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A New Data Driven Approach

License Plate Recognition System

Highlights

Proposed Iraqi Vehicle License

Prewitt Edge Detection Algorithm

Discovering Thoughts, Inventing Future

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Android Controlled Smart Wheelchair for Disabilities

By Tarun Debnath, AFM Zainul Abadin & Md. Anwar Hossain
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Abstract- This paper describes a control technology of wheelchair which may feel more flexible than traditional joystick controlled one. The main objective of our research is to develop new control architecture for a motorized wheelchair as well as an embedded system for monitoring critical patients. Such a smart wheelchair is designed for the disabled people in the developing countries as it will be very low-cost than existing others. Controlling is possible by android operated mobile or tab. In addition to button control, motion sensor controlling mechanism also has implemented. Moreover, bio-metric features have made wheelchair more suitable for critical patients. If the patient is in hostile condition, the wheelchair will produce an alert by raising the alarm with the measurement of the heartbeat at a particular interval.

Keywords: *handicapped, motorized wheelchair, android controller, motion controlled wheelchair, SOS, smart monitoring, bio-metric, accelerometer and GSM.*

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Android Controlled Smart Wheelchair for Disabilities

Tarun Debnath [α], AFM Zainul Abadin [σ] & Md. Anwar Hossain [ρ]

Abstract- This paper describes a control technology of wheelchair which may feel more flexible than traditional joystick controlled one. The main objective of our research is to develop new control architecture for a motorized wheelchair as well as an embedded system for monitoring critical patients. Such a smart wheelchair is designed for the disabled people in the developing countries as it will be very low-cost than existing others. Controlling is possible by android operated mobile or tab. In addition to button control, motion sensor controlling mechanism also has implemented. Moreover, bio-metric features have made wheelchair more suitable for critical patients. If the patient is in hostile condition, the wheelchair will produce an alert by raising the alarm with the measurement of the heartbeat at a particular interval.

Keywords: handicapped, motorized wheelchair, android controller, motion controlled wheelchair, SOS, smart monitoring, bio-metric, accelerometer and GSM.

I. Introduction

Human being is the most beautiful creation of the universe, but much unexpected accidental disabilities or autistic by born have to carry through the tenure of life. Such a disable person feels helpless and becomes disappointed to lead their life. The physically disable, and paralyzed individuals accomplish their movement through manual or powered wheelchair. While manual wheelchair operation involves other's help, the power wheelchair can be operated using joystick, touch screen, voice gesture based or any other control technologies [1]. As many of the wheelchair users do not feel comfortable with joystick and speech recognition is often creates problems and difficulties when we target more than a single user [2]. Researchers are developing sophisticated control technologies for physically disables. An android controller can be a better substitution of joystick and voice-controlled. Like a touch screen button, a person can control his wheelchair by pressing the android button. Besides that, it is also possible to control the devices using the tilt of the mobile. Tilting feature can be supportive of one-sided paralyzed patients who do not get enough strength in their fingers. Biometrics feature also has been implemented in the system.

If the patient or disabled person is in hostile condition, the wheelchair will produce an alert signal through ringing alarm with the measurement of patient's heartbeat. If required an SMS can be sent to any individuals mobile using GSM shield [3]. The whole system development has accomplished in two phases. Initially, the simulation-based prototype has developed and finally, the developed prototype has implemented as a smart wheelchair. The hardware development platform has implemented using PIC Microcontroller, and software development has completed in Java and Android programming. The system tested on various surfaces by some disabled persons with required moderation to test the effectiveness and evaluate performance.

II. Transmitting Unit Architecture

a) System Block Diagram

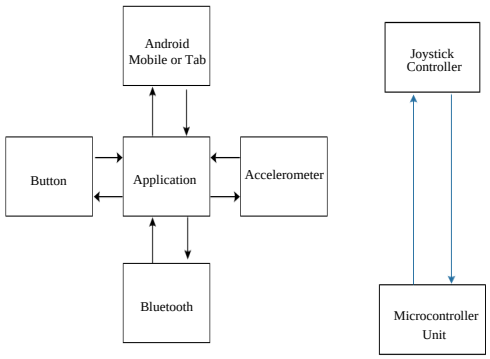

Fig. 1: Block diagram of android & joystick to receiving unit transmission architecture.

Fig. 1. shows separate control architecture for target wheelchair. The first one shows, controlling data communication architecture from android to wheelchair receiving unit over Bluetooth link. The button control interface and the Android sensor produce the same control information. After that separate controlling data will communicate with the device [4]. Another benefit of adding a joystick controlling interface besides Android, will give some advantages. For example, if the mobile device charges run out at the time of traveling, the joystick controlling can be fruitful. Here we will discuss only the android controller, because the joystick sends data directly to the microcontroller. The rest of the process is similar to Android. The concept of Android

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control architecture is like an Android game that we play on our Android phone.

b) Interface Anatomy

Fig.3 explains active and inactive regional view of accelerometer through the coordinate system of motion controlling interface. We know there are three axes in an accelerometer. Smartphone Accelerometer is a semiconductor IC that employs piezoelectric effect and measures the intensity of change along the x, y, and z-axes. *Yaw, pitch, and roll refer to the rotation of the device in these three axes, but the vertical acceleration that is measured by z-axis is not essential for our application. That's why z-axis has eliminated in this architecture.*

The circle of axes pictogram indicates stop region.

When the x and y-axis gravitational value is less than the threshold value, the device performs a stop operation. This value has set by measuring one-third of the gravitational force g. The app will send the stop command of the microcontroller via Bluetooth. Otherwise, the application sends front, back, right and left operation data by mobile rotation. On another side of "Button controlling interface" includes press & hold buttons for each of the commands using in motion controlling. We are using to press and hold button for our driving. So when we lift the finger from the screen button, the stop operation is done automatically.

In case of any urgent situation, SOS (Save Our Soul) dials or Emergency number dial option has included with the mobile application. If the user gets stuck in an uncertain state, he would be able to call one or more SOS numbers. In addition, he can send an SMS to a predefined cell number. This is an additional feature, it can help the user in case of any emergency when using the application for driving [5] [6]. The flow chart given below explains total transmitting unit architecture at a glance.

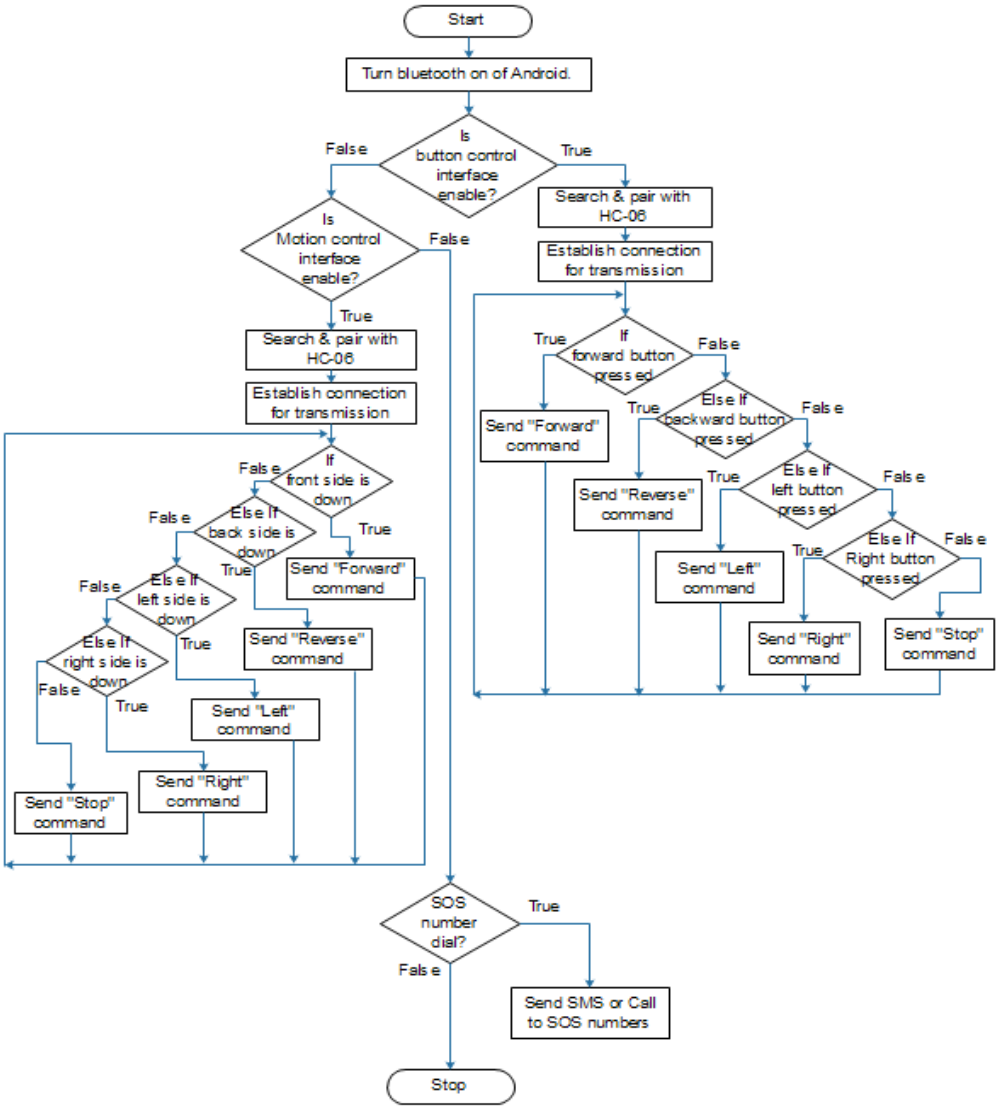

Fig. 2: Transmitting app Flow chart.

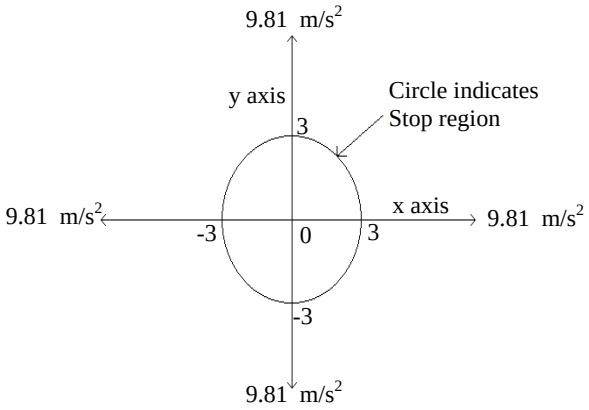

Fig. 3: Coordinate system for motion controlled interface.

III. Receiving Unit Architecture

a) System Block Diagram

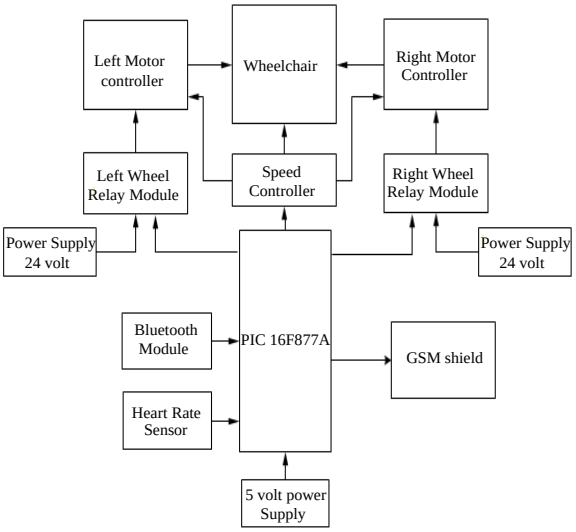

Fig. 4: Block Diagram of Receiving unit.

