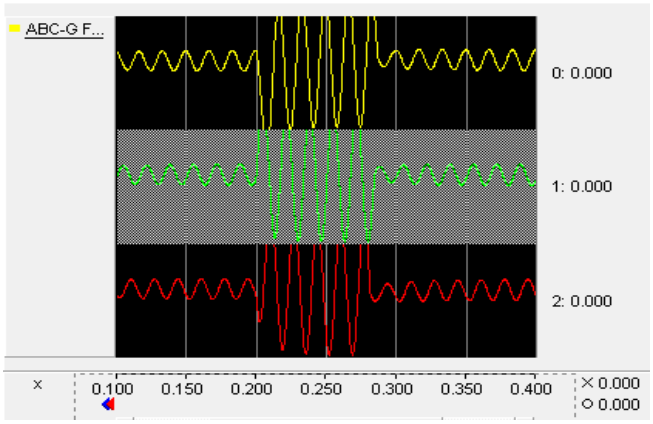

Figure 21: Fault Current Seen by Relay R32

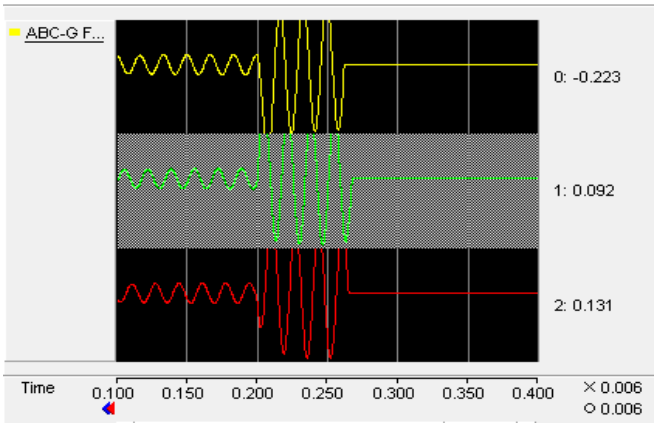

Figure 22: Interruption by Breaker BRKA32 for Case III

Case I: Simulation of IEEE 33 - Bus Test System power distribution system without DG for all the three types of fault. (Single line to ground, double line to ground and three line to ground). The relay settings are presented in Figure 23

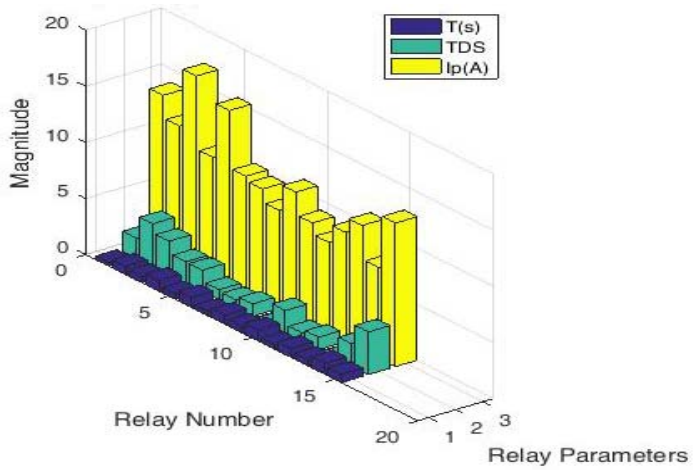

Figure 23: Relay Settings for IEEE 33 - Bus Test System without DG

Case II: One Solar power plant rated 1.874 MW was connected to the IEEE 33 - Bus Test System power Distribution system at bus 27 as suggested by MPSO. Single line to ground (A - G) fault was created at bus 28. The relay settings are presented in Figure 24.

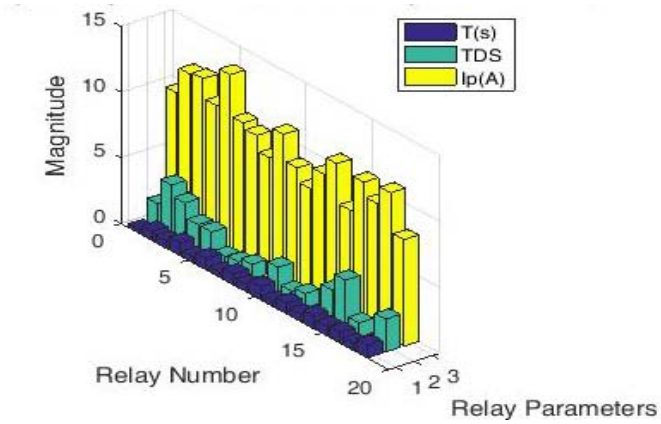

Figure 24: Relay Settings for IEEE 33 - Bus Test System for Case II

Case III: Two Solar power plants rated 1.4 and 0.5 MW were connected to the IEEE 33 – Bus Test System power distribution system at buses 18 and 33 as suggested by MPSO. Double - line to ground (AB - G) fault was created at bus 19. The relay settings are presented in Figure 25.

