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Eliminating Counterfeit Signatures

Membrane Computing Aggregation

Discovering Thoughts, Inventing Future

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Membrane Computing Aggregation (MCA): An Upgraded Framework for Transition P-Systems

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Strictly as per the compliance and regulations of:

Membrane Computing Aggregation (MCA): An Upgraded Framework for Transition P-Systems

Alberto Arteta[α], Luis Fernando Mingo[σ], Nuria Gomez[ρ] & Yanjun Zhao[ω]

Abstract- MCA (Membrane computing aggregation is experimental computational frame. It is inspired by the inner properties of membrane cells (Bio-inspired system). It is capable of problem solving activities by maintaining a special, "meaningful" relationship with the internal/external environment, integrating its self-reproduction processes within the information flow of incoming and outgoing signals. Because these problem solving capabilities, MCA admits a crucial evolutionary tuning by mutations and recombination of theoretical genetic "bridges in a so called "aggregation" process ruled by a hierarchical factor that enclosed those capabilities. Throughout the epigenetic capabilities and the cytoskeleton and cell adhesion functionalities, MCA model gain a complex population dynamics specifics and high scalability. Along its developmental process, it can differentiate into meaningful computational tissues and organs that respond to the conditions of the environment and therefore "solve" the morphogenetic/configurational problem. MCA, above all, represents the potential for a new computational paradigm inspired in the higher level processes of membrane cells, endowed with quasi universal processing capabilities beyond the possibilities of cellular automata of and agent processing models.

I. Introduction

In spite of all the recent emphasis and advancements in systems biology, synthetic biology, and network science about modelling of gene networks, protein networks, metabolic and signaling networks, etc. some of the most important computational properties of membrane cells have not been grappled and "abstracted" et: scalability, tissular differentiation, and morphogenesis -i.e., the capability to informationally transcend the cellular level and organize higher level information processes by means of heterogeneous populations of membrane cells organized as "computational tissues and organs".

Synthetic biology has become extraordinarily active in the manufacture of very simple and robust models and simulations tailored to the realization problems of circuits and modules in vivo, mostly addressed to prokaryotic systems. In the first wave of these studies, very basic elements such as promoters, transcription factors, and repressors were combined to form small modules with specified behaviors. Currently modules include switches, cascades, pulse generators, oscillators, spatial patterns, and logic formulas (Purnick & Weiss, 2009). The second wave of synthetic biology is integrating basic parts and modules to create systems-level circuitry. genomes and synthetic life organisms are envisioned, and application-oriented systems are contemplated. Different computational tools and programming abstractions are actively developed (the Registry of Standard Biological Parts; the Growing Point Language GLP; the Origami Shape Language OSL, the PROTO bio programming language, etc. See details at the Open Wetware site). Evolving cell models of prokaryotes have also been addressed (Cao et al., 2010). (Bashor et al., 2010). As some have put, "systems broaden the scope of synthetic biology designing synthetic circuits to operate in reliably in the context of differentiating and morphologically complex membrane cells present unique challenges and opportunities for progress in the field" (Haynes & Silver, 2009). However, very few synthetic biology researchers do contemplate using systems.

In systems biology, a plethora of modelling developments have been built around signaling pathways, cell cycle control, topologies of protein networks, transcriptional networks, etc. There is a relatively well consolidated thinking, in part due to traditional physiology and to systems science and control theory which were at the origins of this new field, of going "from genes to membrane cells to the whole organ" as D. Noble has done for heart models (Noble, 2002). The integration of proteins to organs has also been promoted by bioinformatic-related projects such as the "Physiome Project" (Hunter et al., 2002). Important works have been done in the vicinity of "network science" in order to make sense of gene networks, protein networks, transcription networks, complexes formation, etc. For instance, about how is dynamically or2anized modularity in the yeast protein-protein interaction network (Han et al., 2004), it was uncovered that two types of "hub" contribute to the organized modularity of the proteome: "party" hubs which interact with their partners simultaneously, and "date" hubs, which bind their different partners at different times and locations (we will see later on the importance of the discussion on "modularity" in the evo-devo field). Predictive models of mammalian membrane cells have been described using graph theory, assembling networks and integrative procedures (Ma'yan et al., 2005). Important systems biology

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compilations and far-reaching cellular models have been made by Balazsi et al. (2005), Kitano (see in Oda et al., 2004), Luscombe et al. (2004), Huh et al., (2010) ...It has to be emphasized that concerning the views advocated in this proposal, most of systems biology works depart from the goal of "abstracting computational power out from systems" and focus instead on "applying computational power to analyze the organization of systems." Notwithstanding the foregoing, studies such as A. Dan chin (2009) on bacteria as computers making computers, and by Ray et al. (2010) on the operating system of bacteria could be considered as forerunners in the former direction.

In the science of development (the "evo-devo" discipline) most of the emphasis has been on modularity. What it exactly means in developmental terms is still a matter of controversy (Schlosser & Wagner, 2004; Carroll, 2005; Sprinzak, 2010); but undoubtedly modularity refers to the capability of cellular networks to dissociate networked processes at a lower level and to recombine or redeploy them at the higher level of the multicellular organism. Thanks to the cellular signaling system, the genetic switches, the cytoskeleton, and some other topobiological mechanisms (Edelman, 1988; Szathmary, 2001), the unitary network of cellular processes integrated into the cell-cycle may be broken down into coherent modules and be performed separately in different membrane cells within differently specialized tissues (Palmer, 2004). This implies a flexible organization for the deployment of biomolecular processing modules, which actually are "cut" differently in each tissue along the developmental process, due also to chromatin remodelling during development (Ho & Crabtree, 2010). Interestingly, not only differentiation but also morphology becomes an instance of the scalable "modular" processing, throughout the "tensegrity" emergent property and the ontogenetic arrangement of symmetry breakings in a force field. The emergence of cellular bauplans where signaling, force fields, and cytoskeletal mechanical modes conspire together to create but a few basic morphologies for membrane cells, depending also on the populations present, seems to be another important consequence (Mojica et al., 2009). Interestingly, complex morphologies obtained out from Turing diffusion model have been cogently discussed as a result of cell-to-cell developmental interactions (Kondo & Miura, 2010) .Currently, the evo-devo field accumulates a considerable mass of biomolecular-or2anization-facts, poorly conceptualized yet, to be computationally "abstracted" in the perspective of MCA advancement.

In the fields closer to computer science and Biocomputing, it has been important the introduction of the agent based approach (as pioneered by W. Fontana and others), which uses sets of rules to define relationships between cellular components substituting for the simple Boolean networks and differential equations used up to now. Proteins and other biomolecules become molecular "automata" and the aggregate behavior that emerges out from these models is the combinatorial expression of all those automata doing their specific micro-functions (Blow, 2009). This approach shows promise for "evolvable" advancement of network models endowed with the flexible modularity property. It is somehow close to the already mentioned predictive models of mammalian membrane cells that are using graph theory, assembling networks and integrative procedures (Mayan et al., 2005). New generations of cellular models (of "automata") have been developed too, with powerful data content and with potential for modelling multi-cellular systems in a general way, supporting user-friendly in silicon experimentation and discovery of emergent properties (Amir-Kroll et al., 2008). Under the approach of Artificial Embryology, a developmental system has been obtained by means of cellular automata systems capable of following "rewriting rules" procedures, emulating elementary morphologies and multicellular distributions (Federici & Downing, 2006).

As for the developments in molecular Biocomputing, the idea that bio-molecules (DNA, RNA, proteins) might be used for computing already emerged in the fifties and was reconsidered periodically with more and more arguments which made it more viable. But the definitive confirmation came in 1994 (Adleman, 1994) when L. Adleman successfully accomplished the first experimental close connection between molecular biology and computer science. He described how a small instance of a computationally intractable problem might be solved via a massively parallel random search using molecular biology methods.

An important part of this project is focusing on bio-inspired models of computation abstracted from the very complex networks in living systems. Its goal is to investigate several aspects of these models particularly focused on connections between theoretical models and natural (biological) networks.

The main topics are:

Computational aspects (computational power, structural and description complexity).

Application aspects (simulation, physical implementation, experimental results, training issues). This part is intended to be a contribution to both Global Computing (which includes neural networks, cellular automata, etc.) and Bio-inspired Computing (as a part of Natural Computing) a new and interdisciplinary field which lies at the crossroads of mathematics, computer science, molecular biology and linguistics. There are research groups working in similar or connected topics in Europe (Germany, France, Spain, Holland, Hungary, Romania, Moldavia, Finland, Poland, Austria, Italy), USA, Japan, India, China.

Several new directions of research have been initiated in the last decade: computing devices inspired from the genome evolution (Dassow & Mitrana, 1997; Dassow et al., 1997; Dassow et al., 2002), membrane systems (Nun, 2002) with an explosive development, evolutionary systems based on the behavior of cell populations (Ardelean et al.,2004) computing models simulating the process of gene assembly in ciliates (Ehrenfeucht et al., 2003), (Freund et al., 2002), (Istrail et al., 2007), networks of evolutionary processors (Manea et al., 2010), etc. The joint efforts of biologists and computer scientists led to a new concept, namely the template-guided recombination which seems to offer a "bioware" implementation of the process of gene assembly (Angeleska et al., 2007), (Presscot et al., 2003).

Swarm computation is mainly based on the same idea: a swarm is a group of mobile biological organisms wherein each individual communicates with others by acting on its local environment (Engelbrecht, 2005). A computational model based on multiset rewriting is used to simulate the emergence of autocatalytic cycles which are often found in living systems is proposed in (Suzuki&Tanaka, 1997). The use of X-machines, a variant of finite state machines with much more computational power, is used to model immunological pathways (Holcombe&Be11,1998). Moreover, (Istrail et al., 2007) proposes a new paradigm, "genomic computer", where the entire genomic regulatory system is viewed as a computational system and not only the immune system as it was considered in (Dasgupta,1998).