The above figure shows whole receiving system block diagram of our wheelchair, the brain of the receiving system is PIC16F877A Microcontroller, which performs forward, reverse, 360 degrees left turn, 360 degree right turn and break commands. There is some extra facility for the emergency. That is real-time patient monitoring.

b) Patient Monitoring Circuitry

The heart rate sensor performs real-time patient monitoring by counting the number of beats in the heart. This process is terming as smart monitoring. As it varies from man to man, it is possible to set the value manually. By default, we have selected the lower threshold as 60 and the upper threshold value as 90. This standard for an adult is very normal. When the heart rate is more or less than threshold, it waits for 5 seconds, and then again observes the condition of the user. If the sensor finds such an unusual situation, SMS (short message service) is sent to emergency SMS numbers through GSM circuits. To complete this purpose, we can use any heart rate sensor, or it can be made manually [7].

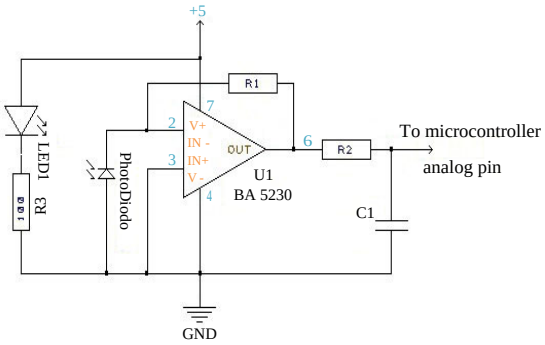

Fig. 5: Heartbeat monitoring circuit.

Where,

Feedback R1 = 1MΩ

Low-Pass filter R2 = 100Ω, C1 = 4 μF

c) Hardware implementation

The hardware implementation has done in both mechanical & electronics parts. Those three control box shown in Fig.6 consist of electronics parts. That includes Microcontroller, assembly of Relay, Bluetooth module, GSM (Global System for Mobile Communication) module circuitry. After receiving commands, microcontroller initiates ports to operate the Relay.

Fig.7 shows assembly of the system. Where mechanical parts of the wheelchair include 24 volts, 250 watts, 150 rpm DC gear Motor and four pcs 12 volts batteries [8]. The connection between motor and batteries has established by motor controller and relay circuit. That helps in *forward & reverse direction rotation*. For turning in a shortage amount of space, the rotation of the wheel in both forward and reverse direction is more significant. Moreover, the speed controller circuit provides variations in speed manually according to user's desire by a suitable potentiometer. Different speed variations can be possible in future using PWM (Pulse Width Modulation).

Fig. 6: Control box and Battery assembly.

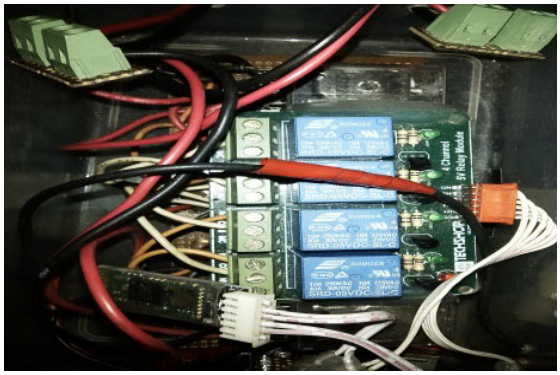

Fig.7: Relay and HC-05 Bluetooth circuit assembly.

Fig. 8: Android controlled smart wheelchair for disabilities.

IV. Conclusion

The system has considered and designed to make lives better for the disabled society. For this, the prototype and the whole system have implemented considering sufferings of the people, who are dependent on the wheelchair for their mobility. Various people with disabilities have tested the prototype for 15 days. Various changes in the system have done according to their wishes. Wheelchair operating application has designed and developed in an easier way so that the general people of our country can easily drive this wheelchair. Fig.8 shows the finally developed system. The aim of our research is to design, and improvement of a modern low-cost android controlled smart wheelchair for disabled people with higher flexibility and better assistance.

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Multi Modal Medical Image Registration: A New Data Driven Approach

By C.Hemasundara Rao, P.V.Naganjaneyulu & Dr. K. Satyaprasad
JNTUK University

Abstract- Image registration is a challenging task in building computer-based diagnostic systems. One type of image modality will not be able to provide all information needed for better diagnostic. Hence data from multiple sources/image modalities should be combined. In this work canonical correlation analysis (CCA) based image registration approach has been proposed. CCA provides the framework to integrate information from multiple sources. In this work, the information contained in both images is used for image registration task. T1-weighted, T2-weighted and FLAIR MRI images has Multimodal registration done on it. The algorithm provided better results when compared with mutual information based image registration approach. The work has been carried out using the 3D rigid registration of CT and MRI images. The work is carried out using the public datasets, and later performance is evaluated with the work carried out by Research scholars previously.

Keywords: image registration, CCA, CT, MRI, T1, T2, FLAIR, FD, MIR, Rigid registration, MI, NMI, SSD, SAD.

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Multi Modal Medical Image Registration: A New Data Driven Approach

C.Hemasundara Rao [α], P.V.Naganjaneyulu [σ] & Dr. K. Satyaprasad [ρ]

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Keywords: image registration, CCA, CT, MRI, T_1, T_2, FLAIR, FD, MIR, Rigid registration, MI, NMI, SSD, SAD.

I. Introduction

The medical image registration process is used to estimate the deformation between the images while considering the domain specific Information into consideration. A closer look at the problem statement intuitively reveals two methods of solving it. The first method operates directly on two different images have intensity values called intensity based registration [1], continuously transforming the entire image to align it with the other. When desirable alignment is obtained for the respective transformation, the optical representation is considered to be registered. These methods are called area based methods [2, 3]. The second method relies on a few salient points which are most prominent in both the images. The goal here is to estimate the deformation based on the corresponding pairs of points/regions across the images.

These are known as feature-based medical picture based on brain methods, have gained popularity over the area based methods These methods[4] are more robust to illumination changes, a partial overlap between the images, occlusion, alterations in background, and viewpoint. Area-based methods are still preferred over feature based techniques, despite these advantages in the medical domain due to two main factors:

1) Its ability to handle local deformations, especially with the case of human organs.
2) Its capability of Dealing with information from different imaging sources.

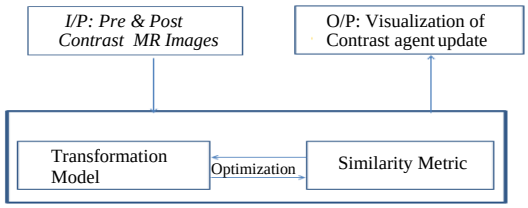

Fig. 1: Image Registration Process

a) Transformation

Transformation step is to determine the position of corresponding points in reference and sensed images, Medical Image Registration (MIR) is considered as a combination of translation, rotation, and scaling parameters. Image registration methods employ transformations such as rigid, affine and elastic (non-rigid transformations [5]. The rigid transformation considers t_x and t_y translations along the x-axis and y-axis, and a rotational angle θ for the registration process [6]. It assumes that the subject in the image maintains its shape and size [7]. Affine transformations offer a high degree of flexibility in accommodating linear distortions by allowing and shearing in addition to translation and rotation [8]. The non-rigid transformation provides more degree of freedom as compared to rigid and affine transformation.

b) Optimization

Optimization problem is formulated by a number of parameters used for transformation [9] to get the maximum value of similarity, for a given registration

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process. The choice of the transformation is dependent on the type of application and its geometrical complexity (i.e., degrees of freedom). Although an exhaustive search guarantees an optimal solution, its computational expense is proportional to the size of the search space as well as the number of parameters used for transformation and, hence, becomes infeasible as they increase [10]. Therefore, these forms the motivation to explore refined search strategies or optimization methods which can help to find the maximum value for a given similarity measure.

Optimization method should be reliable and be capable of finding the best possible transformation quickly [11]. Many optimization methods have been introduced and adopted for the registration process, by the transformation parameters, similarity measure, time restrictions and required accuracy of registration.

c) Similarity Measure

Similarity measure gives the ability to determine the level of global correspondence between two images. During the registration process, the parameters of a given transformation model are changed, based on the optimization technique until the similarity measure reaches a maximum value of alignment[12].Hence the choice of similarity measure along with optimization method plays a crucial role to a successful outcome of a registration process.

II. Image Registration Algorithm

a) Medical Image Registration

In Non-rigid registration consists of Non-rigid transformations can be broadly classified by physical models or basis function expansion. While linear elasticity (Moshfeghi,1991), viscous fluid flow [13] and optical flow [14] are examples of physical model-based transformations, radial basis functions [15], multi quadrics [16], thin-plate splines [17], B-spline [18], wavelets [19] and piecewise affine transforms [20] are some of basis function expansion transformations, involves finding the optimal geometric transformation that maximizes the correspondences across the images. Medical Image Registration consists of components such as Transformation Model, Similarity Metric and Optimization Techniques as shown in Fig 1. An image registration algorithm defines an objective function based on the similarity measure and tries to maximize this objective function. In the proposed method, a new registration method has been explained using canonical correlation analysis (CCA).

b) Canonical Correlation Analysis (CCA)

Canonical Correlation Analysis (CCA) can be seen as the problem of finding the basis vectors for two set of variables such that correlation between projections of the variables on these basis vectors is mutually maximized.

CCA seeks a pair of linear or nonlinear transforms one for each step of variables, such that when one set of variables, is transformed, the corresponding coordinates are maximally correlated. CCA used in image retrieval, image fusion [21] and object recognition problems [22] in computer vision.

CCA finds the relationship between two multi-dimensional datasets [21]. The basic formulation of CCA is as follows:

For a given two multi-dimensional data sets of basis vectors or projection vectors wx, wy respectively, for two data sets that maximize the correlation between the random variables $x=w_x^T(xi-x)$ and $y= w_y^T(yi-y)$,

$$\rho = \frac{E[x,y]}{\sqrt{E[x^2]E[y^2]}} = \frac{E[\widehat{Wx}^T xy^T \widehat{Wy}]}{\sqrt{E\left[Wx^T \widehat{xx}^T \widehat{Wx}\right] E[\widehat{Wy}^T yy^T \widehat{Wy}]}} \quad (2.1)$$

$$\rho = \frac{\widehat{Wx}^T Cxy Wy]}{\sqrt{[Wx^T] Cxx Wx\, Wy^T Cyy Wy}} \quad (2.2)$$

C_{xx} and C_{yy} are the within- class covariance matrix and, C_{xy} is the cross -covariance matrix. Maximum correlation has been found as follows.

$$\rho = \text{argmax}\ (W_x^T C_{xy} Y^T W_y) \quad (2.3)$$

$$\text{s.t}\quad W_x^T C_{xx} W_x = 1 \text{ and } W_y^T C_{yy} W_y = 1 \quad (2.4)$$

The Basic formulation of CCA has the following disadvantage.

1. CCA finds the only linear relationship between two datasets.
2. Difficult to extend more than two data sets.

These problems can be addressed using the following ways.

1. A non-linear relationship between the data sets can be addressed using kernel extension of CCA [23]. Kernel CCA defines the non-linear mapping of two datasets $\varphi: x \rightarrow \varphi(x)$ and $\psi: y \rightarrow \psi(y)$ and performs the traditional CCA on transformed datasets.
2. Neural network based CCA extracts the non-linear relationship between datasets.
3. Locality preserving method based CCA also extracts a non-linear relationship between datasets.