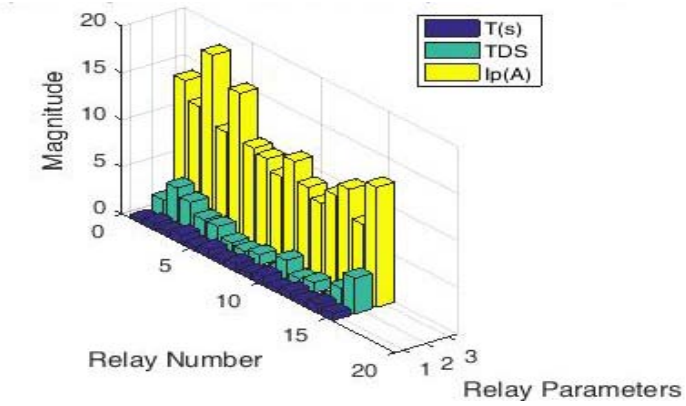

Figure 25: Relay Settings for IEEE 33 - Bus Test System for Case III

Case IV: Two Solar power plant rated 1.4 and 0.5 MW were connected to the IEEE 33 Bus power distribution system at buses 18 and 33.as suggested by MPSO. Three - line to ground (ABC - G) fault was created at bus 32. The relay settings are presented in Figure 26.

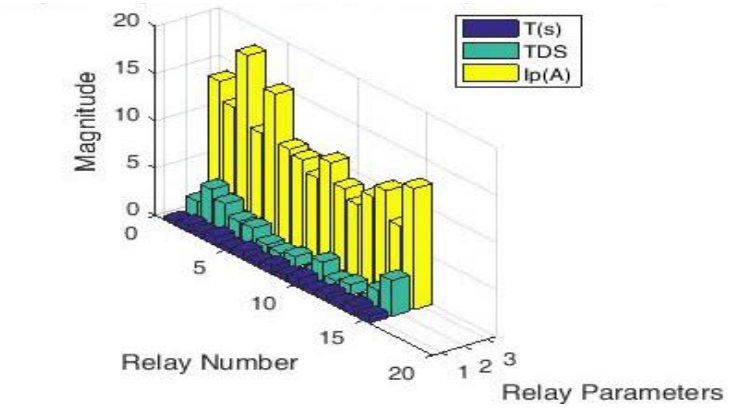

Figure 26: Relay Settings for IEEE 33 Bus Test System for Case IV

Case V: One Solar power plant rated 1.874 MW was connected to the IEEE 33 - Bus Test System power distribution system at bus 27 as suggested by MPSO. Single line to ground (A - G) fault was created at half the length of the lateral. The relay settings are presented in Figure 27.

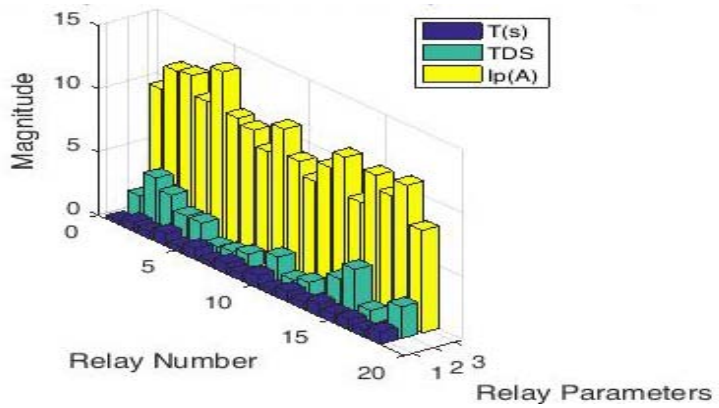

Figure 27: Relay Settings for IEEE 33 - Bus Test System for Case V

Case VI: Two Solar power plants rated 1.4 and 0.5 MW were connected to the IEEE 33 - Bus Test System power distribution system at buses 18 and 33 as suggested by MPSO. Double - line to ground (AB - G) fault was created at half the length of the lateral. The relay settings are presented in Figure 28.

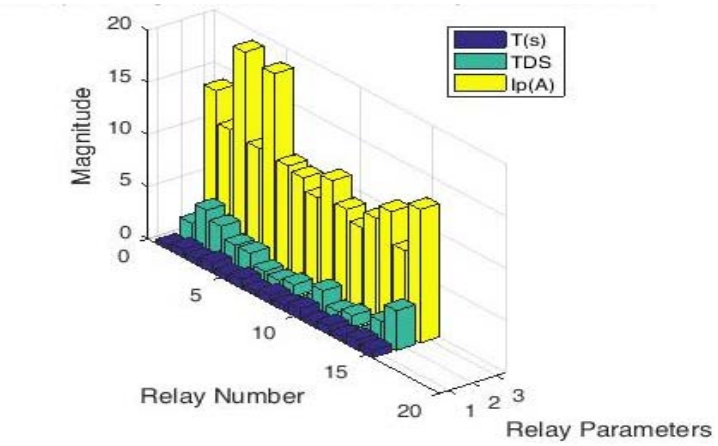

Figure 28: Relay Settings for IEEE 33 - Bus Test System for Case VI

Case VII: Two Solar power plants rated 1.4 and 0.5 MW were connected to the IEEE 33 – Bus Test System power distribution system at buses 18 and 33 as suggested by MPSO. Three - line to ground (ABC - G) fault was created at half the length of the lateral. The relay settings are presented in Figure 29.