Many works were devoted to the study of a wide range of operations on biological sequences in vivo and in vitro (bio-operations): PA-matching, annealing, Watson-Crick superposition, transposition, inversion, duplication, translocation, etc. (Karp,2002) gives an overview of the most important and attractive problems for mathematicians coming from genomics and molecular biology. Last but not least, the molecular computing contributed to the understanding of self-assembly which is one of the key concepts in nanoscience (Reif&LaBean,2007).

The new sub-area of Computation Theory called Bio-Inspired Computing is very dynamic. After approximately 12 years the bibliography about Bio-Inspired Computing counts nearly 1000 papers and several books and grows rapidly each year. These papers were published in either computer science forums or biological ones. Many prestigious international journals hosted special issues but new journals were also created: a permanent column in the Bulletin of the European Association for Theoretical Computer Science, Natural Computing, Journal of Unconventional Computing, Theoretical Computer Science-Track C, Theory of Natural Computing, etc. Each year several conferences are devoted mainly to this area: DNA Based Computers (15 editions so far), Unconventional Models of Computation (8 editions so far), Workshop in Membrane Computing (11 editions so far), International Work-Conference on Artificial and Natural Networks (9 editions so far), International Work-Conference on the Interplay between Natural and Artificial Computation (5 editions so far), Pacific Symposium on Biocomputing (first edition in 1995). Regarding applicative models there are many attempts to update Cells computing paradigm in Arteta (2009) Arteta (2010) Arteta (2011) Arteta (2012) Arteta (2013) Arteta (2014), Frutos (2009) and Frutos (2013) among others.

II. Membrane Computing

A Transition P System of degree n $n>1$ is a construct $\Pi=(V,\mu,\omega_1,\ \omega_n,(R_1,\rho_1)\ ,R_n,\rho_n)(i_0)$

Where:

V is an alphabet; its elements are called objects;

μ is a membrane structure of degree n, with the membranes and the regions labeled in a one-to-one manner with elements in a given set; in this section we always use the labels 1, 2, n;

$\omega_i\ 1\le i\le n$, are strings from V^* representing multisets over V associated with the regions 1,2,..,n of μ

$R_i\ 1\le i\le n$, are finite set of evolution rules over V associated with the regions 1,2,..,n of μ; ρ_i is a partial order over $R_i\ 1\le i\le n$, specifying a priority relation among rules of R_i . An evolution rule is a pair (u,v) which we will usually write in the form $u\to v$ where u is a string over V and v=v' or v=v' δ where v' is a string over

$$(V\times\{here\ ,out\ \})\cup(V\times\{in_j\ 1\le\ j\le\ n\}),$$

and δ is a special symbol not in. The length of u is called the radius of the rule $u\to v$

i_o is a number between 1 and n which specifies the output membrane of Π

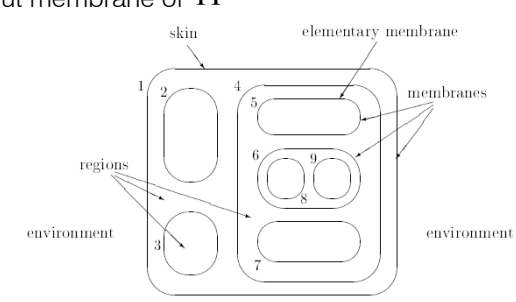

Fig. 1: P-system structure

Definition Multiset of objects

Let U be a finite and not empty set of objects and N the set of natural numbers. A multiset of objects is defined as a mapping:

$$M : U \rightarrow N$$
$$a_i \rightarrow u_1$$

Where a_i is an object and u_i its multiplicity

As it is well known, there are several representations for multisets of objects.

$$M = \{(a_1,u_1),(a_2,u_2),(a_3,u_3). \ \} = a_1^{u1} \cdot a_2^{u2} \cdot a_n^{un} . \quad .$$

Note: Initial Multiset is the multiset existing within a given region in where no application of evolution rules has occurred yet.

Definition Evolution rule with objects in U and targets in T

Evolution rule with objects in U and targets in T is defined by $r = (m,c,\delta)$ where $m \in M(U), c \in M(UxT)$ and $\delta \in \{to\ dissolve, not\ to\ dissolve\}$

From now on 'c' will be referred a s the consequent of the evolution rule 'r'.

Note: The set of evolution rules with objects in Uand targets in T is represented by R (U, T).

Definition Multiplicity of an object in a multiset of objects M(U)

Let $a_i \in U$ be an object and let $m \in M(U)$ be a multiset of objects. The multiplicity of an object is defined over a multiset of objects such as:

$$|\ |_{a_i} : U \times M(U) \rightarrow N$$
$$(a_i, m) \rightarrow |m|_{a_i} = n \mid (a_i, n) \in m$$

Definition Multiplicity of an object in an evolution rule r

Let $a_i \in U$ be an object and let $R(U,T)$ be a multiset of evolution rules. Let $r = (m,c,\delta) \in R(U,T)$ where $m \in M(U), c \in M(UxT)$ and $\delta \in \{to\ dissolve, not\ to\ dissolve\}$

The multiplicity of an object is defined over an evolution rules such as:

$$|\ |_{a_i} : U \times R(U,T) \rightarrow N$$
$$(a_i, r) \rightarrow |m|_{a_i} = n \mid (a_i, n) \in m$$

P-system evolution

Let C_i be the consequent of the evolution rule r_i . Thus,

The representation of the evolution rules is:

$$r_1 : a_1^{u1}\ a_2^{u1}\ ?a_n^{u1n} \rightarrow C_1$$
$$r_2 : a_1^{u2}\ a_2^{u2}\ ?a_n^{u2n} \rightarrow C_2$$
$$. . . . . \rightarrow . . . . . .$$
$$r_m : a_1^{um1} a_2^{um2} . a_n^{um\ \ n} \rightarrow C_m$$

P-systems evolve, which makes it change upon time; therefore, it is a dynamic system. Every time that there is a change on the p-system we will say that the p-system is in a new transition. The step from one transition to another one will be referred to as an evolutionary step, and the set of all evolutionary steps will be named computation. Processes within the p-system will be acting in a massively parallel and non-deterministic manner. (Similar to the way the living cells process and combine information). We will say that the computation has been successful if:

III. The Upgrade

The proposal is a new computational paradigm based on Membrane cells, scalable ones which are capable to produce "computational tissues and organs". The organization of such computational tissues and organs is inspired by the emerging informational properties of biomolecular networks and will be based on scalable "membrane cells" guided by functional rules similar to the biological ones (molecular recognition, self-assembly and topo biology-theory rules).

The direct inspiration from the membrane cells is precisely the breakthrough of the MCA project. By building computational tissues our proposal makes an evolutionary jump with respect of today research in this field, mainly focused on aggregates of unicellular organisms (e.g. bacteria). Far from modelling and simulating the cellular processes, our computational paradigm will be a clear abstraction of the basic mechanisms and computational capabilities of the membrane cells and tissues, in order to solve complex problems in a new (bioinspired) way.

Real tissues display far more complex properties (emergent properties) than the sum of the properties of the individual membrane cells they are made from. In the same way, the emergent properties and functions of our membrane cells and computational tissues will be used for the resolution of real problems, impossible to be appropriately solved by conventional methods: not only biological morphogenesis, but also evolution of economic systems and prediction of crisis, optimization of "industrial ecologies", analysis of the dynamics of social interactions and conflicts, ecosystem disturbances, etc., that are more complex than combinatorial optimization, as well as other classical NP-Complete ones.

Our "membrane cells" will be a species of "proto-membrane cells" and a far objective of the project is also the ex-novosynthesis of " membrane

cells" and tissues performing as living computational biomolecular networks. The lon2-term vision that motivates this breakthrough is to build new information processing devices with evolving capabilities, which will adapt themselves to the complexity of the problems. In particular, we foresee a synthetic approach to build computational membrane cells and tissues, and to create computational bio-inspired devices of higher complexity (tissues-organs). A far future objective of the project goes beyond the mathematical, software and hardware tools. It is to obtain in lab synthesized "living" information processing systems based on artificial "membrane cells" and hybrid systems combining living components (our "synthesized membrane cells") and non-living elements (e.g. silicon-based).

MCA approach is the most appropriate to deal with extremely complex problems that will be crucial in the future. It shows potential to go beyond classical Biocomputing strategies such as self-reproducing machines, cellular automata, perceptron's & neural networks, genetic algorithms, adaptive computing, bacteria-based computation, artificial membrane cells, etc. Specifically, a new generation of natural computing could be built, based upon the scalable " membrane cells" with problem solving capacity in very different realms: biomaterials and bioengineering, non-linear parallel processing, design of bioinspired systems, modelling of economic, industrial and financial systems, optimization strategies in social settings, etc.

For the achievement of our long-term objectives we need to: analyze the wide amount of existing knowledge regarding one of the deepest sources of biocomputational power, the topological and flexible networking properties of biomolecular scalable modules in membrane cells, realize an abstraction of the basic mechanisms and computational capabilities of the membrane cells both at sub cellular and networking level, and develop formal models to be used in new information processing technologies, basically based on combinatory processes of protein domains and genetic switches, together with cytoskeleton dynamics and topobiology-theory, use the above proposed models to create scalable "/proto membrane cells" and abstract-formal "evolvable" cellular networks and computational tissues & organs endowed with these flexible modularity properties.