III. Algorithm for Image Registration

Image Registration methods are trying to find the relationship between two images in intensity domain or feature domain. Regarding similarity measures this relationship is defined. Similarity measures can be classified in two categories (i) in all; similarity measure quantifies the spatial alignment between two images. Various intensity-based similarity measures such as sum of squared difference (SSD) [24], sum of absolute difference (SAD) [25], correlation coefficient (CC) [26], NCC [27] and ratio image uniformity (RIU) [28] have been proposed for mono modal registration process.

These measures do not perform well in all cases. While SSD [25] is highly sensitive to Gaussian noise, SAD is less responsive to outliers on the subject boundaries. CC, NCC and, RIU perform well in these conditions, but are highly sensitive to non -uniform illumination in the images and (ii) The Non-linear similarity measures such as mutual information or divergence measures, etc. Multimodal image registration, the images are captured through different sensors (CT or MRI) or different parameters (T1, T2 or FLAIR) so that the intensity relationships between images are highly non-linear.

In this work, based on the structural representation of images an algorithm has been proposed. The dense set of descriptors which perform the intensity based registration replace the input images. The advantage of this method is that after new representation, one can use any simple similarity measure such as L2 norm or SSD [25] for multimodal image registration.

1. Given two images find projection directions using Kernel CCA (Gaussian kernel used for projection).
2. Project original images or features in lower dimension space using projection direction.
3. Use L2 norm as a similarity measure.

In this algorithm Gradient descent uses φ optimization function.

IV. Methodology

Using two sets of experiments the work has been carried out and is detailed below

1. First set of demonstrations on T1 and T2 MR Images for 3D rigid registration (RIRE dataset). Experiments are carried out with the specifications: 15mm translation and 10-degree rotation as a deviation from correct position with ten times with different affine parameter settings. Mutual information based method for rigid registration has been used to be compared against the experimental results. We show the absolute error for translation (in mm), rotation (in degree) and root mean square error (RMS) in Tab. 1. Consider 1 mm equal to 1 degree for the absolute error computation.

CCA has been performed on for more than two modalities (T1, T2, and PD) also. Tab. 2 Shows results for Brain web dataset. Comparison purpose uses the MI-based on pairwise registration framework. CCA based method performs better regarding accuracy (Tab1) (in translation and rotation) compared to MI-based method. CCA based method improves overall accuracy to 6.7% in pairwise registration and 13 % in Groupwise registration compared MI-based method.

The Degree of freedom: 9^0

The work has been carried out using two sets of experiments and are detailed below.

V. Results

a) Figures and Tables

Table 1: Errors in translation (in mm) and rotation (in degree) in T1 and T2 MR

Method	Translation x(mm)	Translation y(mm)	Rotation (Degrees)
MI-based	3.1	2.0	4.2
CCA	2.9	1.8	4.0

Table 2: Registration error (translation in mm and rotation in degree) in T1, T2, ,and FLAIR

Data Set	Method	Error (RMS)
T1-T2	MI CCA	3.0
T1-FLAIR	MI CCA	2.6
T2-FLAIR	MI CCA	2.7
T1-T2-FLAIR	MI CCA	2.5

Table 3: Registration Error in D1

Method	Error(mm)
MI-based	14.6
CCA	10.3

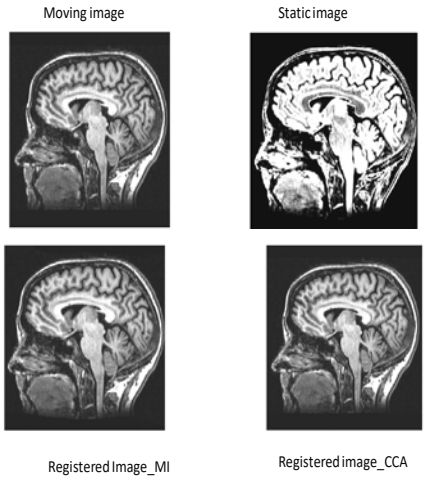


Fig. 2: (a) Moving image, (b) Static image, (c) Registered image_MI, and (d) Registered image_CCA

2. The second set of experiments was carried out on collected data sets (FLAIR, T1 and T2 images). The datasets have been divided into two parts. (i) Datasets which contain large tumors regions (D1, three volumes) (ii) Datasets which do not include tumor lesion or very fewer tumor lesions (D2, three volumes) (Next section contains datasets

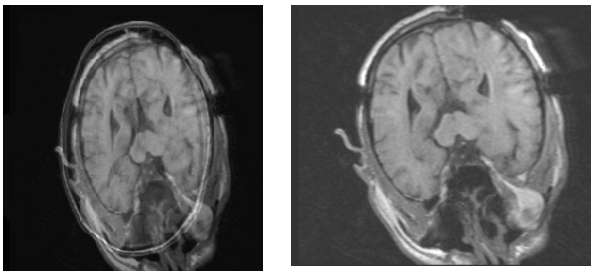
description). For the first part of datasets, we use the T1 and FLAIR images registration model compared with our algorithm with MI-based based method and results shown in Tab.3.

For the error calculation, five manual points were marked on the MRI image. In the second set of images also the experiments in a similar environment and the same method are used for error calculation. Results have been shown in following Tab.4.

Table 4: Registration Error in D2

Method	Error(mm)
MI based	10.2
CCA	8.6

3. CT and MRI Image Registration The work has been carried out on CT and MRI brain images. CT images provide bone structure information and, MRI dispenses soft tissue information of brain. For accurate tumor diagnostic one needs CT and MRI information. In this work 3D, rigid registrations of CT and MRI images were performed. In this work CT image used as the fixed image and MRI image as moving image. On comparing results with some benchmark, algorithm presents in literature such as mutual information; normalize mutual information and correlation-based approaches. Fig.5 shows the results of CT and MRI image registration.



(a)Unregistered (b) Registered

Fig. 3: CT and MRI Registration

Fig.(a) shows the unmatched as unregistered image and Fig.(b) shows the matched image of CT and MRI registration method.

Table 5: Image Registration Algorithms Comparisons

Method	Translation x(mm)	Translation y(mm)	Rotation (Degrees)	Error (RMS)
MI-based	5.6	4.8	5.1	5.2
NMI	5.3	4.6	4.8	4.9
Correlation - based	5.1	4.5	4.4	4.7
Entropy-based	4.9	4.3	4.1	4.4
CCA(proposed)	4.8	4.1	3.9	4.2

VI. Conclusion

In this work new algorithm, CCA has been proposed for image registration. In multimodal framework, due to different acquisition parameters, the relation between datasets not follows the linear relationship. In this algorithm, the kernel version of canonical correlation analysis was used because the basic formulation of CCA gives the only linear relationship between datasets. The results are shown in Table I, Table II, Table III, Table IV and Table V on two different data sets (i) RIRE data sets have shown in Table II and (ii) Our collected data sets shown in Table III, Table IV and Table V.

Two sets of experiments have been performed on the RIRE datasets (T1, T2, and PD images). (i) Pair wise registration and (ii) Group-wise registration. From table I, Table II, it is evident that group-wise registration performs well compared to pairwise registration because group-wise registration consists of extra information (due to other modalities) which helps registration. The advantage of using CCA based method is one can easily extend this framework for more than two modalities.

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Video Recommendation System for YouTube Considering user's Feedback

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Abstract- Youtube is the most video sharing and viewing platform in the world. As there are many people of different tastes, hundreds of categories of videos can be found on YouTube while thousands of videos of each. So, when the site recommends videos for a user it takes some issues which fill the needs of the user. Most of the time a user watches videos related to the previously watched video. But sometimes user's mood changes with time or weather. A user may not hear a song in the whole year but can search the song on a rainy day. Another case a user may watch some types of videos at day but another type of videos at night or another at midnight. In this paper, we propose a recommendation system considering some attributes like weather, time, month to understand the dynamic mood of a user. Each attribute is assigned a weight calculated by performing a survey on some YouTube users.

Keywords: youtube video recommendation system, weighted attribute based video recommendation system, youtube watch-list recommendation, youtube video suggestion.

GJCST-G Classification: H.5.2

VIDEORECOMMENDATIONSYSTEMFORYOUTUBECONSIDERINGUSERSFEEDBACK

Strictly as per the compliance and regulations of:

Video Recommendation System for YouTube Considering user's Feedback

Md. Shamim Reza Sajib [α], Md. Ariful Islam Malik [σ], Md. Ashraful Islam [ρ] & Sudip Kumar Halder [Ω]

Abstract- Youtube is the most video sharing and viewing platform in the world. As there are many people of different tastes, hundreds of categories of videos can be found on YouTube while thousands of videos of each. So, when the site recommends videos for a user it takes some issues which fill the needs of the user. Most of the time a user watches videos related to the previously watched video. But sometimes user's mood changes with time or weather. A user may not hear a song in the whole year but can search the song on a rainy day. Another case a user may watch some types of videos at day but another type of videos at night or another at midnight. In this paper, we propose a recommendation system considering some attributes like weather, time, month to understand the dynamic mood of a user. Each attribute is assigned a weight calculated by performing a survey on some YouTube users. Most recently viewed videos is assigned heavy weight and weather is assigned lower. This recommendation system will make YouTube more user-friendly, dynamic and acceptable.

Keywords: youtube video recommendation system, weighted attribute based video recommendation system, youtube watch-list recommendation, youtube video suggestion.

I. Introduction

Since the launch of YouTube in 2005, it has become a popular destination site for users to find videos as well as share their videos. YouTube has earned worldwide popularity in the past decade. Thousands of users watch and upload millions of videos daily. So YouTube has a recommendation system for each user individually. But the mood and need of a user is very dynamic and changes dramatically. So it is the challenge of the recommendation system to understand the current mood and need of a user and suggest that types of videos that the user wants. As YouTube recommends a very few videos from thousands of videos, they are very selective for this recommendation system. The system recommends personalized sets of videos to users based on their recent and frequent activity on the site, subscribed channel, etc [1]. The recommendation made by the system is reasonably recent and fresh, as well as diverse and relevant to the users recent action. But user mood can change at any time. Let a user generally does not watch songs of the rainy day. But on a rainy day he may search for a favoured rainy day song that he watched many days ago or not at all. In another case: a user watches many videos regularly but some of those he may watch at mid of a day, some of them he mostly watches at early night and some of them at late night. So user's mood can change at different time of a day. So when the system recommends videos, it should also consider the current time and what videos mostly he watches at that time. So dealing with this dynamic mood and need of a user is the prime challenge of this recommendation system.

In the paper, a new recommendation system is proposed where we consider some attributes for recommending videos along with most recently and most frequently viewed videos. The new attributes are time, month and weather. As each of them is not equally significant for deciding which video a user may watch, a weight assigned to each attribute. The weight is calculated by surveying some YouTube users. Most of the users feel that they expect a video which is related to the previously of frequently watched videos. So a high weight is assigned to these two attributes. Some users feel that they watch different types of videos at the different time of the day. So a moderate weight is assigned to this attribute. A less number of users feel that they watch some videos in a particular time of the year but not in the other time like they watch rainy day song in rainy weather but not in the cold weather. So this attribute is assigned a less weight. But the highest weight is assigned to a new video of a channel that the user subscribed and watches the videos on that channel regularly. So, when the system recommends videos, the weighted sum of related videos is calculated. The highest valued videos are recommended for the user and top N videos are shown on the home page like the method [5].