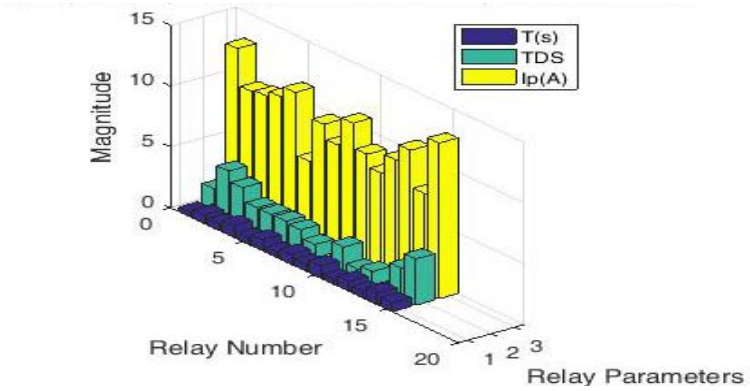

Figure 29: Relay Settings for IEEE 33 - Bus Test System for Case VII

Case VIII: One Solar power plant rated 1.874 MW was connected to the IEEE 33 Bus power distribution system at bus 27 as suggested by MPSO. Single line to ground (A - G) fault was created at the end of the lateral. The relay settings are presented in Figure 30.

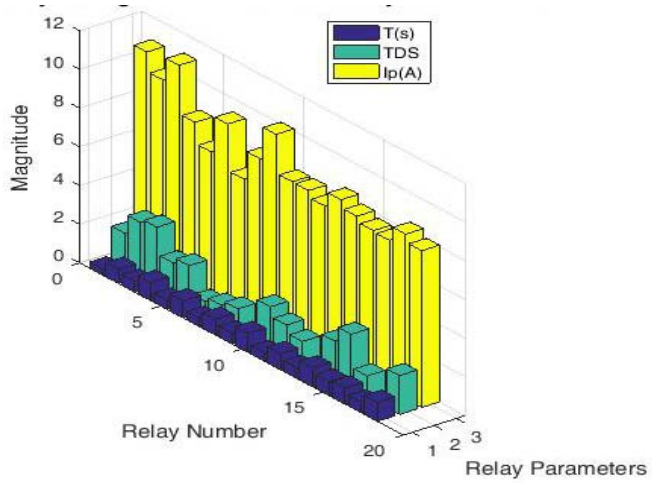

Figure 30: Relay Settings for IEEE 33 - Bus Test System for Case VIII

Case IX: Two Solar power plants rated 1.4 and 0.5 MW were connected to the IEEE 33 - Bus Test System power distribution system at buses 18 and 33 as suggested by MPSO. Double - line to ground (AB - G) fault was created at the end of the lateral. The relay settings are presented in Figure 31.

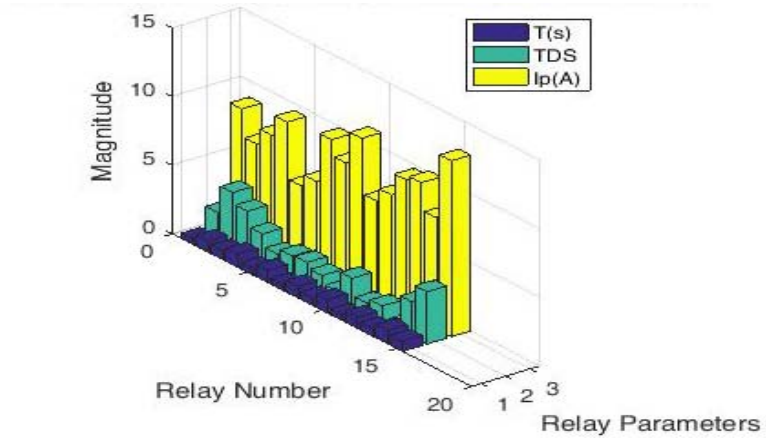

Figure 31: Relay Settings for IEEE 33 - Bus Test System for Case IX

Case X: Two Solar power plants rated 1.4 and 0.5 MW were connected to the IEEE 33 - Bus power Test System distribution system at buses 18 and 33 as suggested by MPSO. Three - line to ground (ABC - G) fault was created at the end of the lateral. The relay settings are presented in Figure 32.