For our far final objective we need to obtain in lab proof that synthesis of new forms of living" membrane cells" in an inverse process: "membrane cells and tissues" => "theoretical abstract/formal models" => "artificial membrane cells and tissues" => "in lab synthesized living membrane cells" is possible. MCA breakthrou2h is an essential step towards the achievement of our lon2-term vision because it will set the theoretical basis and develop the experimental tools for the creation of the scalable membrane cells, computational tissues and organs (both abstract and living ones).

IV. MCA System

A MCA is a set $\Omega = \{\mathbb{M}_0, \mathbb{M}_1, \mathbb{M}_2, \ldots, \mathbb{M}_{N-1}, \mathbb{M}_N)$ and a set $\aleph$ of aggregation rules among membranes. The set of aggregation rules are not fully integrated with the evolution rules of a given p-System but establishes the correlation between 2 given membrane models by deciding the way 2 or mere P-systems are being aggregated. The rules can be defined as a Matrix relation

$$\varphi_1(k_1, k_2, .k_m,) \equiv \begin{pmatrix} u_{1\ 1} & u_{2\ 1} & . & u_{m1} \\ u_{1\ 2} & u_{2\ 2} & . & u_{m2} \\ . & . & . & . \\ u_{1n} & u_{2n} & . & u_m \end{pmatrix}_n \begin{pmatrix} k_1 \\ k_2 \\ . \\ k_m \end{pmatrix} = \begin{pmatrix} u_1 \\ u_2 \\ . \\ u_n \end{pmatrix}$$

Where φ1(k) is the aggregation relation and is defined by the association of n P-systems, k determines the aggregation rules of each component in every p-system Iand Uare the component (objects).

Evolution rule application phase.

This phase is the one that has been implemented following different techniques.

In every region within a p-system, the evolution rules application phase is described as follows:

Rules application to a multiset of object in a region is a transforming process of information which has input, output and conditions for making the transformation.

Given a region within a p-system, let U= $\{a_i \mid 1 \le i \le n\}$ be the alphabet of objects, m a multiset of objects over U and R(U,T) a multiset of evolution rules with antecedents in U and targets in T.

The input in the region is the initial multiset m.

The output is a maximal multiset m'.

The transformations have been made based on the application of the evolution rules over m until m' is obtained.

Application of evolution rules in each region of P systems involves subtracting objects from the initial multiset by using rules antecedents. Rules used are chosen in a non-deterministic manner. This phase ends when no rule is applicable anymore.

The transformation only needs rules antecedents as the consequents are part of the communication phase.

Observation

Let $k_i \in N$ be the number of times that the rule r_i is applied. Therefore, the number of symbols a_j which have been consumed after applying the evolution rules a specific number of times will be:

$$\sum_{i=1}^{m} k_i \cdot u_{ij}$$

Definition

Given a region R and alphabet of objects U, and R (U, T) set of evolution rules over U and targets in T.

$$r_1 : a_1^{u_{11}} a_2^{u_{12}} . a_n^{u_{1n}} \rightarrow C_1$$

$$r_2 : a_1^{u_{21}} a_2^{u_{22}} . a_n^{u_{2n}} \rightarrow C_2$$

$$\ldots \qquad \rightarrow \ldots.$$

$$r_m : a_1^{u_{m1}} a_2^{u_{m2}} . a_n^{u_{mn}} \rightarrow C_m$$

Maximal multiset is that one that complies with:

$$\bigcap_{l=1}^{m}\left[\bigcup_{i=1}^{n}\left(u_i - \sum_{j=1}^{m}(k_j \cdot u_{ji}) \leq u_{li}\right)\right]$$ [1] [Arteta,2010]

V. Correction

The correction of the system fully relies in the correction of the internal P-system of the MCA. In order to prove the aggregation system is distributed then 2 processes need to be proven.

1. Correction of the formal definition of Transition P-System (Paun , 1998)
2. Correction of the aggregation rules applying to 2 given P-systems.

The correction of the second point gets reduced to a deductive demonstration where the aggregation of 2 given P-systems is base case and the generic case of n-P-systems can be seen as the aggregation of n-1 P-systems (inductive case) with a correct aggregation to the last one.

Thus, the key is to prove that aggregation of 2 given P-system is a correct process and indeed reinforce the idea of full inherent parallelism and nondeterministic modelling that membrane models are after.

Aggregation rule. Let us use a short definition of a given P-System $\Pi = (V, \mu, \omega_1, \ \omega_n, (R_1, \rho_1) \ , R_n, \rho_n)(\rho_0)$

Base case. Given 2 Transition P-system $P_1 = \{\mathbb{III}_1, \mu, \omega, R1\}$ $P_2 = \{\mathbb{III}_2, \mu, \omega, R2\}$

Aggregation $(P_1, P_2) = P_{12} = \{\mathbb{III}_{12}, \mu_{12}\omega_{12}, R_{12}\}$ where P_1, P_2 are 2 given P-Systems, P_{12} is the aggregated P-system where $\mathbb{III}_{12}$ is the aggregated alphabet of both P-systems , μ_{12} is the set of regions in the aggregated P-system and ω_{12}, R_{12} are the multiset of objects and set of evolution rules of the aggregated P-system.

- Building the aggregated alphabet $\mathbb{III}_{12}$ is obvious. The result is the Union of both. Correctness for this operation is also obvious.
- The aggregation of the 2set of multisets is obvious. The result is the Unionof both. Correctness for this operation is also obvious.
- The aggregation of the 2set of the set of the evolution rules R_{12} is obvious. The result is the Union of both. Correctness for this operation is also obvious.

There are 2 factors in the aggregation that are not obvious which are the aggregated Set of regions μ_{12}. This set of regions is constructed in our proposal as supervised and directed by the factor λ that defines the capabilities previously mentioned. This λ is defined dynamically by the nature of problem the MCA is about to fix. i.e.in a problem of sum of squares is not necessary aggregation as 2 independent P-system could calculate their squares [Paun,2001] and send those outputs to a third (obvious) one that calculates the sum of both results. However, for didactic purposes and aggregated solution could be provided in where a MCA is created with 2 Input P-systems. The aggregated would assign equal λ (priority) to both of them, and then either of them could contain the other one. The container P-system process the output of the contained P-system by adding it to an another square number.

Other problems, especially those that requires sub solutions that are part of optimization techniques would be required to establish a clear hierarchy in the aggregation of MCA. Thus:

- The aggregation of the regions of 2 P-systems would be determined by a priority or hierarchy described by λ. This is a dynamic factor that must be configured right before the problem is dealt with.
- The aggregated P-system will have to work the communication phase after every evolutionary step. This communication phase also fully relies on the hierarchy establish by λ and will operate as normal when the aggregation is complete and the MCA is finished.

a) *Inductive case*

Given a successful aggregation (MCA) of n P-systems MCA (n), is it correct to aggregate n+1 P-systems?

The inductive case is a direct consequence of the aggregated property.

MCA (n) system becomes a complex P-System with an aggregation of regions according to the λ factor .MCA (n)= let's call the aggregated P-system as $P_n = \{\mathbb{III}_1, \mu, \omega, R1\}$. Once the aggregation is seen as a P-system, aggregating it with another P_1 is obvious by applying the base case.

b) *Simulations and results*

We have been performing some simulations in simple problem solving in same traditional computing paradigm for small problems clearly aggregation is not necessary, although the advantage of this proposal shows up, when the complexity of the problem increases. Theoretically a fully and corrected aggregated Solution (A whole MCS) would overweight

the cost of the calculation of λ and he redesign of the membrane system that can always occur during compiling time anyways.

	Membrane System (simulation)	MCA (Simulation) λ (prefixed)
Sum of squares	1.9µsec	2.9µsec
Product of squares	2.3µsec	2.4µsec
Square +random	1.92 µsec	2.92 µsec
Cubic random	1.93 µsec	3.93 µsec
Square +random	1.92 µsec	2.92 µsec
NAND continuous	2.83 µsec	2.87 µsec
XOR continuous	2.72 µsec	2.56 µsec
Cubic random AND XOR	3.96 µsec	4.01 µsec
Square +random AND XOR	3.82 µsec	3.52 µsec
Cubic random CONTINUOS XOR	4.77 µsec	3.99 µsec

The analysis is very direct. The simulations are running in the same platform and just focuses in performance time based. All problems are considered simple problems due to the limitations of processing a complex problem with a complex set of aggregation rules which will jeopardize the accuracy of the analysis. Nevertheless, it is indicative to see that there is a variation in the performance when the level of complexity slightly increases which suggest that aggregation can be a good approach when the level of complexity increases.

VI. Conclusions

Membrane computing has been growing since George Paun defined it in 1998. Since then new variations have been suggested to try to fit this model to new realities. The main goal for this unconventional paradigm is to improve the performance of the traditional algorithms due to the inherent limitation of the model. Simulations are still a big part of membrane computing and they are useful to extract right conclusions about the new model. In particular, this model is a great candidate to be applied to complex models that require an aggregated solution that is part of other sub solution whole super solutions as long as the defined rules in the MCA are followed. The aggregation factor that is linked to the minimal membrane cells is the component that complement the use membrane computing as a whole and as unite aggregated model. As the creation of this factor generates difficulties because it depends on the nature of the problem, it does not damage the performance during the execution as the factor is calculated in compiling time. New techniques to atomize the generation of λ as this could create a complete dynamic model that fully adjust to the problem and create the right MCA. The necessity of opening the line of research is out of question. The field is growing and new experiments are required. MCA systems are provided as a natural solution to upgrade the nature of membrane computing by not only taking advantage of the properties of the membrane cells but by the way these cells are aggregated. The future work will be involving complex problems in complex aggregated structures, so the analysis can be more relevant. Nevertheless, the evidence points out that aggregation is a natural solution to deal with complex problems that nowadays are being processed by conventional approaches such as backtracking or dynamic programming.