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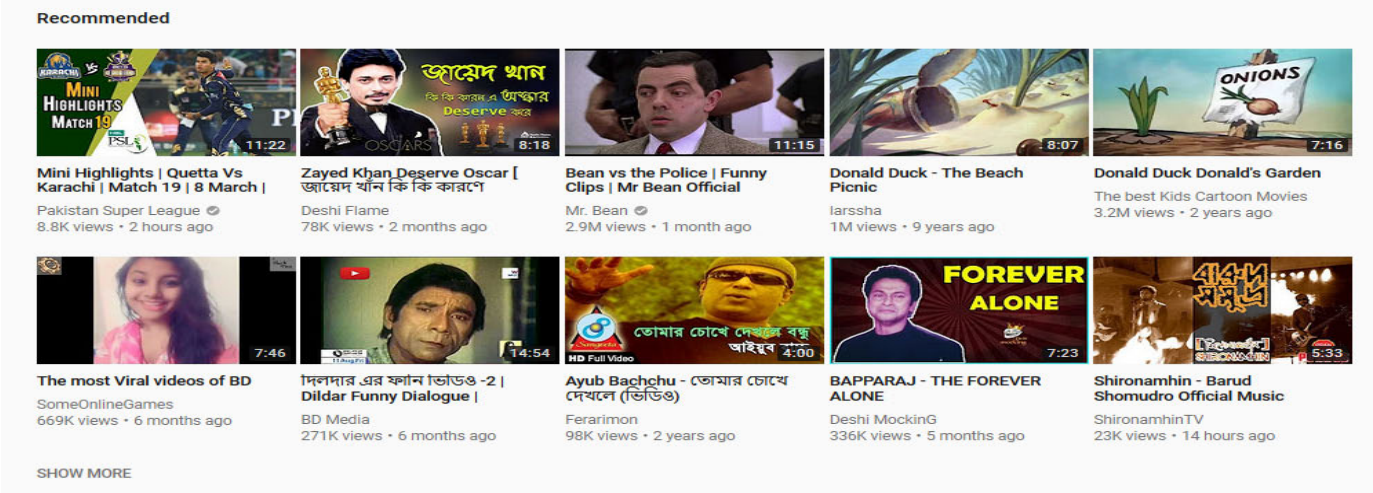

Fig.1: Recommended Videos of a user

II. Proposed Method

As stated above, we do not only consider a user's recent activities, we also consider some other important attributes to make the system more dynamic and to make user understand why a video is recommended to them. The method is designed in four stages: i) Weight Calculation, ii) Generating Related Videos iii) Generating Recommended Candidates and iv) Finding recommended videos by calculating a weighted sum.

a) *Input Data*

During the generation of personalized video recommendations, we consider some data sources. In general, there are two broad classes of data to consider: 1) content data, such as the raw video streams and video metadata such as title, description, etc. and 2) user activity data, which we can further divide into explicit and implicit. Explicit activities include rating a video, favoriting/liking a video, or subscribing to an uploader. Implicit activities are datum generated as a result of users watching and interacting with videos. We also define some others behavior of a user as explicit data such as the specific time, date and weather when a video the user watches. But user data only captures a fraction of a users activity on the site and indirectly measures a users engagement and happiness. Because a user may watch a video for a long time, but that cannot conclude that actually he/she has liked it. The implicit activities data is generated asynchronously and can be incomplete. So it is very challenging to deal with this huge amount of discrete and noisy data.

b) *Assigning Weight*

There may be a large number of input data for further processing. Among them, all the videos are not equally important. So, we have to find out the significant ones for further processing. For this purpose, a weight is assigned to each attribute based on a number of user's feedback. We take the feedback of the users on some questions like: Whether user's mood or taste vary at different times of the day or with the change of weather. The questions and the survey result is given in Table I. The weight is calculated considering the

Table I: Survey Result on the Questions asked to some Youtube users

Question	No. Of User	Always Yes	Most Often Yes	No
Do You Want New Videos Uploaded by Subscribed Channel You Watch Regularly	250	203	38	9
Do You Want New Videos Uploaded by Subscribed Channel You Watch Irregularly	250	129	91	30
Do You Want Videos Related to Recently Watched Videos	250	147	87	16
Do You Want Videos Related to Frequently Watched Videos	250	162	77	11
Do You Watch Different Types of Videos at Different Time	250	113	78	59
Will You Be Happy if a Rain Song is Recommended on a Rainy Day	250	109	95	46

value of the answers of the users. The equation for calculating weight is

$$W_i = A_i + 0.8 * O_i - N_i$$

Where W_i is the weight of an attribute,

$$A_i = \frac{NoofUsersAnsweredAlwaysYes}{TotalNumberofUser}$$

$$O_i = \frac{NoofUsersAnsweredMostOftenYes}{TotalNumberofUser}$$

$$N_i = \frac{NoofUsersAnsweredNo}{TotalNumberofUser}$$

O_i is multiplied with .8 as its contribution of the total weight should be less than the contribution of always yes. N_i is subtracted from the weight as those users do not want those videos. So, for the first attribute which is The Videos Uploaded by Subscribed Channel That a User Watches Regularly, its weight should be W_{sr} = (203/250) + 0:8 * (38/250) - (9/250) = 0.90. Another attribute which is a new video by the channel a user follows irregularly, the weight will be W_{si}= (119/250) + . 8 * (81/250) - (50/250) = 0.54. Thus the weight is calculated for each attribute. The most significant attribute that affects the user mind mostly, gets the highest weight. The final value is calculated by multiplying the attribute value which is 0 or 1 with the corresponding weight. Suppose a video candidate is generated which is newly uploaded by a subscribed channel watched by the user regularly, the user watches that type videos at night, the user watches that type of videos recently but not frequently. The current time the user sign-in is day, and it is a hot day. Then the attribute value for $A_{sr} = 1, A_{si} = 0, A_r = 1, A_t = 0, A_r = 0$.

c) Generating Related Videos

For this work, we are using the method proposed by [1]. We are not proposing a new method for finding related videos. In this stage of recommendation, we have to construct a mapping from a video vi to a set of similar or related videos R_i The similar videos are defined as those that a user is likely to watch after having watched the given seed video v. For computing this mapping [1] has used a well-known technique known as association rule mining [2]. They also consider the duration of a session of a user and count for each pair of videos (v_i, v_j) how often they were co-watched within sessions. This co visitation count is denoted by *cij* and they calculate the relatedness score of v_j to a base video (v_i by the following equation.

$$r(v_i, v_j) = \frac{(c_{ij})}{f(v_i v_j)}$$

where c_i and c_j are the total occurrence counts across all sessions for videos v_i and v_j , respectively. $f(v_i, v_j)$ is a normalization function that takes the global popularity of both the seed video and the candidate video into account. One of the simplest normalization functions is to simply divide by the product of the videos global popularity:

$$f(v_i, v_j) = c_i.c_j$$

One of the simplest normalization functions is to simply divide by the product of the videos global popularity $f(v_i, v_j) = c_i, c_j$. Other normalization functions are possible. See [6] for an overview of possible choices. [3] used a video co-view graph which represents the videos watched by some users. They then use it for generating related videos. They then pickup N videos from a number of related videos based on the value or relatedness score. N is variable depending on a threshold. If there are many videos satisfying the relatedness score, N will be larger. So this system face difficulty generating related videos which has a lower view count. There may be some additional problem like presentation bias, noisy watch data etc.

d) Generating Recommendation Candidates

For computing personalized recommendations, the related videos association rules are combined with a user's personal activity on site. This can include videos that were watched recently, frequently or liked or added to playlists. The union of those videos is called seed set. There may be many videos which can come with several categories, but each video is present only one time in the seed set. Assume the generated seed set S; we expand the related video graph G in order to find the related and connected videos. For each video Vi in the seed set, assume its related video Ri. The related video set Ci will be

$$C_i(S) = \bigcup_{vi \in S} R_i$$

In many cases, computing C1 is sufficient for generating a set of candidate recommendations that is large and diverse enough to yield interesting recommendations. However, in practice the related videos for any videos tend to be quite narrow, often highlighting other videos that are very similar to the seed video. This can lead to equally narrow recommendations which can achieve the goal of recommending content close to the users interest, but fail to recommend videos which are truly new to the user. This problem can arise after generating recommendation candidates by this process. To get rid of that possibility, a distance of n will be traversed through the related video graphs to find more candidates. Due to the high branching factor of the related videos graph, we found that expanding over a small distance yielded a broad and diverse set of recommendations even for users with a small seed set. That's why the value of n should be set a smaller value. A large value of n can generate a huge candidate set which will be time consuming and unnecessary. Note that each video in the candidate set is associated with one or more videos in the seed set. We keep track of

these seed to candidate associations for ranking purposes and to provide explanations of the recommendations to the user. A deep neural network based method is used by [4] to generate recommended candidates. They also consider related videos for candidate generation, but they have used a deep neural network to generate the best candidates from the millions of videos. But their method need high computational resources and millions of data. In the proposed method we use the same process proposed by [1] for generating candidates.

e) Recommended Videos

After generating recommendation candidates, the recommended set may contain many videos. But the designed user interface shows only some of them. So the question is how they should be selected. After the generation step has produced a set of candidate videos they are scored and ranked using a variety of signals. [1] Considers three different signals i) Quality, ii) user specificity, iii) diversification.

The proposed method also uses these signals with considering some other attributes. For video quality, the proposed method considers view count (the total number of times a

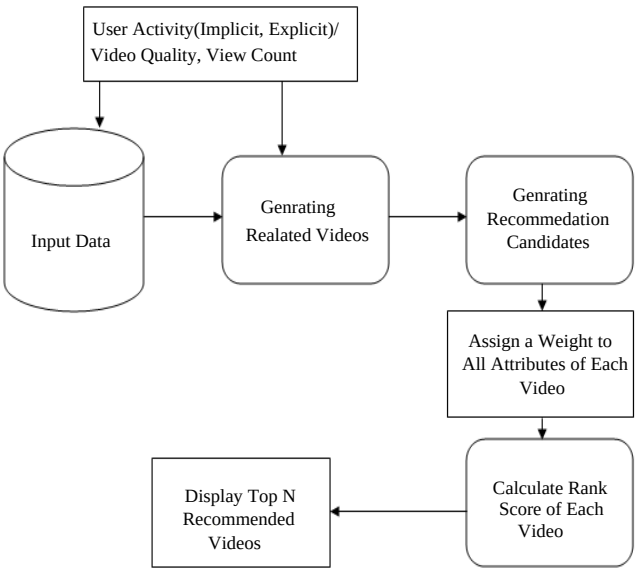

Fig. 2: System Architecture of Proposed Method

video has been watched), the ratings of the video, commenting, favoring and sharing activity around the video, and upload time. Considering all these things, the proposed method calculates the value of quality Q_i like the method [1].

User specificity is a unique user's taste and preferences. For this the current method only considers users watch history, such as view count and time of watch. But these attributes are not enough to detect user's mood and recommend the desired videos. For this we propose to consider some other attributes described earlier. We propose to consider subscribed channel videos, recently watched videos, specific time when a video has been watched. The value of user specification can be generated by equation. Considering all these things the proposed method calculates the value of user specificity of a video v_i is:

$$U_i = W_{sr}.A_{sr} + W_{si}.A_{si} + W_r.A_r + W_t.A_t$$

Using a linear combination of these signals we generate a ranked list of the candidate videos. As YouTube only displays a small number of recommendations between 4 to 60, we have to generate a recommendation lists. In this stage diversity is considered. Since a user generally has interest in multiple different topics at differing times, videos that are too similar to each other are removed at this stage to further increase diversity. For this diversity we consider weather information. In a rainy day a video of rainy song may be recommended or a snowy video may be recommended on a snow falling evening though the user does watch this types of videos very often. After generating those videos the value of W_w is assigned to a video v_i Considering all these issues that can affect a user mind, we generate an equation that calculates the rank of a video from the video set of recommended candidates. The equation is the sum of all three signals considering all the attributes described. If the system shows N videos from the set, the highest ranked videos will be displayed. The rank of a video v_i from the candidate set can be calculated by the following equation:

$$R_{vi} = Q_{vi} + U_{vi} + D_{vi}$$

Then the top N scored videos will be displayed in the user interface.