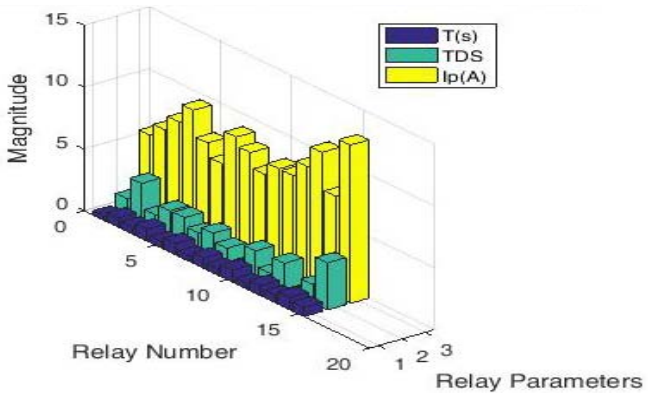

Figure 32: Relay Settings for IEEE 33 - Bus Test System for Case X

XVIII. Conclusions

DG are often used as back- up power to enhance reliability or as a means of deferring investment in transmission and distribution networks, reducing line losses, deferring construction of large generation facilities, displacing expensive grid supplied power, providing alternative sources of supply in markets and providing environmental benefits. However, power distribution systems integrated with DGs are always subjected to changes in the system configuration. During fault clearance or maintenance requirements, certain DGs might get disconnected. The changes in the configuration may lead to significant changes in the fault current level, which cause mis - coordination and malfunctioning of the previously coordinated directional overcurrent relays. To maintain proper coordination, protection relays should change their settings automatically whenever a change in the power system configuration occurs. Therefore, in this work, communication based adaptive protection scheme that can update the relay settings in accordance with the configuration of the network is proposed for distribution network with distributed generation.

Herein, MPSO was developed to optimally sized and sited DG which provides minimum power loss and enhanced voltage profile. IEEE 33 bus test system was used to test the effectiveness of the technique by integrating one DG and two DGs. And finally deployed for two Nigerian distribution networks: University feeder in Maiduguri and Ran feeder in Bauchi. The optimal location, DG size and percentage power loss reduction obtained for the IEEE 33 bus test system when single DG was integrated is bus 22, 2.59 MW and 47.3 % respectively when differential evolution was used while bus 28, 1.89 MW and 48,85% respectively when MPSO was used. For the second case i.e. integration of two DGs, the optimal location, DG size and percentage power loss reduction are buses 20 and 25, 1.58 and 0.97 MW and 50.6% for differential evolution and buses 18 and 33, 1.41 and 0.51 MW and 71.51% for MPSO. It can be concluded from the analysis that MPSO is gives better results in terms of power quality.

In this research, effort has also been made to model the three networks in both ETAP and PSCAD environment and evaluate the impact of DG on the protection systems when DG is integrated in the systems. The type of DG integrated was solar photovoltaic and Hydro power systems. The result shows that there was change in the fault current level and there was unintentional islanding and false tripping as a result of the current contribution from the DG.

The final goal of this research work concerned with the development of adaptive protection scheme for distribution network with DG using PSCAD. The operation of the adaptive protection scheme was verified through several simulation cases. The experimentation was carried out by conducting ten scenario cases with four different fault types. The simulation studies yielded far-reaching results that have been exhaustively discussed.

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SOFIA - Optical Operating System and Medical Analyses

By Rafael Gomes Botelho, Rafael dos Santos Maffei, Carlos Eduardo Bastos, Miguel Grequi, Miguel Furtado & Rafael Galli

Abstract- Nursing is an area of extreme relevance to society. It is an area that requires intense psychological due to excessive working hours. However, the accumulation of patients, added to the exhaustion of the routine, causes many nurses to face psychological problems, such as the Burnout syndrome. The assistance becomes impaired through a cascade effect. This set of questions ends up generating a considerable delay in attendance, causing the hospital queues to increase, which in turn causes an aggravation of the patients' diseases. The care of the elderly and children, especially children with down syndrome or autism, is more complicated and, without attention, can make these people feel uncomfortable, stressed, or even enter into a panic. The SOFIA project (Optical System of Operation and Medical Analysis) aims to provide public hospitals and other similar places with an electronic system that can perform a screening process more quickly, effectively, and non-invasively and monitoring the patients if necessary.