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Modern IT-Infrastructure and IT-Managment in Small and Medium Enterprises

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Abstract- Small and medium enterprises (SMEs) face the same challenges in their IT-departments as their bigger counterparts. In this article, we will take a quick look at existing best practices to deal with those challenges. Also, we will discuss a generic approach to introduce IT-Structure and IT-Management in an actual SMEs using these best practice methods.

Keywords: enterprise architecture management, IT governance, IT service management, SME.

GJCST-G Classification: K.3.2

MODERNIT-INFRASTRUCTUREANDIT-MANAGMENTINSMALLANDMEDIUMENTERPRISES

Strictly as per the compliance and regulations of:

Modern IT-Infrastructure and IT-Managment in Small and Medium Enterprises

Georg Egger α & Martin Ebner σ

Abstract- Small and medium enterprises (SMEs) face the same challenges in their IT-departments as their bigger counterparts. In this article, we will take a quick look at existing best practices to deal with those challenges. Also, we will discuss a generic approach to introduce IT-Structure and IT-Management in an actual SMEs using these best practice methods.

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I. Introduction

Strategy without tactics is the slowest path to victory. Tactics without strategy is the sound before defeat. (Sun Tzu) Planning and deploying IT-resources is one of the most important tasks of management today. The majority of business processes are supported by information technology. The accessibility of IT-services as well as their reliability and security usually only represent the tip of the iceberg. A variety of other topics, such as access control, security vulnerabilities, interfaces, service portfolio, IT budget, hardware architecture, monitoring and outsourcing are also of great importance to the IT-department and the management level. To avoid chaos businesse a strategy ("what to do") and a tactic ("how to do it") is needed. A major challenge certainly is to develop these strategies and tactics, if the IT never has been planned but only reacted to momentary demand. This "laissez faire" behavior usually leads to IT-landscapes that are very inhomogeneous and complicated to manage, and usually leaves the company largely dependent on the IT-architects of these systems. For this reason best practices have been developed in recent years, on how to deal with the topic of IT, mainly to deal with the complexity of IT in large companies. However small and medium-sized enterprises will not fare better in this area, with the impeding factor of limited resources for information technology, which is reflected not only at the investment level but also at the employee level. With this premise the following research shall be investigated: Is it possible to model an approach using these best practices for large corporations for SMEs that yield useful results? To validate the results of this study it was finally put in practice for a specific SME, a growing medium sized company with about 300 employees and co-workers.

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II. Research Design

The following steps to reach a conclusion have been used:

- Identify relevant best practices, research current state
- Classify best practices
- Classify a SME
- Develop a model for implementation
- Decision making on implementation
- Develop a model for Enterprise Architecture Management
- Determine usage and scope of IT Governance
- Determine usage and scope of IT-Service-Management

a) *Best practices*

In terms of managing IT and developing strategies research revealed Enterprise Architecture Management, IT-Governance and IT-Service Management as the three best practices being deployed in large companies with height ened IT-awareness.

i. *Enterprise Architecture (EA)*

Enterprise Architecture describes the system overlapping view of the complete IT-Landscape regarding all layers of implemented technologies including the business architecture. This is one way of describing EA, since John Zachman created an article on EA and presented a matrix oriented framework in 1997(16). In the meantime over 50 frameworks exist to deploy Enterprise Architecture Managment (EAM) as there are numerous definitions of Enterprise Architecture itself. Only recently the TOGAF framework from the Open Group is emerging to be the standard framework implemented by companies (13). Figure 1 displays the components of EA.

Enterprise Architecture Management describes the transition from a current to a desired state. The Open group identifies two methods for implementing EA (13, 187): „ Baseline first“, if the individual departments in the company had great autonomy or „Target first“, if the target state is commonly agreed upon. In the first case the current EA will be analyzed and a plan to transition to a future EA developed, in the latter case the desired EA will be planned and measures to reach that goal from the current situation must be planned. Every enterprise has an Enterprise Architecture whether it is

has been planned or has just grown and evolved over the time.

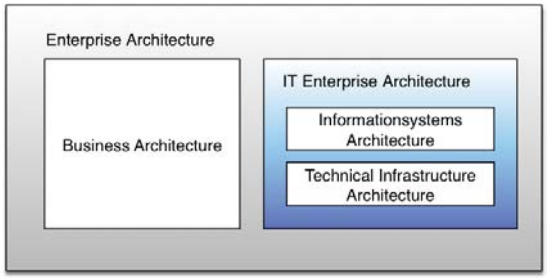

Figure 1: Enterprise Architecture (7, 12)

ii. *IT-Governance (ITG)*

Similar to EA there are different definitions of ITG. Steve Romero formulated a very concise statement: „IT-Governance consists of processes and relations that lead to a reasonable decision making in the area of IT." (11, 6) It is important not to mistake IT-Governance with IT-Management. IT-Management deals with the processes and optimisation of current tasks and services in the IT-Landscape while ITG has its focus in the future and is more of a strategic instrument. The primary goal at hand ist to align the IT with business processes. The IT-Governance Institute puts the stakeholders in the center of processes as a driver for the desired results. Weill and Ross identified three critical questions for IT Governance(15, 10-11):

- Which decisions must be governed?
- Who takes responsibility for governing these decisions?
- How are these decision being governed?

Furthermore, each company has to deal with 5 related decisions(15, 10-11):

- IT-Principles: Define the role of IT in the company.
- IT-Architecture (IT-EA): Define integration and standardisation needs.
- IT-Infrastructure: Identify shared and enabling services.
- Business and application demands: Specify the business demands for bought or internally developed IT-applications.
- IT-Investment und Prioritisation: Choose which initiatives will be funded and how much will be spent.

Regardless of the framework that will be used to put IT-Governance into action, the most important task is to clarify the three critical questions, if those responsibilities and areas of decision making are not clarified IT Governance cannot take place. The most popular framework is COBIT, due to its emphasis on characteristic numbers and the Sarbanes-Oxley Act in the United States COBIT is often being used for control mechanisms(6).

iii. *IT-Service-Management (ITSM)*

IT-Service-Management focuses on defining, implementing and managing IT-Services to fulfil business goals and customer demands (1, 1). In recent years there has been a shift from solely providing the technical expertise for IT-Services, even within a company the coworkers can be regarded as customers. This customer oriented approach requires additional skillsets and understanding for the customers needs. ITSM is a term that actually stems from IT-System-Managment and was developed by a British agency because measures needed to be employed to cut the blatant cost of IT in the government. ITIL (the IT Infrastructure Library) was born and published as recommended guideline. While there are several frameworks for dealing with ITSM, ITIL is the predominant framework in use, even in the North American region, where ITIL was not common in the beginning. A study showed that 92% of 197 companies implemented ITIL v3, 5% ITIL V2 (5, 28). While there are many terms and approaches to effectively manage services the importance of Service level agreements (SLAs) cannot be stressed enough. SLAs (or internal versions called operational level agreements) provide clarity how services are being delivered and maintained and eliminate wrong expectations and assumptions for both the customer and provider of a specific service.

b) Classifying best practices

For the three discussed best practices, there exist several frameworks with a different focus. In the area of EA a huge variety of frameworks exist, and mostly custom solutions of these frameworks are being used. The situation is similar in ITG, however COBIT has the edge on employed frameworks. Still, custom solutions comprise the major contributor for ITG. In ITSM the situation is very different, ITIL is clearly de facto standard for ITSM. With every new release each of the respective frameworks strive to expand functionality, unfortunately sometimes it is unclear when to use which framework or when to even find a solution on ones own. A general observation is, that it is wise to research each framework for its core functionality, while ITIL now provides control numbers in its newer version trying to cover ITG for a large part it might be better to use COBIT instead, depending on the companies needs. Because of the popularity of frameworks people tend to replace the corresponding term of the best practice with a framework. However ITG is not COBIT, ITG is the strategy, COBIT represents the tactical component to implement that strategy. Figure 2 displays a classification of the best practices. The attributes taken into consideration are strategic, tactical, operational and the time span involved.

Best practice	strategic	tactical	operational	short	medium	long-term
EAM	x	-	-	-	-	x
ITG	x	x	x	-	x	x
ITSM	-	x	x	x	x	-

Figure 2: EAM, ITG, ITSM

Enterprise Architecture deals with the big picture, the strategy that should generate benefits for the enterprise in the future and also includes the System-Architecture and Business- Architecture in contrast to ITG and ITSM. This best practice can be regarded as purely strategic and has the broadest viewpoint of the business needs. An overlap can exist with IT-Governance within the Application- Architecture domain. If both methods are implemented the orientation of EAM is to be preferred over ITG.

The primary domain of IT-Governance is not within the operational area. ITG creates guidelines for the future and focuses on how IT Services can facilitate business processes and hence has a strong strategic element. The tactical component primarily consists of tailoring the IT-Services according to the business needs. (It should be noted that the framework COBIT has a well documented operational area).

IT-Service management takes its place foremost in the operational domain. The focus into the future exists, but is very short in comparison to the other best practices. ITSM purpose is the optimal deliverance of IT-Services. In this layer, it is not questioned if the service itself supports business processes in an optimal way. The core concern is if the service itself is deployed in the best feasible way. ITSM hence should be categorized as tactical.