III. Implementation

[1] Choose a batch-oriented pre-computation approach rather than on-demand calculation of recommendations. The proposed method does the on-demand calculation of recommendation. As there are millions of data in the logs, the most significant downside of this approach is the delay between generating and serving a particular recommendation data set. To reduce the problem, we propose to use a pre-calculated recommendations. This recommend-dations are updated regularly so there is no chance of recommending same videos again and again. The actual implementation of YouTubes recommendation system can be divided into three main parts: 1) data collection, 2) recommendation generation and 3) recommendation serving. We collect input data from many users manually from their YouTube logs and store

those in a big table [7]. Then we select the top N videos by the system described in section II.

IV. Experimental Result

A large number of user data is experimented by the method. User data are collected from the watch history of a large number of users for a period of three weeks (21 days). The data then processed for each individual users and recommended videos are generated by the proposed method. The result then analysed by the feedback of the users. As we cannot experiment the result by the random users of YouTube, we manually generate result for each individual users and ask which video he/she may click if the video appeared in the recommendation sector of YouTube home page. Based on some user's feedback, some results are shown in. The proposed method has been

Table II: User's Feedback on Recommended Videos by the Proposed Method

User No	Recommended Videos	Videos He May Watch	Videos He May Ignore	Success Rate
User 1	43	28	15	65.11%
User 2	52	40	12	76.92%
User 3	33	25	8	76.76%
User 4	55	43	12	78.18%

experimented on more than 100 users. According to their feedback they would click around 75% of the recommended video. At the same time they would click only 63% video recommended by current recommendation system. Since we cannot implement our method in YouTube, we calculate our result manually considering user's feedback and their feedback on current recommendation system. There may be different result in real case. As the recommendation system is designed considering user's feedback, there may be many users who do not think in the same way. It is very difficult to understand user's need as millions of user's do not think the same way. But this recommendation system is accepted by most of the users we experimented.

V. Conclusion

Recommending suitable video to a user is a very challenging task as the mood of the user is very dynamic. In this paper, we consider almost every attribute that can affect user mood. It makes our recommendation system more friendly, reliable and dynamic. But all the values of the attributes depend on the previous activities of a user. So it may not perform well while recommending videos to a new user or the users who are not signed in. A user's mood can change rapidly on some incident, our system may fail to understand that. But our recommendation system can deal with almost every other possible cases. Though we consider five attributes, all of them are not equally important identifying the rank of a video. So we assign a weight to each attribute according to the significance of that attribute to the user. After that a final value is calculated for a video considering all these facts. The highest valued videos will be recommended to the user. Selection of attributes that take care of the dynamic behavior and the calculating process makes our proposed system more robust, dynamic and reliable.

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Klikker: A Method and Infrastructure for Mining, Analysis, and Visualisation of user Behaviour and Usability Issues for Mobile Application Development

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Abstract- In the early stages of mobile application development, mockups can be used to receive feedback from potential end-users. This richness of feedback is limited by the lack of interactivity and requires a lot of time for a more significant study population. The Klikker methodology aims to unite the designer, developers, and end-users in the initial phases of development by utilising modern web technologies and readily available – and interchangeable - design and analytic software. Klikker combines the collection of quantitative user behaviour and qualitative feedback from end-users on their own devices without additional effort from researchers. The method is intended to be deployed in the first few weeks of the development process.

Keywords: *usability testing, distributed systems, user behaviour, event logs, mobile applications.*

GJCST-G Classification: *K.6.3, H.2.8*

Klikker: A Method and Infrastructure for Mining, Analysis, and Visualisation of user Behaviour and Usability Issues for Mobile Application Development

Mart Wetzels [α], Peter Peters [σ], Idowu Ayoola [ρ], Joost Liebregts [ω] & Loe Feijs [¥]

Abstract- In the early stages of mobile application development, mockups can be used to receive feedback from potential end-users. This richness of feedback is limited by the lack of interactivity and requires a lot of time for a more significant study population. The Klikker methodology aims to unite the designer, developers, and end-users in the initial phases of development by utilising modern web technologies and readily available – and interchangeable - design and analytic software. Klikker combines the collection of quantitative user behaviour and qualitative feedback from end-users on their own devices without additional effort from researchers. The method is intended to be deployed in the first few weeks of the development process.

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I. Introduction

The early stages of the design and development of a mobile application often involve producing sketches of interfaces. After the ideas have been conceptualised, (interactive) mock-ups can be made using *What You See Is What You Get* (WYSIWYG)-editors such as Invision Studio (invisionapp.com), JustInMind (justinmind.com), PowerMockup (powermockup.com), ProtoIO (proto.io), Sketch (sketchapp.com), or Adobe XD CC (adobe.com). Most of these editors can produce an exported version that runs on a mobile phone and allows for testing the interaction internally within the development team. Iterations and refinements during this process depend on the experience of the team members, only at a later stage, where an actual version of the mobile application is available, real user feedback can be obtained through applications such as Google Analytics (analytics.google.com), Apple Analytics (developer.apple.com/app-store/app-analytics/), AppsFlyer (apps- flyer.com), or Appsee (appsee.com).

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The intention of the work presented in this paper aims to include (potential) users in the early phases of the development of a mobile application. Related work evaluated the benefit of performing field testing for mobile applications versus laboratory settings [Kaikkonen et al.2005]. Reviewed test procedures and tools for field testing [Bastien2010]. Provide similar remote- based user tracking methods using an HTTP Proxy [Atterer et al.2006]. WebQuilt [Hong et al.2001] has a similar strategy of visualising behaviour as a process but still utilises a separate web browser and requires the use of multiple custom services. The approach of this work is to be non-disruptive, integrating into existing workflows/software of developers, and have 'dumb' clients (no custom software or framework required).

The mining of data is achieved by attaching event listeners to existing design tools and communicating event information through web sockets to a server that also serves the interface of the mockup. The analysis and visualisation of user behaviour are treated as an Event Log used for Process Mining [van der Aalst2011]. The process analysis program Disco (Fluxicon) [Gunther and Rozinat 2012] produces a process map from the event log that enables analysis of behaviour and detects outliers in expected paths.

The asynchronous nature of recording events by the server allows for high throughput for new events. The advanced filtering methods of Disco enable removing uncompleted instances and provide a visual representation showing the bottlenecks in the mobile application design. The method discussed in this work is tested through a use-case presented in this paper on the development of a healthcare and wellbeing mobile application [Wetzels et al.2017]. The resulting application is used for the clinical trials in the European Horizon 2020 project DoCHANGE [Habibović et al.].

II. Methodology

The aim of the Klikker-method is to connect user interactions with a mock- up interface-exported

in HTML format to an event log. In the next sections, 3 different points of view will be described: system view, experience view and implementation view. From a system point of view, the methodology is expressed through a system architecture model. From an experience point of view, the methodology contains guidelines to improve the user experience. From the technical perspective, a WebSocket service with a NoSQL-database (MongoDB) is used to receive and store events. Combined with a small script attached to the client-side code which monitors and sends events to that service.

a) System view

Figure 1 shows the system architecture, containing the Klikker Host, several clients, and a separate offline client. The clients connect to the web service provided by the Klikker Host, whereas the offline client receives periodical exports of the MongoDB.

The Klikker Host service runs on a local research cluster, assigned 2 CPUs, 2Gb of memory (dynamically scaling to 8Gb), and 100Gb of storage within a dedicated Virtual Machine (VM). Node.JS is used to serve the static content of the website and act as a web socket server for the clients to establish a persistent connection to. Uncomplicated Firewall (UFW) is used to restrict the in- and outgoing traffic. An SSL-certificate is used to upgrade the HTTP and WebSocket (WS) connections to HTTPS and Secure WebSocket (WSS). PM2 (Process Manager 2) is used for process management. When during peak-moments the server is on heavy use, PM2 allows quick clustering of processes. The nature of the application logic itself will enable this type of horizontal scaling without adjustments. A MongoDB instance is running on the VM; binding only a port on the localhost. Per event triggered by clients, a new document is inserted based on the type of event.

The Klikker clients consist of desktops, tablets, or mobile phones. The scalability features (user interface) from the exported website and the soft- wares ease-of-use were determining factors for choosing JustInMind (JIM) as the mock-up designing software. When loading the website, the injected script connects to the Klikker Host over a secure WebSocket connection. In addition to the source IP-address and timestamp (server-side), the connection is assigned a unique identifier that is used for separating events within the users (e.g. *to differentiate between users behind the same public IP-address*).

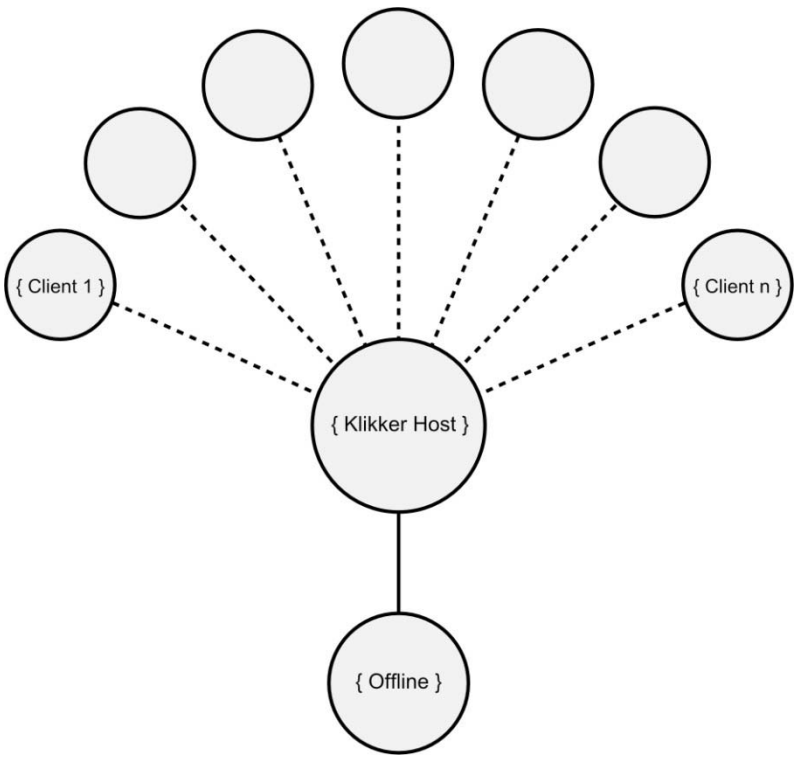

Figure 1: System architecture visualisation of Klikker method

The offline client is a desktop or laptop of the research team. The client connects to the MongoDB service through an SSH-tunnel that is configured for key-based authentication over password-based for security reasons. An export of the dataset is made using the mongo command

line interface (CLI) or through the use of Studio 3T (studio3t.com). Depending on the settings of export provided by the data extraction approach, the resulting dataset will be provided as a JSON-file (JavaScript Object Notation) or CSV-file (Comma-separated Values). In our analytics setup, the JSON-file is imported into a Jupyter Notebook running a Python (2.7) kernel.