Keywords: *effective, clinical exams, totem robot.*

GJRE-F Classification: *FOR Code: 290901p*

Strictly as per the compliance and regulations of:

SOFIA - Optical Operating System and Medical Analyses

Rafael Gomes Botelho [α], Rafael dos Santos Maffei [σ], Carlos Eduardo Bastos [ρ], Miguel Grequi [ω], Miguel Furtado [¥] & Rafael Galli [§]

Abstract- Nursing is an area of extreme relevance to society. It is an area that requires intense psychological due to excessive working hours. However, the accumulation of patients, added to the exhaustion of the routine, causes many nurses to face psychological problems, such as the Burnout syndrome. The assistance becomes impaired through a cascade effect. This set of questions ends up generating a considerable delay in attendance, causing the hospital queues to increase, which in turn causes an aggravation of the patients' diseases. The care of the elderly and children, especially children with down syndrome or autism, is more complicated and, without attention, can make these people feel uncomfortable, stressed, or even enter into a panic. The SOFIA project (Optical System of Operation and Medical Analysis) aims to provide public hospitals and other similar places with an electronic system that can perform a screening process more quickly, effectively, and non-invasively and monitoring the patients if necessary. The device in question would sharply reduce nurses' workload, enabling them to perform other tasks, given that they could only take care of hospitalized patients or those in serious condition, thus avoiding the various problems mentioned above. The initial idea is for the construction of a totem robot that can travel to the ill, performing an initial interaction with the person while, at the same time, acquiring the patient's data, in addition to doing the screening process, being that initially, the robot would obtain the patient's temperature. That said, a thermographic infrared sensor, which will measure the temperature on the foreheads of a person, can fulfill this task. The active professional receives the data obtained at the end of the process. Also, to provide a broader range of tests, such as glucose level exams, it is intended to add other sensors. All mechanisms are controlled by a programmable microcomputer, which is very versatile for improvements and later changes in the project. SOFIA has several advantages, such as the reduction of the professional's excessive workload, reducing the cases of depression, or Burnout syndrome in them. It is worth noting this project's objective to help the professionals, never to replace them.

Keywords: effective, clinical exams, totem robot.

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I. Introduction

As reported in the media, the care of hospitals and health centers in Brazil has become increasingly precarious. Said precariousness is due to the excessive workload, unhealthy conditions, and lack of PPE's; this affects the psychological of the nurses, which can cause depression or Burnout syndrome, among other problems. All of this culminates in affecting patient care and the effectiveness of screening and monitoring. That said, the efficiency of care at health centers and similar places has become an increasingly relevant social problem in Brazil. Increasingly, patients in public hospitals feel uncomfortable to perform examinations or for simple temperature monitoring; also, we cannot ignore the nurse's health. Based on these facts, was developed the research project SOFIA - Optical System of Operation and Medical Analysis; Which aims to optimize the acquisition of conventional clinical examinations in the queues of hospitals and other similar places. The initial idea is the creation of an electronic system capable of acquiring the temperature in a non-invasive way, ensuring a considerable optimization of the medical service. The thermographic sensor would measure the patient's temperature and, through programmed speech and voice communication, the robot would make a record for the patient; the professional would receive the sent data.

II. Development

The first phase of the project's development aims to provide Brazilian hospitals and health centers with an electronic device capable of quickly and non-invasively screening patients, acquiring the results of conventional clinical examinations such as body temperature. The development of the project will take place in several stages. In its first stage, the system would be able to capture a person's temperature through the forehead with the thermographic sensor obtaining this data through a program on the microcomputer. This step, in turn, is already partially completed; a calibration was performed but aimed at to do a more detailed one focused on human applications. The new calibration process started, and; a small-scale prototype too. In the prototype, an ultrasonic sensor and a voice recognition sensor would use together. The robot would use programmed speeches to interact with

the patient. The idea would be to make the device able to detect the distance of the patient through the ultrasonic system and the programmed speeches. The robot would interact with the person asking for his data; In turn, the voice recognition device would capture everything the patient says and then set up their profile with the results of the screening; The doctor at the end of the process would receive these profiles via wifi. It is to add new sensors to perform other types of tests, in particular, the glucose test. The device would use the infrared to capture the level of sugar in the blood, so it would not be necessary to pierce the finger as is the conventional examination. The advantage of being done this way is that it is non-invasive; it would make people do it more often since many do not like the conventional way. This step would be developed based on the thesis "Glucose monitoring system in a continuous and non-invasive way to the human body based on spectroscopy and photoplethysmography methods" (Santos, Samuel, 2017). The aim is also to be able to use the thermographic image to perform the breast cancer exam; in this way, it would be non-invasive.

a) The micro-computer

The Raspberry pi 3 B plus (Figure 1), produced by the Raspberry Pi Foundation, is a micro-computer that uses the Broadcom BCM2837B0 processor, which is very versatile and intuitive. The microcomputer acquires the sensor data, sending this information to the professional. This development board selected for its high processing capacity and the ease of implementation of other sensors.

Figure 1: Raspberry pi 3 B plus

b) The thermographic sensor

The temperature sensor chosen was the AMG8833 (Figure 2); Panasonic Industries produced the device; however, the plate printed by Adafruit Industries, the same as a thermographic device, ends up capturing the temperature in the form of an image.