III. Large Companies vs SME

In the German-speaking European area SME do not have more than 249 employees and an annual turnover of less than 50 Million Euro(3, 4). In the American region, the classification is similar however the industry branch is taken into consideration as another factor. This way a company with 1500 employees can still be regarded as SME because it is considered small or medium in the specific business area (14, 1-4). In most SME the IT is a critical factor for business success, parallel to large companies. However, the inhibiting factor of limited resources is not only relevant at the investment level but also at the number of employees in the IT-Department. Putting best practices at work is always coupled with manpower, commitment from the executive level and last but not least cost. In consequence, the question of applying best practices should first be asked with the expected benefits in mind. In small and medium enterprises the IT-Landscape often has just grown over the years with ad hoc demands, which usually leads to a very inhomogeneous landscape especially concerning interfaces between applications.

IV. Model for Implementation

Considering the classification from figure 2 the following concept for deploying the discussed best practices has been developed. A three-layered Deming cycle (Plan, Do, Check, Act) (2) as shown in figure 3 represents long term to short-term implementation of EA, ITG and ITSM. This figure only represents a guideline. If one of the best practices will not be implemented it is highly recommended to skip it but still follow the order from the outer to inner circle. ITSM with ITIL is already implemented in a Deming circle by its concept, COBIT has a similar approach. With Enterprise Architecture a PDCA-Cycle makes perfect sense. If the business demands change, the IT-Landscape most probably is not set up for these changes and actions need to be taken to remedy the situation.

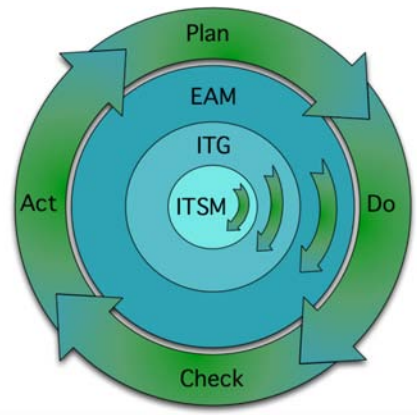

Figure 3: Concept for implementation

As mentioned before, the difficulty not only lies in deciding which of the three best practices to deploy but also in the level of granularity. Unfortunately there is no universal recipe guaranteed to succeed for each SME, because companies and their IT-Landscapes vary to a great degree. However, we will discuss a general approach that can be adapted to individual needs. At first, methods are needed to aid decision making of whether implementing a best practice or not instead of relying on instinct. The following sections show decisions based on the example of the company we will refer to as Nova.

V. Methods to Decide on Implementation

a) EA

There is very little literature on Enterprise Architecture in SME but a practical decision matrix for

the question of implementing EA has been introduced by Keuntje & Barkow (8, 336).

	Doesn't apply	Partly applies	Applies
The relevant parts of your IT-Landscape are known (interfaces, data, applications) and are well documented		x	
The current IT-Infrastructure is up to date and aids business processes verifiably	x		
Information technologies are not competitive factors in your market area	x		
The market and regulatory area in which is interacted with will not change significantly in the medium or long term future		x	
The company size und structure will not change significantly in the foreseeable future	x		

Figure 4: EAM Decision matrix Nova

The matrix yields points from 1 (does not apply) to 3 (applies). If a high value is reached it is questionable that EA will yield benefits compared to time and effort spent on implementation. Regardless of company size the following statement can be reached: „ The relevance of EAM for a company is mostly determined by the dynamic and change rate of the company and its surrounding environment and the importance of the production factor information, rather than by size and complexity.“ (8, 336) In the instance of Nova a value of 7/15 had been reached. The company has plans to increase its staff significantly, explore new areas of business and change communication with its external partners. The hardware of the IT-Infrastructure is outdated and not sufficient for the growing number of users and services. Hence in case of Nova the decision has been made to implement EA.

b) ITG

The question if IT-Governance will benefit the enterprise can be answered with a tool from the COBIT framework, the ITG maturity model.

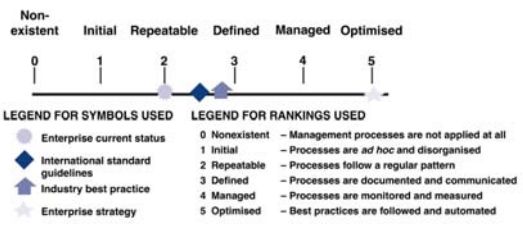

Figure 5: COBIT 5 maturity model (6, 48)

Detailed information on the maturity model can be found in the COBIT 5 manual, in case of NovaNova the following situation applies: The „governance“ of IT depends on the initiative and experience of the IT-team with limited input from the rest of the organization. Performance indicators are usually limited to technical figures within the IT-function itself. (6, 48) This circumstance relates to maturity degree 1 and leaves significant room for improvement. If a company has already reached a degree 3 or even 4 an implementation of ITG is to be questioned, as these degrees of maturity indicate that IT is already is being managed well. In case of Nova the maturity degree of 1 was deemed insufficient and the implementation of ITG recommended.

c) ITSM

To determine the question whether to implement ITSM or not the question matrix shown in figure 6 had been developed. This matrix was built with the quality of service motto in mind, if a result over 10 points can be achieved an implementation should be discussed. One should keep in mind that the number of services coupled with the amount of customers using them obviously makes a huge impact on decision making. However, it is hard to generalize since vital services that only a small customer base use can have tremendous impact on the enterprise business.

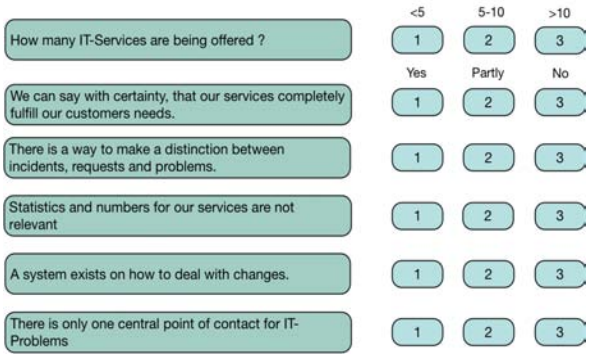

Figure 6: ITSM Decision matrix Nova

VI. Implementing EAM

The matrix in figure 4 yielded 7 out of 15 points, a relatively low value so it was decided to realize EA in the company. For the implementation it was decided not to use any existing framework. For example TOGAF itself boasts several hundred pages manual and the effort and time factor was considered too costly. In addition many basic principles had not yet been clearly written down in the concrete case of Nova and it was chosen to model a generic approach to formulate the basic cornerstones of the desired Enterprise Architecture. The concept model from Keller (Figure 7) was used as a starting point to define the necessary basic building blocks and steps required to plan a future EA. Instead of an application landscape a service landscape had been implemented:

The business strategy defines the business architecture. The IT-Strategy drives the IT Business architecture which consists of the different services and the system architecture these service are being deployed on. Defining the business strategy on paper is the first task,

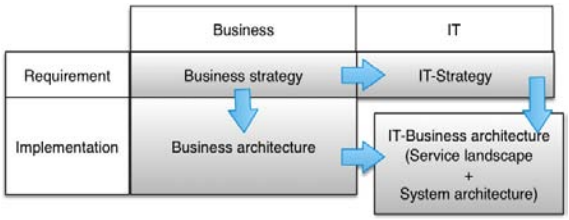

Figure 7: EA Concept (on the basis of (7, 24))

if it is not already written down in a concise matter. Describing the business architecture which is created from the strategy seemed a bit taxing at first but can easily be accomplished by a process map. Generating a process map already can indicate main and supporting processes and helps to generate a quick understanding of the tasks that achieve the business goals (Figure 8). Processes that are important and IT-dependant can already be identified, in addition processes planned in the near future can already be implemented in this map.

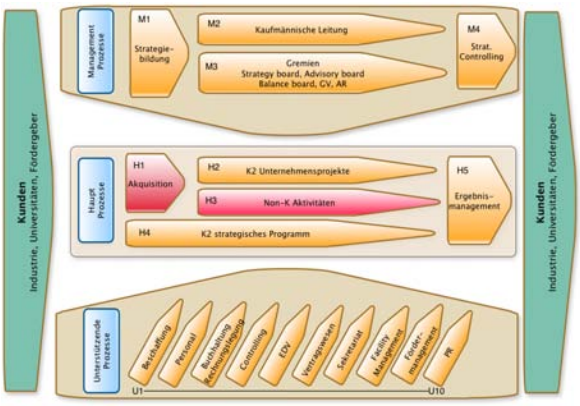

Figure 8: Process map Nova (Source: Nova)

The IT itself had been identified as a supporting process. However, the IT enables all other supporting processes to aid the main processes and has, therefore, a special relevance. To define the IT-Strategy from the business strategy is the next step and while it may look like a straight forward task, it proved quite taxing to derive a meaningful IT-Strategy that was not too generic. In search of ways to incorporate the business strategy a matrix used by the Consulting Group Gartner was identified and put into use.

This matrix shown in figure 9 can now pro- vide clues, open questions were clarified in a discussion with the management. As a result, an IT Strategy that was concise and meaningful had been formulated for Nova.