b) Experience view

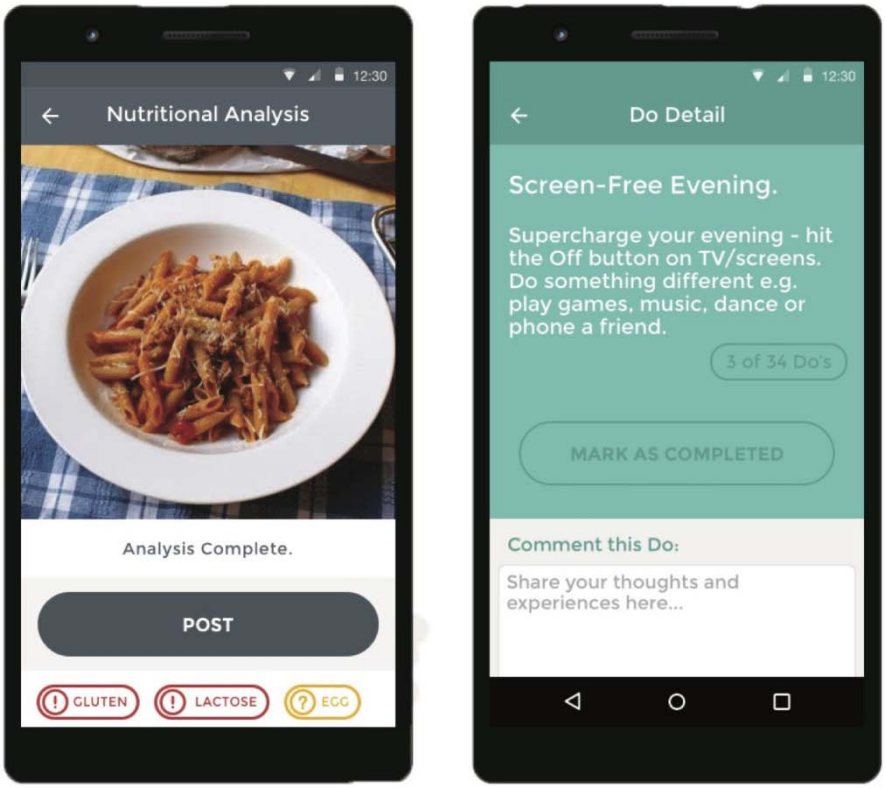

Figure 2: Example of interfaces used in the Klikker study

Figure 2 shows two screenshots of the DoCHANGE mobile application [Wetzels and Liebregts2017]; the use-case of this methodology. Two functionalities of the app are: being able to get insight into nutritional values of food in pictures, and receiving personalised behavioural prompts. The latter bases its personalisation parameters on data from Fitbit (fitbit.com) and Moves [Evenson and Furberg2016] using the Consume-backend [Wetzels et al.2018]. Before executing the prompts, specific to the use-case, the participant is asked to agree to informed consent and provide basic demographics, age range, and gender used to annotate the events during analysis. A feature available in JIM-exports is that when the user presses on noninteractive elements of the interface, visual cues are given to what elements are interactive. It is up to the use-case to include this behaviour, as it is monitored as well, or exclude it by changing the export settings or making the mock-up as interactive as the future product. The latter would result in more work required to create the mock-up; contradictory to the intent of the (rapid-prototyping) method.

The process of making a mock-up suitable for this purpose starts with defining what the elements that are interesting to evaluate. These elements can consist of general styling and organisation of buttons, specific functionalities, or the general structure of the app. In general, everything that can be simulated using a *Wizard of Oz* [Hannington and Martin2012] user test can be evaluated.

Although not utilised in this study, A/B-testing [Hannington and Martin2012] can be applied when hosting variations of the same mock-up. The static file serving should simply switch between versions, or a merged version is served where, based on demographics, one version is shown over the other.

c) Implementation view

Buttons and other UI elements exported by JIM are generated as HTML elements; like *div*, *img*, and *span*. The jQuery-library (jquery.com) allows event handeling on specific elements. More specifically, certain mouse-events such as *mouse-down*, *hover*, *mouse-out*, *toggle*, and *mouse-over* are available. JIM exports the mock-up inside a container

with the *simulation* identifier. In case of tracking the mouse event, this prevents events being transmitted that are outside of the scope of the simulation.

The *mouse-down* event is monitored on all elements within the *simulation* container. The event handler is connected to the *simulation* element but takes the *source Element.id* of the event as an output parameter to send to the Klikker Host. This approach enables to detect participants *misclicking* - e.g. *seeing that the active area of the selection box is too small on mobile* - or clicking on non-interactive elements. The first is commonly more an issue on touch-based interfaces than on pointer-based due to the lack of granularity of the input sensors (finger versus pointer). The *mouse-down* events are used for the generation of the event log shown in the results section of this paper.

```
$('#simulation').on("mousedown", function(event)
        { socket.send({
        'event':event.srcElement.id,
        'timestamp':event.timestamp
            })
    })
```

Code Snippet 1: mousedown event

The *mouse-move* event is also monitored on all elements within the *simulation* container. As configured in code snippet 1, The event handler is called on every refresh of the interface. According to the developer guides of Google modern devices refresh at 60 frames per second (fps); leaving about 10ms per refresh for work in each cycle [Developer]. The time consumption of extracting the event information and, most importantly, sending the web socket message can cause *janks*. Janks is a result of frame-rate dropping and results in laggy interfaces. It is advisable to reduce the collection rate or buffer events to reduce the relative time-consuming work of sending a message. In practice, sending messages over WebSockets is faster than the three-way handshake required by TCP for HTTP calls [Chaniotis et al.2015];*e.g. using HTTP calls*.

The benefit of collecting *mouse-move* events, at a reduced interval, is the ability to reproduce user behaviour as they interact with the mouse. An example of behaviour not captured by the *mouse-down* event is the indecision of a participant in choosing which button to press. Based on the *mouse-down* event, a long time span is observed between two events, but it cannot explain what the user was doing in between. With the *mouse-move* event, a researcher could differentiate between indecisiveness while moving the mouse and *Away From Keyboard* (AFK) as is possible with traditional tracking software.

```
$('#simulation').on("mousemove", function(event){
    socket.send({
    'x':event.offsetX,
    'y':event.offsetY,
    'timestamp':event.timeStamp
      })
    })
```

Code Snippet 2: mousemove event

Code Snippets 1 and 2 show the code required for handling these events and sending them to the Klikker Host. As can be seen, no identifiable infor- mation is stored on the client or appended to the message. The identifiers are added to the message by the server based on connection details. This approach results in a database, or *collection* for MongoDB, that consists of thousands of separate events that can be regrouped based on identifiers but are stored as independent data-points. The timestamp keys ensure reproducibility of chronological order. The combination of identifiers and timestamps result in not having to rely upon or even implement, session- management in the Klikker Host.

III. Results

This section addresses the application of Klikker-methodology on the use- case of the development of a mobile health application for the DoCHANGE project. Prior work consists of defining the functionalities and producing a visual style of the DoCHANGE application. The results section is divided into the four phases: generation, collection, analysis, and evaluation.

a) *Phase 1: Generation*

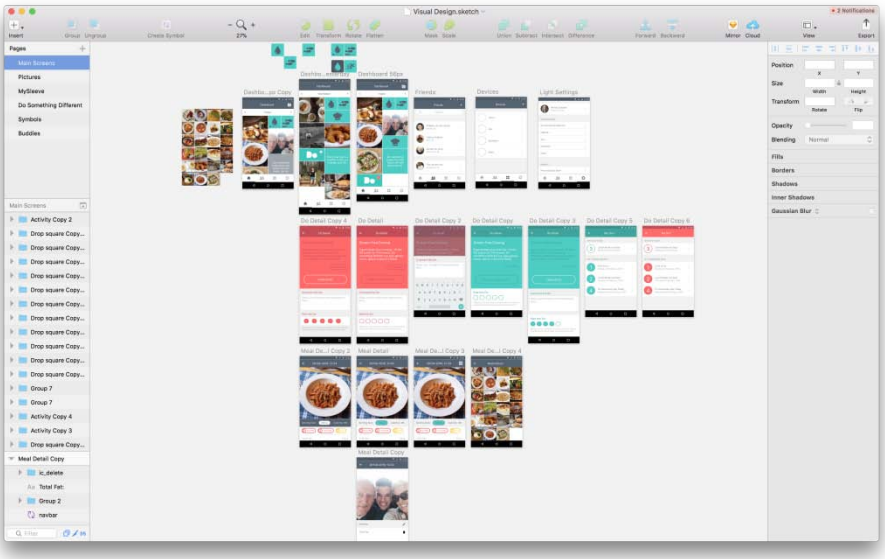

Figure 3: Overview of screens for mockup procuded in Sketch

Figure 3 shows a screenshot of the mockup design created in Sketch. The primary role of this overview is to iterate over the chosen visual language and conceptualisation of specific features. The overview should contain an exhaustive amount of screens that cover the range of possibilities for the mobile application. The application development team can define focus points for user analysis.

The DoCHANGE mobile application aggregates data from various commercial devices, such as Fitbit, and newly developed devices and services such as Smart Sleeve [Ayoola et al.2014] and Horus. This mobile application intends to preside next to existing applications from the devices. Smart Sleeve is a liquid intake monitor for heart failure patients with a fluid restriction. Horus is a service for providing nutritional advice based on photographs.

In this use-case, the following tasks are given to participants:

1. Upload a picture from the camera roll. Use a family picture for this one.
2. Keep a record of what you eat. Upload a picture of your last meal.
3. You have just received a new DO (message)! Check it out and mark it as completed.
4. Change the profile settings so buddies can find you.
5. Text one of your buddies on your Buddies list.
6. Add a new device to your Devices list.
7. Check your liquid intake data.

Based on the sequence of tasks, the interface of the application can change. *E.g. after Task 1, a family photo should be visible on the dashboard.* This type of detail is added to make the mockup experience feel complete and bind the result of a task to the next task. As depicted in Figure 4, after completing a task, a separate screen is used to introduce the next task. Pressing the start button serves a normalisation timestamp to compensate the time difference between tasks.

The interactive mockup is internally tested by the development team as a dry-run test for completeness. After exporting to an interactive website, the mockup-with the custom integration injected- is placed on a dedicated server hosting the static files. Again, the development team performs a dry-run to identify the correct functionality of the service.

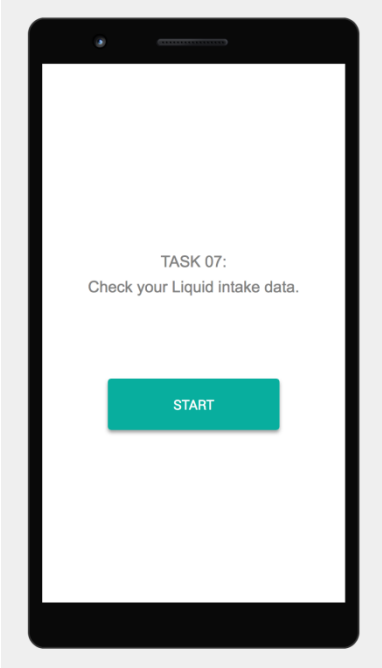

Figure 4: Example screenshot of task screens

b) Phase 2: Collection

The Klikker study for the DoCHANGE project was put online for three weeks and available online through a link. All members of the consortium were asked to distribute the link through social media or by word of mouth. The consortium partners are situated in The Netherlands, Spain, United Kingdom, and Taiwan; which explains why the data points shown later on Figure 6 clusters around this regions.

Before the in-depth analysis, a quick view of general statistics is per- formed to determine whether the size of the dataset is satisfactory for the analysis. *E.g. if the sample size is too small, additional recruitment efforts need to be performed.* Using the Mongo CLI, an export was made of the full dataset in a JSON-format. This dataset was transferred using *scp* (Secure Copy based on SSH protocol). A total of 160 unique users - based on the IP-address, connection identifier, and submission of demographics before the first task - are found in the exported database. These have produced 5097 events based on the *mouse-down* event handler described in the methodology section. For the events *sourceElement.id*, 165 unique events are found in the dataset.