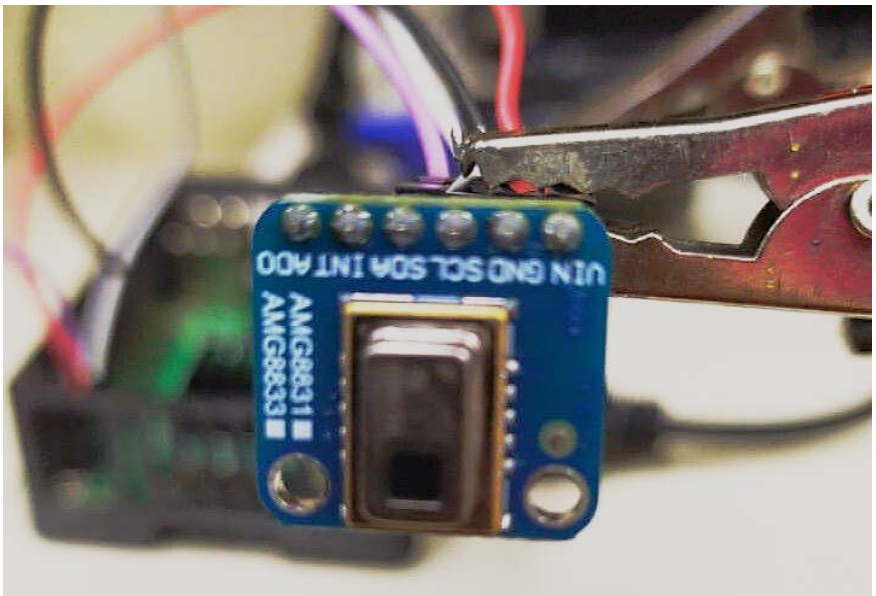

Figure 2: Thermographic sensor AMG8833

The AMG8833 has an accuracy of + - 2.5°C but can circumvent through calibration. It also uses the I2C interface, which facilitates the connection with the microcomputer. The minimum temperature for use would be 0°C and the maximum 80°C; it is also sensitive to humidity, operating at 15% to 85% R.H. Outside this range, it can end up deteriorating. The capture of the sensor can see it in Figure 3, where it shows the operation.

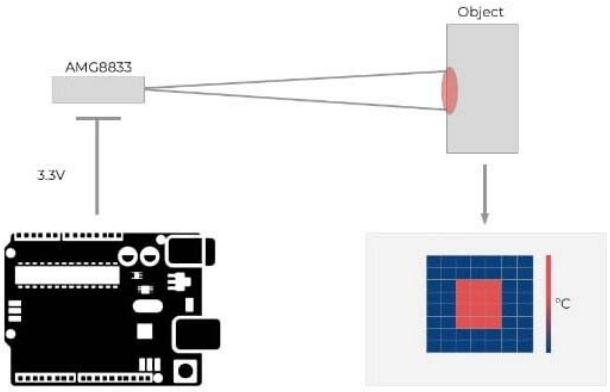

Figure 3: Diagram of operation of the thermographic sensor

It's worth point out that the acquisition distance also influences the reading, being that it measures up to 7m, however in practice, to measure a person, the maximum is + -30cm. The device itself works as a matrix; that is, if you capture the image of a specific point that is capable of measuring the human body, such as the forehead and the armpit when averaging that matrix, you find the temperature in common. That said, it was necessary to perform a calibration to make sure that the average is indeed correct. For this, were used a Peltier plate, a bench power supply, a multimeter, and a thermocouple. With the source, it was possible to control the temperature of the Peltier plate; the thermocouple would be the base temperature sensor. In this way, were recorded in an excel spreadsheet the values that the thermocouple and the sensor captured. Also, were noted the day temperature, humidity, current, and voltage, as seen in Figure 4; However, this was only for academic purposes; Since what matters in the graph is the thermocouple and sensor data.

TEMP	MOISTURE		
26°C	68%		
CURRENT	VOLTAGE	THERMOCOUPLE	SENSOR
0	0	28	2,4
0,05	0,2	29	31
0,1	0,4	29	23,567
0,15	0,5	30	3,85
0,2	0,8	31	24,733
0,25	0,8	33	26,367
0,3	1,2	34	27,3
0,35	1,3	36	29,9
0,4	1,5	38	31,5
0,45	1,7	40	32,433
0,5	2	43	34,717
0,55	2,2	46	35,7

Figure 4: Spreadsheet with sensor calibration values

After writing down the data, was created the graph and then get the equation to correct the errors. The thermocouple was X, and the sensor was Y, as can be seen in Figure 5