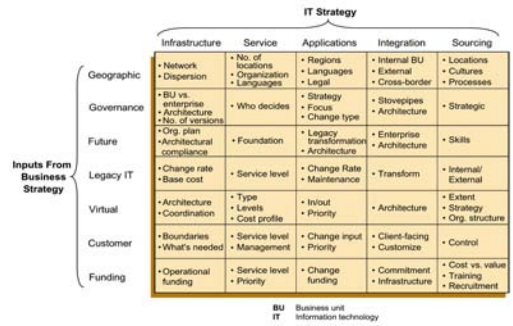

Figure 9: IT Strategieentwicklung Gartner, (9, 17)

The next step in developing an EA was to take a look at the existing IT-Infrastructure. In case of Nova a semiprofessional solution had been implemented with shortcomings in availability, backup, and resources. All services had been implemented on a single server. The IT-Enterprise-Architecture itself consists of the following identified building blocks:

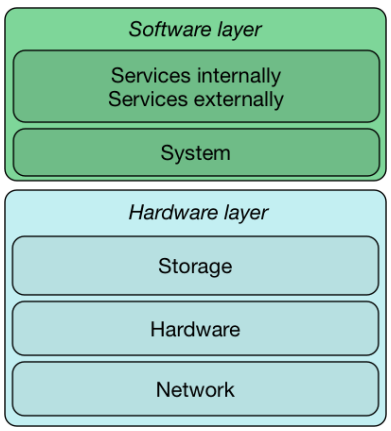

Figure 10: IT-Enterprise-Architecture building blocks

There are two ways to plan a new or modified IT-Infrastructure, analyse the current situation then plan a transition or determine the needs of the desired IT-EA and trace backward. In case of Nova it had already been known beforehand that several new services had been planned for the new business period. Hence it was decided to start examining the Service-Portfolio. The Service-Portfolio-Management is a standard IT-Process since its relevant in any company to a minimalistic or intricate degree. Managing and planning the Portfolio represent core processes of ITG and ITSM. However, according to "form follows function" to really plan an efficient Enterprise-Architecture, this process will be brought forward into EAM since it makes no sense planning an EA without knowledge of the actual implementations. The Service Portfolio was categorized into two sections, „internal“ and „external“. The internal services were categorized again in "same platform", „external to internal (make or buy decisions)“, „new service“, and „to be canceled“. The new Service-Portfolio revealed the actual demands on the Software-

and Hardware-layer and it was easy to look at the existing EA and especially plan the necessary hardware layer. This was simply done by examining the status quo vs. the new demands of the IT-EA.

Component	Server X	Requirements new Architecture
Hardware	Mac Pro 5	19 inch rack compatible
Network	redundant	redundant
Power Supply	single	redundant
Storage/maximum Storage	2x 3 TB Raid 5 2 Hotspare Fibre Channel / can be doubled	multiplicable
Memory/maximum Memory	12gb/32gb	considerable more
Backup	local internal 4TB HD	backup 2nd location
Redundancy	none	On hardware failure sufficient resources must be available to continue services
Licensing	Mac OSX	any

Figure 11: IT-System-Architecture components

Each component was analysed for the physical machine and compared to the requirements of the new EA to accommodate the Service-Portfolio. Eventually a new EA was planned that was redundant, upgradeable and scalable in form of a high availability cluster hosting virtual machines. In case of Nova this professional solution was necessary because four new services had been planned and five services had to be moved from external providers to an in house solution. During research a very apt Framework OBASHI (10) had been identified to display dependencies across exactly those layers which had been analysed before. Figure 12 displays a planned business process across layers which basically represents the IT-Architecture of an EA. This illustration provides insight in the flow of information across those layers and very quickly reveals dependencies. It is an excellent tool to plan new services, which has been adapted by adding the layer „service" to clearly identify the applications purpose and aid in a service oriented approach.

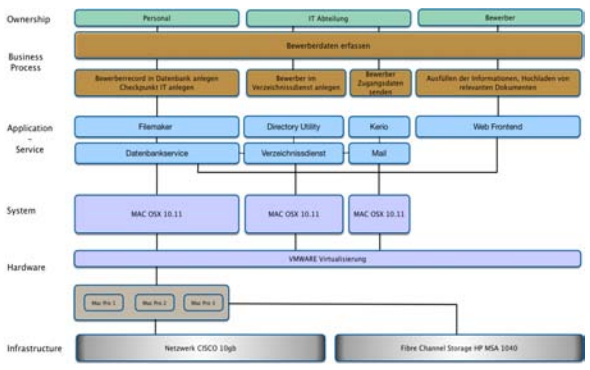

Figure 12: Example OBAS(S) HI (based on (10))

At least once or twice a year revisions should be held to determine the state of the EA. Has the environment the company is navigating through changed and have new goals and areas been planned? In this case, most likely the EA is not up to the task of supporting these new goals and needs to be revised.

VII. Implementing ITG

A strong motivator for implementing ITG in the concrete case is the current level of maturity. Before IT-Governance can be tackled in any enterprise the following three questions should be answered:

- Which decisions need to be governed?
- Who takes responsibility to govern these decisions?
- How are these decisions being governed?

To answer these questions a matrix from Weill & Ross shall be used (Figure 13). Horizontally the areas of decision making are listed, vertically stereotypes of archetypes are listed. The black markers represent the current state and the green markers represent the desired state. Federal decisions involve high-level executives, IT and business units, feudal leaves the decision making exclusively to business units.

Decision / Archetyp	IT Principles	IT Architecture	IT Infrastructure	Business and Application demands	IT Investments
Business Monarchy					
IT Monarchy	X	X X	X X		
Feudal					
Federal	X			X	X
Duopoly					X
Anarchy				X	
Unknown					

Current
Future

Figure 13: IT Governance Matrix Nova (based on (15, 11))

Nova's IT-Strategy had been formulated with the help of the CIO, CEO and General-Management this represents a federal decision making process, which should provide good basis to align IT with business. The IT-Architecture is the equivalent of the ITEnterprise-Architecture which falls into ITMonarchy. It makes sense to leave the technical decisions in this department. The same applies to the IT-Infrastructure. The main reason for this is that business and application requirements are to be decided on a federal level, where IT is playing a rather subordinate role. It is essential that the IT-Department can make decisions about the appropriate applications/services based on the specifications and can subsequently adapt the IT- Infrastructure. If these specifications are agreed on by the stakeholders, the technical core competence of the implementation procedure should ideally remain with IT-Department. This includes the prerequisite that these specifications must meet the requirements of the stakeholders. In the case of IT-Investments, the previous approach was generally to decide on a federal level. In the future, the

management level should make this decision as a duopoly with the IT-Department. Since there is no official IT-Budget in the company, and the subsequent need to justify IT-Investments, it is advisable to combine both the technical justification from the IT point of view and the business-oriented justification. Of course, this only applies to investments within a certain magnitude. This classification creates clarity on how to decide in the relevant domains.

After clarifying the decision-making and responsibilities the next step was to implement ITG-Processes. For Nova COBIT was chosen and presented to the CEO. It was decided to only implement very few processes to ensure success in realisation.

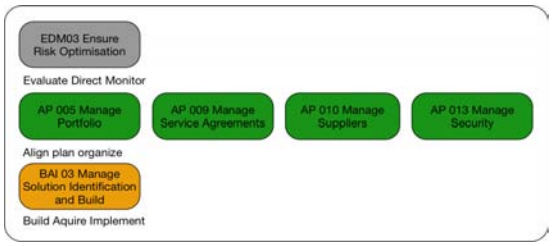

Figure 14: Planned COBIT Prozesse

AP005 had already been covered in Enterprise Architecture Management. Manage suppliers is probably an important process for many SME due to outsourcing possibilities. Managing Service Agreements (SLAs) is often a neglected area, however, it clarifies expectations of how services are being delivered, even internally. This process is coupled with AP005 as well. The same goes for AP013 which purpose is to identify security risks and incidents and EDM03 which should mitigate those security risks amongst other risks. BAI03 helps to find a formula on how existing solutions should be improved or new ones can be found. For each of these processes a diagram had been developed on a very flat hierarchy. Key performance indicators had been identified for each process, which should be reviewed once a year, to determine if they are meaningful and relevant or if more or other data are needed. None of the „deliver and support“ processes from COBIT had been chosen, already at this point it was apparent that these belong to ITSM and in case of an ITSM implementation ITIL would be chosen instead. Furthermore for Nova as an SME a RACI model for each process had been neglected due to the flatter hierarchy in an SME.

VIII. Implementing ITSM

Managing quality of service is also important for small and medium enterprises. This is reflected in the amount of research published on ITSM in SMEs. Compared to EAM or ITG there are quite a lot of articles and studies dealing with ITSM in small and medium enterprises. The most widely used framework for ITSM with over 90% implementation is ITIL (5, 28). For Nova the "Classic ITIL lite" constellation suggested by AXELOS is recommended as a starting point (4). In Nova's case, the question whether to implement ITSM or not had already been decided in the IT-Governance process. An excerpt from the IT-Strategy: „The services need to be as simple and reliable as possible for our employees so they do not chose anarchistic solutions by themselves.“ To achieve this goal IT-Service Management was deemed vital by the executive level.

Figure 15: ITIL lite for Nova (4, 89))

Figure 15 shows the implementation for Nova. The "Service asset management and configuration" process according to the original template are not to be implemented here in the beginning. The current and future situation is more than manageable in regard to this aspect. Instead, the processes "Event management" and "Access management" shall be added to the catalogue of processes which will be implemented. The Service Desk is not a process but a component, however an essential component for the "Service operation" area. "Change management" is assigned to the "Service Transition" area. The service desk in the center needs an efficient tool to handle the processes and this tool will most likely be a ticket system. Ticket systems often generate rejection in the IT-Department until their value is discovered. To classify problems from constant reoccurring incidents and to measure the number of requests, a ticket system can document and clarify which steps have been taken to resolve problems. The focus for an SME should be generating meaningful numbers from this system, to see where a lot of incidents happen and which problems need to be addressed by change management rather than to measure the efficiency of employees solving tickets. Categorising tickets will help in analysing data and decision making on facts rather than trusting gut feeling. In Nova's case, each ticket was assigned to its service category and then further on labeled as either incident, problem, change or request.