For the study, gaining insight on the user behaviour and difficulties in executing the predefined tasks, it was concluded that the continuation of the analysis of the methodology was warranted. As mentioned above, in the case where more data would be needed, it would simply require recruiting more participants and export a new dataset.

c) Phase 3: Analysis

The exported dataset is imported into the Disco program. Every participant is considered as a case for the Event log and their button presses as their activities. The *sourceElement.id* values are labeled as *Activities* and an aggregation of IP-address and connection-id is used as *CaseIDs*.

An extension to the basic analysis showed a mean case duration of 2.9 minutes (median 99.5 seconds). Based on internal testing, the questionnaire can be performed in 4 minutes. This observation triggered the investigation towards the length of the cases (number of activities). A high number of cases did not finalise all tasks. For that reason, a filter was applied to take out all cases that not completed up to Task 2. Task 2 was chosen to not discriminate non-compliance to the study based on the difficulty of the task versus not wanting to finalise participation. The filter reduced the sample size to 94 participants.

The remaining cases are imported into a Jupyter Notebook (jupyter.org) for analysis. Figure 5 visualises the age-range and gender distribution of the remaining 94 participants. The Figure highlights a bias in the sample for males between the age of 18 and 45 (combining the lower age-ranges).

Based on the IP-address of the case, a geo-distribution is made using the Map View plugin (Figure 6). The Figure illustrates the bias for Dutch participants over the other partner countries. This visualisation does not take into account the possible use of a Virtual Private Network (VPN) connection, hiding the actual geo-source of the participant, and can provide a visually skewed picture based on the different sizes of the countries. *E.g. the number of participant from Finland might appear larger than those of Spain.* Although this visualisation is not a crucial element to the analysis, it does provide an insight to the participant population as the geolocation is available as a second parameter in the dataset. Considering the ease of producing such overview, it is recommended to generate it to identify any bias.

Figure 7 shows a map of general pathways of cases through the tasks. The red line highlights the correct pathway to complete the Tasks. The pathway is filtered to hide activities with relatively low occurrence for clarity of the visualisation. Deviations from the correct path show unintended user behaviour. Based on the activities that are performed, the intuition of the participant, expecting a specific action resulting in the correct outcome, can be reconstructed. As discussed in the evaluation section, this can result in concrete design- and development-requirements.

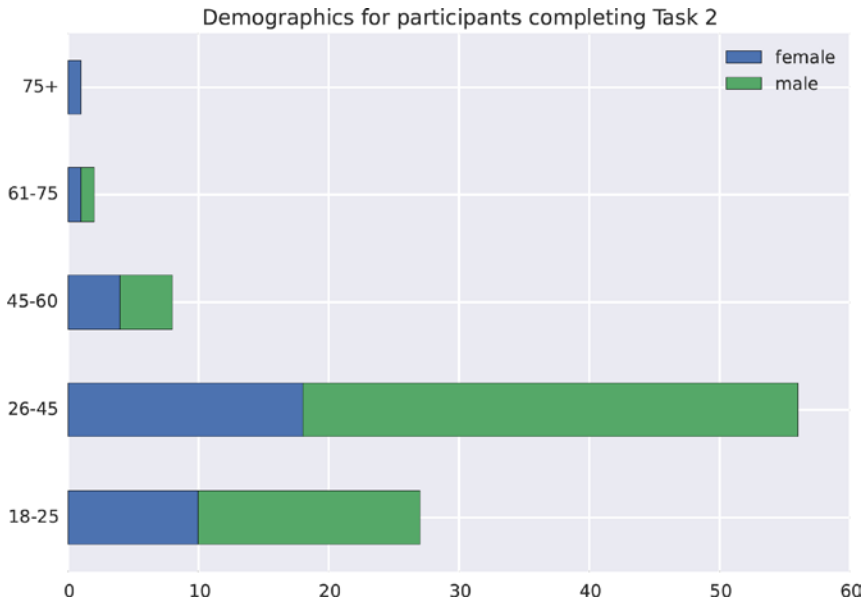

Figure 5: Stacked bar chart showing demographics of participants

After completing all tasks, the participants were given the opportunity to provide written feedback to express experiences not captured during the study. As presented in the evaluation section, 92 out of 94 participants provide additional feedback.

d) Phase 4: Evaluation

Based on the results from the analysis, several learning can be derived. Looking at Figure 7, the circles highlight the bottlenecks in tasks. A bottleneck is defined as a high deviation from the correct pathway. These bottlenecks occurred at the following tasks:

Figure 6: MapView of participant geo-distribution

Task 4: Change your proftle settings so buddies can ftnd *you* Al- though the majority followed the correct activity, going to settings to change, the second largest group searched for the settings in the buddies panel. This shows unclarity in how to change the profile settings.

Task 5: Text one of your Buddies on your Buddies list the majority chose a buddy that was not listed as a friend yet; the top of the list. To stimulate the social experience from the application, a suggested friend list is put on top of the screen. Considering that the largest group chose the first item on the list, it can be concluded that the suggested buddies disrupts the user flow.

Task 6: Add a new device to your Devices list As stated in the qualitative feedback, and low number of

participants choosing the correct event, the intended device button in the interface did not identify itself as such.

Based on the qualitative feedback, the following observations are extracted from the entire list of feedback:

- The visual style of mock-up was general considered to be good. Some Tasks, involving pressing icons as buttons, created confusion to the purpose of the button. *E.g. the devices list button consisted of four squares.*
- Multiple participants stated that they only finished a specific tasks based on trial-and-error or due to the interactive element highlighting from JIM.
- The purpose of the study was not clear to some participants as no introduction of the study was provided. This was done intentionally by the researchers to prevent pre-educating the participants for the purpose of the app. If required, additional introductory stories can be added prior to loading the mock-up to provide some context to the study.
- Some participants wanted to see more of the application; this is limited by the mock-up and outside the purpose of this approach.
- Feature-specific feedback consisted of raising the concern of showing *People you might want to know* as suggestion in the Buddies list or prioritising these suggestions over actual Buddies by showing the sug- gestion first.
- These insights provided direction for future efforts: re-evaluate the application navigation and investigate how to improve the usage of icons to convey meaning. The latter might seem obvious from a third perspective, but bias blind spots are only discovered by receiving feedback from others.

IV. Conclusions

The Klikker-methodology has proven to be easy to implement and requires few resources in comparison with other methods to collect user behaviour and feedback. The process requires the involvement of researchers with different backgrounds to create the mockups and analyse the produced dataset. Prior work by the authors, also highlighted the relevance of combining the perspectives of researchers, designers, and developers [Wetzels et al.2017]. The Klikker method intends to achieve this cooperation at an early stage of the application development to increase efficiency in the development process and prevent major overhauls in the later stages of development. From a technical perspective, the authors would recommend modernising the setup by containerising all services using Docker [Chamberlain and Schommer2014], implementing a reverse proxy-such as NGINX [Nedelcu2010] or Traefik (traefik.io)-, and having NGINX or a separate service to host the static files instead of the Node.JS process. Future efforts will also investigate the mimicking of the TCP three-way handshake using web sockets to confirm successful delivery of events. From a research perspective, the method is positioned as an early stage explorative approach to kick-start an iterative development cycle and promote end-user involvement. The method has not been designed to evaluate large, in depth, topics such as user behaviour over a longer period. It is recommended to focus on UI elements and general functionalities; preferably the study does not take more than a few minutes.

Acknowledgements

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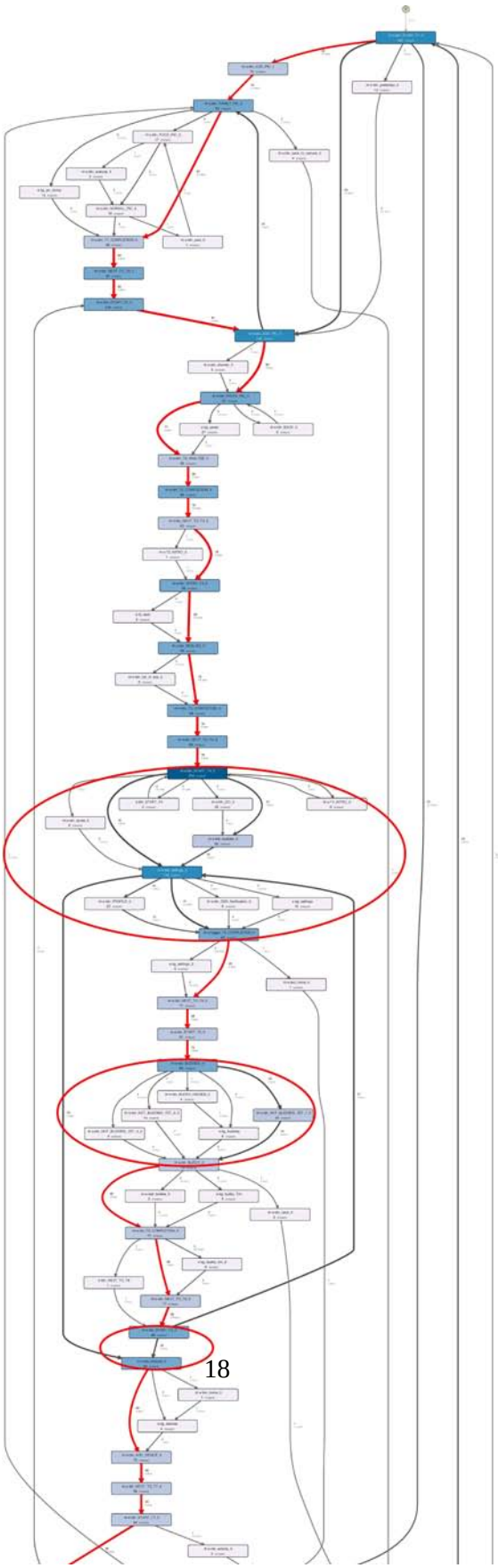

Figure 7

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The following benefits can be availed by you only for next three years from the date of certification:

FARSC designated members are entitled to avail a 40% discount while publishing their research papers (of a single author) with Global Journals Incorporation (USA), if the same is accepted by Editorial Board/Peer Reviewers. If you are a main author or co-author in case of multiple authors, you will be entitled to avail discount of 10%.

Once FARSC title is accorded, the Fellow is authorized to organize a symposium/seminar/conference on behalf of Global Journal Incorporation (USA).The Fellow can also participate in conference/seminar/symposium organized by another institution as representative of Global Journal. In both the cases, it is mandatory for him to discuss with us and obtain our consent.

You may join as member of the Editorial Board of Global Journals Incorporation (USA) after successful completion of three years as Fellow and as Peer Reviewer. In addition, it is also desirable that you should organize seminar/symposium/conference at least once.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time. This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

The FARSS can go through standards of OARS. You can also play vital role if you have any suggestions so that proper amendment can take place to improve the same for the benefit of entire research community.

As FARSS, you will be given a renowned, secure and free professional email address with 100 GB of space e.g. johnhall@globaljournals.org. This will include Webmail, Spam Assassin, Email Forwarders,Auto-Responders, Email Delivery Route tracing, etc.

The FARSS will be eligible for a free application of standardization of their researches. Standardization of research will be subject to acceptability within stipulated norms as the next step after publishing in a journal. We shall depute a team of specialized research professionals who will render their services for elevating your researches to next higher level, which is worldwide open standardization.

The FARSS member can apply for grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A.
Once you are designated as FARSS, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria. After certification of all your credentials by OARS, they will be published on your Fellow Profile link on website https://associationofresearch.org which will be helpful to upgrade the dignity.