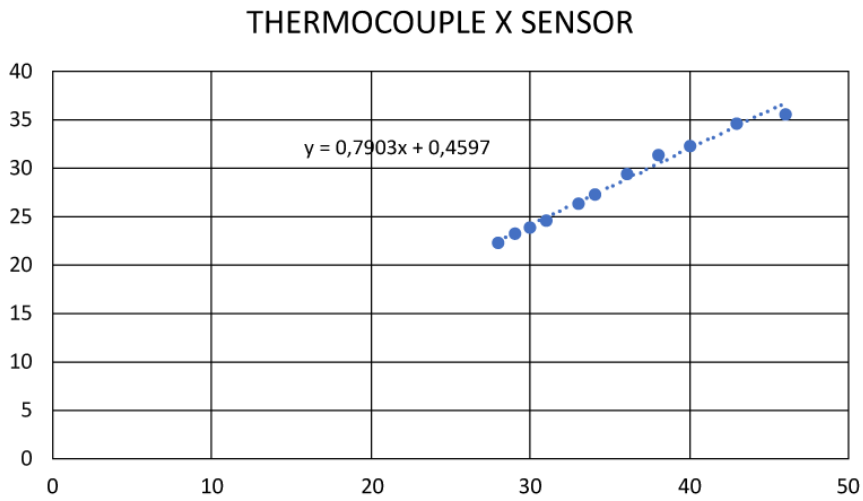

Figure 5: Graph of the temperature between the thermocouple and the sensor

In the sensor program to correct the errors of the amg8833, was placed the equation(1).

$$Y = 0{,}7903x - 0{,}4597 \quad (1)$$

However, it was an initial test; to correct all errors will be done a more detailed one. To not invade the patient's personal space, the equipment will have characteristics that can provide this requirement; and will be designed with materials that cannot damage the skin or cause any allergy or any other unforeseen to the patient.

c) Set Sensor-Microprocessor

The connection sensor-microprocessor is an I2C connection, as shown in Figure 6, so the red wire connects the raspberry's 3V3 pin to the VIN pin of the sensor; yellow connects the two SDAs; blue connects the two SCLs; and finally, black connects the two GNDs.

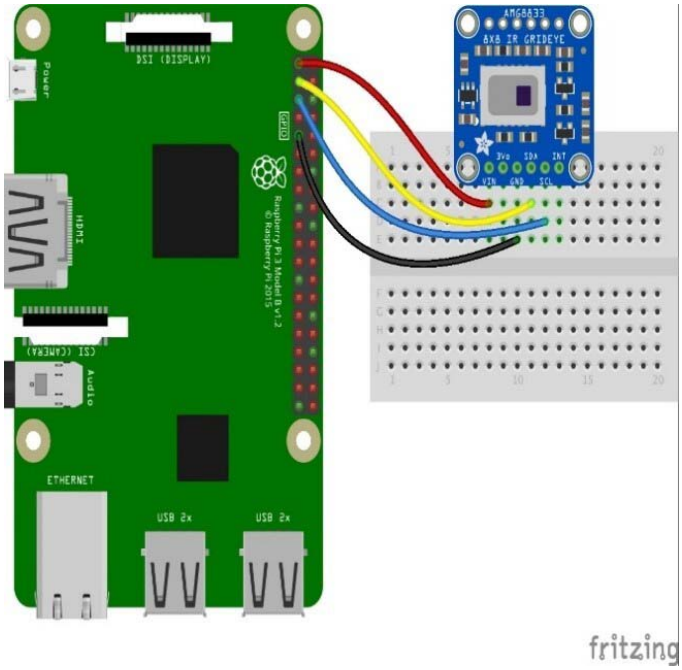

Figure 6: Mounting of the sensor and raspberry pi, avaliable at <https://learn.adafruit.com/adafruit-amg8833-8x8-thermal-camera-sensor/python-circuitpython>.

The basic program, available on the Adafruit Industries website (Rembor, Kattini, 2019), was posteriorly downloaded. Is not calibrated the initial code, than was necessary a calibration. After these processes, was placed in the program, the equation(1). With a thermographic sensor, it is possible to capture the body structure at the temperature, as in Figure 7. The idea would be to use it to detect other problems, being possible even to detect breast cancer.

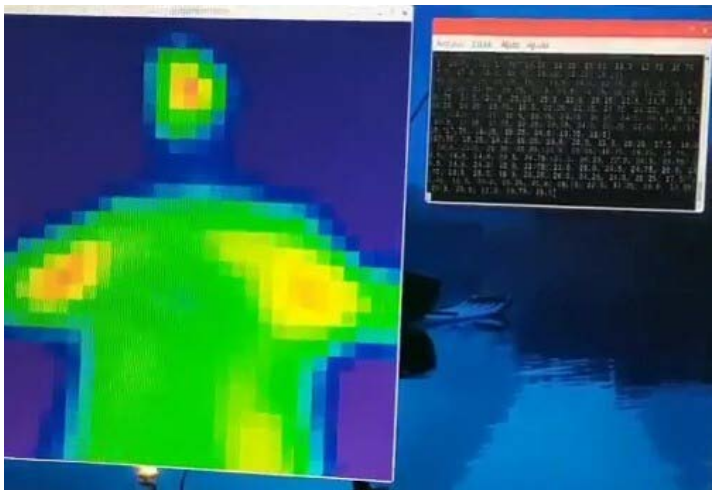

Figure 7: Thermographic image acquired in tests

However, the resolution of the sensor used is inferior to others; Is not yet discarded the possibility of getting such an exam. Despite the current work on calibration more detailed; Is building an attractive interface that would send the data to the active professional; A patient's record, with name, blood type, current temperature. All this information, through voice, would be computed; This would be very attractive for children, especially those with down syndrome or autism.

d) Distance sensor

To obtain the right distance for an ideal temperature reading will be used as an ultrasonic sensor, the model HC-SR04 (Figure 8); The sensor works with distances from two centimeters to four meters.