Figure 16 shows the blue print for the process„ Event management“ and reflects the necessary detail level which was chosen for Nova.

IX. Conclusion

The problem of taxing complex best practices along with their respective frameworks can only be tackled by customisation. The abbreviated roadmap shown for Nova can certainly be used as a starting point for other SMEs, but each enterprise is different and has different requirements for its IT-Needs. In the case at hand, the biggest benefit was derived from Enterprise Architecture Management. Clarifying strategies, building a business process map and writing down a derived IT-Strategy led to a better understand of the companies

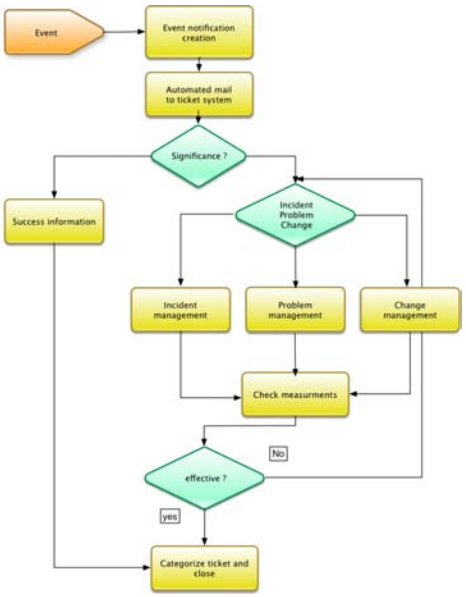

Figure 16: Event management Nova based on (12, 70))

mission and its future demands on IT. When mixing best practices the method of classifying into tactical, strategical and operational proved very helpful. Most best practices overlap in certain areas, especially the revised versions of frameworks tap into other areas that had not been their core competency before. The example of Nova shows the considerations that have been made at which point to implement which building block and take the best part of each framework for the needs of the enterprise. EAM has been built from scratch since the available frameworks are way too complex. ITG has been implemented with very few COBIT processes alongside clarifying decision making in IT. ITSM has been also implemented with only a few ITIL processes tailored to the enterprise's needs.

The result of this study shows, that the most important thing for SMEs is to stick to the vital points and not get sidetracked by too much detail. Only processes with great benefit should be implemented at first. If these benefits come through then governing IT in small and medium enterprises instead of just managing it can become reality. If a PDCA cycle is used than each iteration will fine-tune the results to an optimized result.

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Computer Vision based Traffic Monitoring and Analyzing from On-Road Videos

By T.M. Amir-Ul-Haque Bhuiyan, Mrinmoy Das & Md. Shamim Reza Sajib

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Abstract- Traffic monitoring and traffic analysis is much needed to ensure a modern and convenient traffic system. However, it is a very challenging task as the traffic condition is dynamic which makes it quite impossible to maintain the traffic through traditional way. Designing a smart traffic system is also inevitable for the big and busy cities. In this paper, we propose a vision based traffic monitoring system that will help to maintain the traffic system smartly. We also generate an analysis of the traffic for a certain period, which will be helpful to design a smart and feasible traffic system for a busy city. In the proposed method, we use Haar feature based Adaboost classifier to detect vehicles from a video. We also count the number of vehicles appeared in the video utilizing two virtual detection lines (VDL). Detecting and counting vehicles by proposed method will provide an easy and cost effective solution for fruitful and operative traffic monitoring system along with information to design an efficient traffic model.

Index Terms: *video based traffic monitoring, traffic surveillance, counting vehicles, traffic model.*

GJCST-G Classification: *I.2.8*

COMPUTERVISIONBASEDTRAFFICMONITORINGANDANALYZINGFROMON-ROADVIDEOS

Strictly as per the compliance and regulations of:

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T.M. Amir-Ul-Haque Bhuiyan[α], Mrinmoy Das[σ] & Md. Shamim Reza Sajib[ρ]

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I. Introduction

Vision based traffic surveillance system has become an active area of research interest over the past decade in the developed countries. This is a potential area of research as it has some significant applications. In Bangladesh traffic jam is very common an unpredictable. Due to limitation of work force, authorities are unable to find the reason and control this. It is of interest to digitally process and analyze these videos in real-time in order to extract reliable data on traffic flow and to detect traffic events. For example, because of such video analysis, traffic density in major arteries can be estimated and the least congested routes and travel time estimates can be computed. This information can be achieved by counting vehicles passing through the roads. By implementing this, the authority can have the information of traffic flow on a particular road on a particular time, measure rush and reduce the problem. This type of traffic surveillance system is becoming popular in many countries.

The proposed method needs two major things to be implemented: i) Detecting and counting vehicles, ii) Generate necessary information to be used to maintain the traffic. Many approaches have been introduced for vehicle detection. Some available methods uses lidar, radar and computer vision. As camera is cheaper than radar or lidar, vision based vehicle detection and classification has become more popular than lidar or radar based detection system. Though computational power has increased dramatically, vehicle detection and classification is not an easy task. The problem is the dynamic environment of the road. The condition of the road cannot be predicted. There can be many human made infrastructures; pedestrians, which makes this, task a difficult one. In addition, there are change in background, illusion and heterogeneity of vehicles.

II. Related Works

Background subtraction based method is used by [1] for detection. Deep neural network based detection and classification model [2] is very expensive in terms of computational resources and time and is not suitable in real time. Niluthpalet. al. [3] generates time spatial images from video frames and gain a very good speed and accuracy in detection. Vehicle detection approaches can be divided into two broad categories: appearance based and motion based methods.

Camera placement plays a significant role in video-based vehicle detection. Camera can be moving or static. As occlusion is the main problem in vision based detection system, camera should be placed in some position that minimizes the probability of occlusion. Camera placement depends on the appearance of the vehicles. In [3] camera is placed in an over bridge for taking both incoming and outgoing vehicles. It takes both front and rear view of vehicles. Broggi et al. [4] placed a camera to capture the side view of vehicles. Sivram and Trevedi [5] mounted camera in front of the moving vehicles that capture the rear view of front side vehicles. For static camera, good choice is some higher position than the level of vehicles that reduces the chances of occlusion. This decreases the chance of partial occlusion caused by vehicles but vehicles appearance changes from first lane to third len or fourth len. Yong Tang [6] placed the camera in a high position like over bridge and capture the front view of the vehicles

To detect vehicles from a frame, features are extracted from the frames. Many types of features have been introduced for vehicle detection so far. Sivram and Trevedi [7] used edge features to highlight the side of a vehicle and cast shadow. In recent years, some strong

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features due to the robustness and reliability replace simple features like edges or corners. These features are commonly used in computer vision for both detection and classification. Histogram of oriented gradient (HOG) was extremely well represented for vehicle detection as well as object detection. Inspired by human detection method [8] of Dalal and Triggs [9] has used HOG features nicely to detect vehicles. At first they compute gradients from the images and extract HOG features. A linear SVM classifier trains the extracted features. Though HOG features provide a very good detection rate, the main drawback is its calculation speed. As classification will be done after detection, its speed should be good. Haar-like features have been used nicely for face detection. Haar-like features are calculated with the help of integral image. Integral image can be calculated at a very fast speed. Due to its calculation speed and successful use in face detection, it has been also used for vehicle detection in [10] and [11] successfully. Scale invariant feature transform (SIFT) [12] was used in [13] to detect rear faces of vehicles. Though this feature cannot provide better performance than HOG or Haar, it is considerably good in case of occlusion. Lin et al. [14] used a combination of SURF [15] and edge features to detect vehicles in the blind spot.

Support vector machine (SVM) is a strong binary classifier. It has been widely used for vehicle detection. The combination of HOG features and SVM classifier have been used for vehicle detection in [9] and [16].

AdaBoost [17] is also widely used in real time vehicle detection. As the classification speed of AdaBoost classifiers is high, it has become popular in real time classification applications. A combination of Haar-like features and AdaBoost classification is used in [18] and [19] for vehicle's rear face detection and perform very good in real time. The purpose of the AdaBoost algorithm is to use the feature to discover the best weak classifiers to form a strong classifier, and has shown its capability to improve the performance of various detection and classification applications. Actually the strong classifier is an ensemble classifier composed of many weak classifiers that just better than a random guess. Tang et al. [6] also used this method successfully. This method is very fast and provide high accuracy. However, the main drawback of this method is high false positive rate. The method proposed in [18] and [19] achieve a accuracy of 98% with 3%-5% false positive rate which is not tolerable in these type of applications. Yong Tang [6] used this method and achieved good accuracy but had a false positive rate of 3%. This method is very fast and applicable in real time. But false positive rate can cause inapplicable in some sectors.

In recent year deep neural network and model, based classification is being used to detect 3D vehicles. Both need high computational resources and execution time. Researchers have done some motion-based approaches. In [4], an adaptive background model was constructed, with vehicles detected based on motion that differentiated them from the background. Adaptive background modeling was also used in [20], especially to model the area where overtaking vehicles tend to appear in the cameras end of view. In [3] they used three virtual detection lines and generate time spatial image (TSI) from three frames. The vehicles present in a time spatial image is called TSI object blobs (TOBs). Then canny edges of TOB is generated. After that binary masks of the TOBs are obtained. Then vehicles are detected from multiple TOBs. This method generates a very good result with a good calculation speed and applicable in real time application. However, it is not suitable in conditions where there is heavy rush on the road and vehicles are moving in a low speed.