The FARSS members can avail the benefits of free research podcasting in Global Research Radio with their research documents. After publishing the work, (including published elsewhere worldwide with proper authorization) you can upload your research paper with your recorded voice or you can utilize chargeable services of our professional RJs to record your paper in their voice on request.

The FARSS member also entitled to get the benefits of free research podcasting of their research documents through video clips. We can also streamline your conference videos and display your slides/ online slides and online research video clips at reasonable charges, on request.

The FARSS is eligible to earn from sales proceeds of his/her researches/reference/review Books or literature, while publishing with Global Journals. The FARSS can decide whether he/she would like to publish his/her research in a closed manner. In this case, whenever readers purchase that individual research paper for reading, maximum 60% of its profit earned as royalty by Global Journals, will be credited to his/her bank account. The entire entitled amount will be credited to his/her bank account exceeding limit of minimum fixed balance. There is no minimum time limit for collection. The FARSS member can decide its price and we can help in making the right decision.

The FARSS member is eligible to join as a paid peer reviewer at Global Journals Incorporation (USA) and can get remuneration of 15% of author fees, taken from the author of a respective paper. After reviewing 5 or more papers you can request to transfer the amount to your bank account.

MEMBER OF ASSOCIATION OF RESEARCH SOCIETY IN SCIENCE (MARSS)

The ' MARSS ' title is accorded to a selected professional after the approval of the Editor-in-Chief / Editorial Board Members/Dean.

The “MARSS” is a dignified ornament which is accorded to a person’s name viz. Dr. John E. Hall, Ph.D., MARSS or William Walldroff, M.S., MARSS.

MARSS accrediting is an honor. It authenticates your research activities. After becoming MARSS, you can add 'MARSS' title with your name as you use this recognition as additional suffix to your status. This will definitely enhance and add more value and repute to your name. You may use it on your professional Counseling Materials such as CV, Resume, Visiting Card and Name Plate etc.

The following benefitscan be availed by you only for next three years from the date of certification.

MARSS designated members are entitled to avail a 25% discount while publishing their research papers (of a single author) in Global Journals Inc., if the same is accepted by our Editorial Board and Peer Reviewers. If you are a main author or co-author of a group of authors, you will get discount of 10%.

As MARSS, you will be given a renowned, secure and free professional email address with 30 GB of space e.g. johnhall@globaljournals.org. This will include Webmail, Spam Assassin, Email Forwarders,Auto-Responders, Email Delivery Route tracing, etc.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time. This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

The MARSC member can apply for approval, grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A.

Once you are designated as MARSC, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria.

It is mandatory to read all terms and conditions carefully.

Auxiliary Memberships

Institutional Fellow of Open Association of Research Society (USA)-OARS (USA)

Global Journals Incorporation (USA) is accredited by Open Association of Research Society, U.S.A (OARS) and in turn, affiliates research institutions as "Institutional Fellow of Open Association of Research Society" (IFOARS).

The "FARSC" is a dignified title which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., FARSC or William Walldroff, M.S., FARSC.

The IFOARS institution is entitled to form a Board comprised of one Chairperson and three to five board members preferably from different streams. The Board will be recognized as "Institutional Board of Open Association of Research Society"-(IBOARS).

The Institute will be entitled to following benefits:

The IBOARS can initially review research papers of their institute and recommend them to publish with respective journal of Global Journals. It can also review the papers of other institutions after obtaining our consent. The second review will be done by peer reviewer of Global Journals Incorporation (USA) The Board is at liberty to appoint a peer reviewer with the approval of chairperson after consulting us.

The author fees of such paper may be waived off up to 40%.

The Global Journals Incorporation (USA) at its discretion can also refer double blind peer reviewed paper at their end to the board for the verification and to get recommendation for final stage of acceptance of publication.

The IBOARS can organize symposium/seminar/conference in their country on behalf of Global Journals Incorporation (USA)-OARS (USA). The terms and conditions can be discussed separately.

The Board can also play vital role by exploring and giving valuable suggestions regarding the Standards of "Open Association of Research Society, U.S.A (OARS)" so that proper amendment can take place for the benefit of entire research community. We shall provide details of particular standard only on receipt of request from the Board.

The board members can also join us as Individual Fellow with 40% discount on total fees applicable to Individual Fellow. They will be entitled to avail all the benefits as declared. Please visit Individual Fellow-sub menu of GlobalJournals.org to have more relevant details.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time. This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

After nomination of your institution as "Institutional Fellow" and constantly functioning successfully for one year, we can consider giving recognition to your institute to function as Regional/Zonal office on our behalf.
The board can also take up the additional allied activities for betterment after our consultation.

The following entitlements are applicable to individual Fellows:

Open Association of Research Society, U.S.A (OARS) By-laws states that an individual Fellow may use the designations as applicable, or the corresponding initials. The Credentials of individual Fellow and Associate designations signify that the individual has gained knowledge of the fundamental concepts. One is magnanimous and proficient in an expertise course covering the professional code of conduct, and follows recognized standards of practice.

Open Association of Research Society (US)/ Global Journals Incorporation (USA), as described in Corporate Statements, are educational, research publishing and professional membership organizations. Achieving our individual Fellow or Associate status is based mainly on meeting stated educational research requirements.

Disbursement of 40% Royalty earned through Global Journals : Researcher = 50%, Peer Reviewer = 37.50%, Institution = 12.50% E.g. Out of 40%, the 20% benefit should be passed on to researcher, 15 % benefit towards remuneration should be given to a reviewer and remaining 5% is to be retained by the institution.

We shall provide print version of 12 issues of any three journals [as per your requirement] out of our 38 journals worth $ 2376 USD.

Other:

The individual Fellow and Associate designations accredited by Open Association of Research Society (US) credentials signify guarantees following achievements:

- The professional accredited with Fellow honor, is entitled to various benefits viz. name, fame, honor, regular flow of income, secured bright future, social status etc.

- In addition to above, if one is single author, then entitled to 40% discount on publishing research paper and can get 10%discount if one is co-author or main author among group of authors.
- The Fellow can organize symposium/seminar/conference on behalf of Global Journals Incorporation (USA) and he/she can also attend the same organized by other institutes on behalf of Global Journals.
- The Fellow can become member of Editorial Board Member after completing 3yrs.
- The Fellow can earn 60% of sales proceeds from the sale of reference/review books/literature/publishing of research paper.
- Fellow can also join as paid peer reviewer and earn 15% remuneration of author charges and can also get an opportunity to join as member of the Editorial Board of Global Journals Incorporation (USA)
- • This individual has learned the basic methods of applying those concepts and techniques to common challenging situations. This individual has further demonstrated an in–depth understanding of the application of suitable techniques to a particular area of research practice.

Note :

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- In future, if the board feels the necessity to change any board member, the same can be done with the consent of the chairperson along with anyone board member without our approval.
- In case, the chairperson needs to be replaced then consent of 2/3rd board members are required and they are also required to jointly pass the resolution copy of which should be sent to us. In such case, it will be compulsory to obtain our approval before replacement.
- In case of "Difference of Opinion [if any]" among the Board members, our decision will be final and binding to everyone.

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Preferred Author Guidelines

We accept the manuscript submissions in any standard (generic) format.

We typeset manuscripts using advanced typesetting tools like Adobe In Design, CorelDraw, TeXnicCenter, and TeXStudio. We usually recommend authors submit their research using any standard format they are comfortable with, and let Global Journals do the rest.

Alternatively, you can download our basic template from https://globaljournals.org/Template.zip

Authors should submit their complete paper/article, including text illustrations, graphics, conclusions, artwork, and tables. Authors who are not able to submit manuscript using the form above can email the manuscript department at submit@globaljournals.org or get in touch with chiefeditor@globaljournals.org if they wish to send the abstract before submission.

Before and during Submission

Authors must ensure the information provided during the submission of a paper is authentic. Please go through the following checklist before submitting:

1. Authors must go through the complete author guideline and understand and *agree to Global Journals' ethics and code of conduct,* along with author responsibilities.
2. Authors must accept the privacy policy, terms, and conditions of Global Journals.
3. Ensure corresponding author's email address and postal address are accurate and reachable.
4. Manuscript to be submitted must include keywords, an abstract, a paper title, co-author(s') names and details (email address, name, phone number, and institution), figures and illustrations in vector format including appropriate captions, tables, including titles and footnotes, a conclusion, results, acknowledgments and references.
5. Authors should submit paper in a ZIP archive if any supplementary files are required along with the paper.
6. Proper permissions must be acquired for the use of any copyrighted material.
7. Manuscript submitted *must not have been submitted or published elsewhere* and all authors must be aware of the submission.

Declaration of Conflicts of Interest

It is required for authors to declare all financial, institutional, and personal relationships with other individuals and organizations that could influence (bias) their research.

Policy on Plagiarism

Plagiarism is not acceptable in Global Journals submissions at all.

Plagiarized content will not be considered for publication. We reserve the right to inform authors' institutions about plagiarism detected either before or after publication. If plagiarism is identified, we will follow COPE guidelines:

Authors are solely responsible for all the plagiarism that is found. The author must not fabricate, falsify or plagiarize existing research data. The following, if copied, will be considered plagiarism:

- Words (language)
- Ideas
- Findings
- Writings
- Diagrams
- Graphs
- Illustrations
- Lectures

- Printed material
- Graphic representations
- Computer programs
- Electronic material
- Any other original work

Authorship Policies

Global Journals follows the definition of authorship set up by the Open Association of Research Society, USA. According to its guidelines, authorship criteria must be based on:

1. Substantial contributions to the conception and acquisition of data, analysis, and interpretation of findings.
2. Drafting the paper and revising it critically regarding important academic content.
3. Final approval of the version of the paper to be published.

Changes in Authorship

The corresponding author should mention the name and complete details of all co-authors during submission and in manuscript. We support addition, rearrangement, manipulation, and deletions in authors list till the early view publication of the journal. We expect that corresponding author will notify all co-authors of submission. We follow COPE guidelines for changes in authorship.

Copyright

During submission of the manuscript, the author is confirming an exclusive license agreement with Global Journals which gives Global Journals the authority to reproduce, reuse, and republish authors' research. We also believe in flexible copyright terms where copyright may remain with authors/employers/institutions as well. Contact your editor after acceptance to choose your copyright policy. You may follow this form for copyright transfers.

Appealing Decisions

Unless specified in the notification, the Editorial Board's decision on publication of the paper is final and cannot be appealed before making the major change in the manuscript.

Acknowledgments

Contributors to the research other than authors credited should be mentioned in Acknowledgments. The source of funding for the research can be included. Suppliers of resources may be mentioned along with their addresses.

Declaration of funding sources

Global Journals is in partnership with various universities, laboratories, and other institutions worldwide in the research domain. Authors are requested to disclose their source of funding during every stage of their research, such as making analysis, performing laboratory operations, computing data, and using institutional resources, from writing an article to its submission. This will also help authors to get reimbursements by requesting an open access publication letter from Global Journals and submitting to the respective funding source.

Preparing your Manuscript

Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.

Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11'", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

a) A title which should be relevant to the theme of the paper.
b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
d) An introduction, giving fundamental background objectives.
e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
f) Results which should be presented concisely by well-designed tables and figures.
g) Suitable statistical data should also be given.
h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
j) There should be brief acknowledgments.
k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.

Format Structure

It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

All manuscripts submitted to Global Journals should include:

Title

The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, “What words would a source have to include to be truly valuable in a research paper?” Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.

Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

Preparation of Eletronic Figures for Publication

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

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 Computer Science Research Paper

Techniques for writing a good quality computer science 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 computer science 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.

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	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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