Figure 8: Sensor HC-SR04

The idea is to use prepared speeches where it will tell if the patient should move away or get closer, to leave him where the sensor can measure the temperature correctly.

e) Prototype

As stated earlier, the intention is to create a small-scale prototype; the idea is to create a totem robot. The project already has a prototype design (Figure 9).

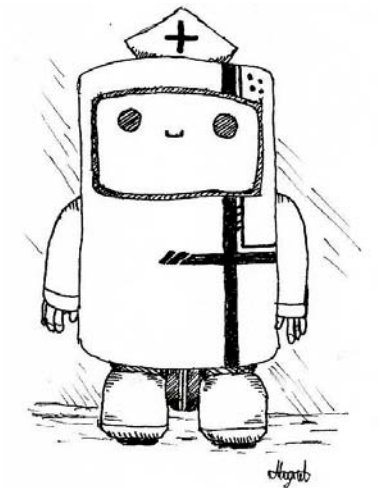

Figure 9: Design of the totem robot, created by the artist Miguel Furtado

The design was made especially for this project; the robot's face would consist of a small LCD screen that connects to the raspberry, the sensor would be in the lower right corner.

III. Results and Discussions

Currently is partially completed the calibration process for the AMG-8833 thermographic sensor. The device already works with the initial calibration; however, to achieve greater precision and superior quality in temperature acquisitions, a more detailed calibration will be performed. The project presented at technological exhibitions and the result of the temperature measurements with the initial calibration is entirely satisfactory. To analyze the approval of the project will be carried out a popular survey. Will interviewed health professionals to obtain an approval index about the possible effectiveness of the prototype in the field, possible implementation in health establishments in Brazil, and widespread approval regarding the willingness to undergo robot analysis.

IV. Conclusions and Future Works

The project has many health benefits; As mentioned before, it could decrease the nurse's workload, thus reducing cases of exhaustion that lead to depression or burnout syndrome, in addition to improving care, making it faster and not invasive. There are still some issues, more accurate calibration, and the prototype test in the field. Despite this, it already shows great potential; Since, with the initial calibration, it was already able to measure people's temperature correctly. It is estimated to create an interactive interface in conjunction with the programmed speeches; this would facilitate the user's interaction with the robot. After the exchange, as previously mentioned, the active professional would receive the obtained data professional. It is intended in the future to add other sensors to expand the range of exams. In principle would be created a sensor to measure glucose based on infrared, as it would be non-invasive without the need to pierce the finger. The idea for the construction of this device is based on the "Glucose monitoring system in a continuous and non-invasive way to the human body based on spectroscopy and photoplethysmography methods" (Santos, Samuel, 2017). Also, the possibility of obtaining another thermographic sensor more powerful, it is being studied. Still, of low cost, the idea will be to use it to perform the examination of breast cancer in a non-invasive way.

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For scanned images, the scanning resolution at final image size ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs): >350 dpi; figures containing both halftone and line images: >650 dpi.

Color charges: Authors are advised to pay the full cost for the reproduction of their color artwork. Hence, please note that if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a Color Work Agreement form before your paper can be published. Also, you can email your editor to remove the color fee after acceptance of the paper.

Tips for Writing a Good Quality Engineering Research Paper

Techniques for writing a good quality engineering research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of research engineering then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.

6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.

- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

Administration Rules to Be Strictly Followed before Submitting Your Research Paper to Global Journals Inc.

Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection.

Segment draft and final research paper: You have to strictly follow the template of a research paper, failing which your paper may get rejected. You are expected to write each part of the paper wholly on your own. The peer reviewers need to identify your own perspective of the concepts in your own terms. Please do not extract straight from any other source, and do not rephrase someone else's analysis. Do not allow anyone else to proofread your manuscript.

Written material: You may discuss this with your guides and key sources. Do not copy anyone else's paper, even if this is only imitation, otherwise it will be rejected on the grounds of plagiarism, which is illegal. Various methods to avoid plagiarism are strictly applied by us to every paper, and, if found guilty, you may be blacklisted, which could affect your career adversely. To guard yourself and others from possible illegal use, please do not permit anyone to use or even read your paper and file.

Criterion for Grading a Research Paper (Compilation) by Global Journals

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals.

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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