After detecting the vehicles, we count the total number of vehicles. Bas, Erhan and Tekalp [21] proposed adaptive background subtraction and Kalman filtering based model to count vehicle. However, their method provides a very good accuracy but it is comparatively slow to compute. Unzueta, Luis, et al. [22] propose a robust adaptive multi cue segmentation strategy that detects foreground pixels corresponding to moving and stopped vehicles, even with noisy images due to compression. This method is also reliable and provides satisfactory result in various conditions.

III. Proposed Method

Our method is proposed targeting real time applications. Therefore, the execution time must be faster in both detection, counting and analysis. We are proposing a cost effective and faster model that can easily be implemented for real time traffic surveillance. In the next sub sections, we will discuss about the approaches and methods we use for detection and counting vehicles from a video and then generate the information about traffic.

a) *Detection*

i. *Camera placement:* At the very first stage of detection, we have to select a suitable place to set camera. We propose our method targeting to run on videos taken by some static camera.

ii. *Feature Extraction:* As we propose our method for real time application, we need so select a feature that is fast to compute. In proposed method, haar-like features are chosen for vehicle detection.

The detection is done using Viola-Jones object detection framework. A window of the target size is moved over the input image, and for each subsection of the image, the Haarlike feature is calculated.

Fig. 1: Left is the view from over bridge and right side shows the view from side

iii. *Classifier:* SVM is faster in training stage than AdaBoost classifiers. SVM becomes quite slower in test stage. We need our method to perform faster in testing. Some weak classifiers are trained in AdaBoost learning algorithm and then combine them to make a strong classifier. A cascade of 25 classifier is made in proposed method. The first two classifier

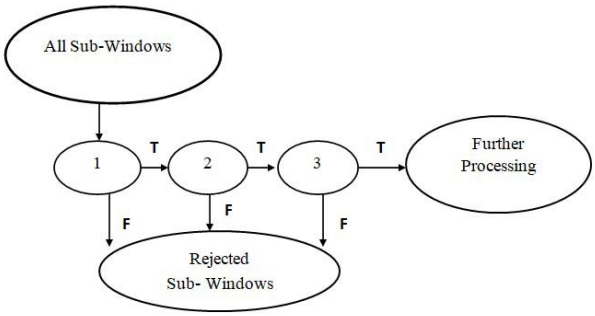

Fig. 2: Testing process of AdaBoost Classifiers

is the strongest one because it is made from the strongest feature selected in AdaBoost feature selection process. These two classifier can produce a 100% detection rate with a 50% false positive rate. As the number of classifier increases, the false positive rate becomes lower. For training the classifiers, we take 5000 images as positive that contains vehicles and 2000 negative images. After training, we get a cascade of 25 classifiers. In testing stage, a sub window of size 40x40 is moved over the input image of size 640x360. The sub windows that become positive after classifying by the first classifier is set as input for the second classifier. The negative sub-windows are discarded in each step. Sub-window that remains positive after going through some steps are said to be positive and the area covering by some joined sub-window is detected as vehicles.

b) Counting

As a vehicle can appear in multiple frames, it will be detected multiple times also. However, we have to count only once. Therefore, we cannot count each vehicle of all the frames. To count a vehicle only once, we use two virtual detection lines (VDL). The classifier only computes the region of the virtual detection line. So when vehicles appear on the region within virtual detection lines, only then they are detected. When a vehicle appears in the VDL its full rear view must be seen

Fig. 3: Left: Detected vehicles from video taken from over bridge, Right: Detected vehicles from a video taken from the side of the road

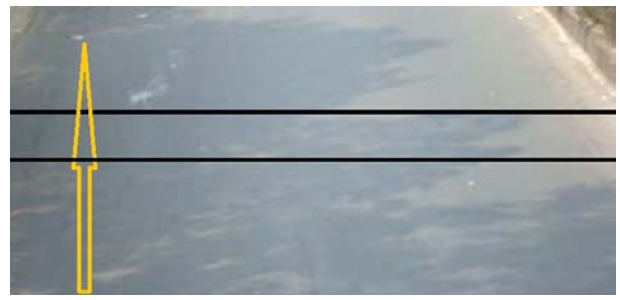

Fig. 4: Two virtual detection lines of a frame. Arrow indicates the flow of traffic

and for this no chance of false detection. As a vehicle must appear within the region of VDL, there will be no possibility to miss any vehicle. Still there is possibility of counting a vehicle more than once. Therefore, we count vehicle after each three frames. The length of the VDL is set in such a way that no vehicle can go past the VDL within these three frames.

The difference of the two VDL is the length a vehicle can cover within five frames at an average of 40km/h. Therefore, the faster vehicle like bus or car cannot disappear within five frames and the slower vehicle like rickshaw won't appear twice within the frame as we count after each three frames. This provides a very good accuracy in counting.

c) Classifying Road Condition

After counting the vehicles passing through a road, we generate some useful information that can be used to operate traffic smartly and design an efficient traffic model. We experiment the proposed method in the videos taken from a road then we count the number of vehicles passing through that road in a certain amount of time. Suppose there is a busy road where a large number of vehicles go through within 9.00 am to 9.30 am. However, this road can be free at another time. We count the number of vehicles for every 20 minutes. According to that number and the width of the road, we classify the condition of the road. We make four categories of the condition of the road i) free ii) moderate iii) busy and iv) heavy. We generate ratio of vehicle and the lane by following equation.

$$Density = \frac{Number of Vehicles}{Number of Lane of the Road}$$

The value number of vehicles is found by counting vehicles in every 20 minutes. If the density is less than or equal 200, then we say the condition of the road is free. If it is between 200 and 300 then the condition of the road is moderate. If it is between 300 and 400 then the road is busy and after that, the condition of the traffic of the road is heavy.

Table I: Classification of Road Condition by Density

Density	Road Condition
0-200	Free
201-300	Moderate
301-400	Busy
401- Rest	Heavy

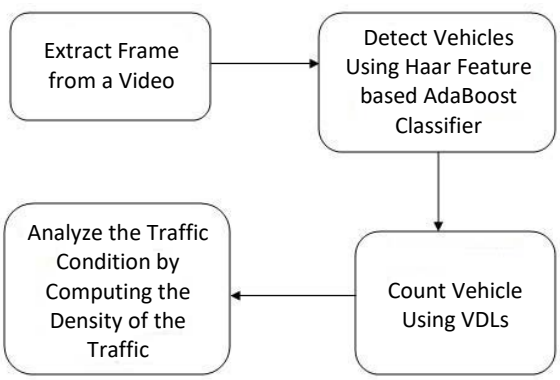

Fig. 5: System Architecture of the Proposed Method

IV. Experimental Result

Multiple experiments have been done to generate the result of the method. All the experiments have been done on different videos.

a) *Data Set Collection*

There are 15 videos taken from Kalshi Road, Mirpur, Dhaka, Bangladesh from the side of the roads. Videos are taken on different environments including sunny, cloudy weather in different times. Some videos are taken in and opposite direction of sunlight.

Another 10 videos taken by MVDL [3] authors is used to test the proposed method.

For training we take two instances of each image thus the positive image set for detection contains almost 5000 images of vehicles. For negative image set, we use 1300 negative images of Caltech car data set and 700 images of local roads. The negative image set contains almost 2000 images. Those images are resized and used for training.

b) *Result*

Extensive experiments have been carried out to generate the result of the proposed method. Without considering occlusion, the average detection rate is 97.81%. Average false positive rate is reduced to 1.8%.

The accuracy of counting is also satisfactory. The proposed method provides 93.11% counting accuracy. The Roads where

Table II: Collected Data Set Description

Place	No. of Videos	Position	Time	Duration (Mins)	Environment
Kalshi Road, Mirpur, Dhaka	4	Side	9.00 AM	6.36	Sunny
Kalshi Road, Mirpur, Dhaka	4	Side	12.00 PM	6.23	Cloudy
Kalshi Road, Mirpur, Dhaka	5	Side	4.00 PM	9.25	Sunny
Kalshi Road, Mirpur, Dhaka	2	Side	2.00 PM	5.17	Sunny
Cantonment Fly Over Road, Dhaka	3	Side	11.00 AM	3.11	Against Sun-light
Shahbagh, Dhaka	5	Over Bridge	10.00 AM	22.54	Sunny
Shahbagh, Dhaka	3	Over Bridge	2.00 PM	12.21	Cloudy
Shahbagh, Dhaka	2	Over Bridge	4.00 PM	9.46	Partially Sunny
BUET, Dhaka	2	Over Bridge	10.00 PM	8.35	Sunny
BUET, Dhaka	2	Over Bridge	12.00 PM	4.49	Cloudy

Table III: Detection Accuracy of Proposed Method for Different Data Set

Data Set	Detection Accuracy	False Positive Rate
Data Set 1	97.81%	1.25%
MVDL [3](Data Set 2)	97.23%	1.67%
Zhang [1]	97.37%	2.5%

rickshaws are plenty, there the accuracy of the method decreases. The rickshaws are very slow compared to others vehicle and for this one rickshaw may appear twice in the VDL region. We can see the result of the video taken from BUET. Most of the vehicles there are rickshaws and the total count is greater than the actual count.

After counting the vehicles for a particular time (20 minutes), the proposed method provides the information about the condition of the roads. The results are generated by calculating the density. We have carried out experiments in our collected videos taken from different place of Dhaka city. We find that the method provides accurate result about the condition of the roads.

V. Conclusion

Traffic monitoring by analysing videos of the road is a very challenging task. It is more difficult on the busy roads like the roads of Dhaka city as the density of the traffic is very high in most of the time. The proposed method can provide a solution to this problem as it is cheap and easy to implement. The proposed method uses Haar-like feature based Adaboost classifier that is faster to compute and provide a very good accuracy in detection. Two virtual detection line (VDL) is used to count the vehicle. The difference of the two VDL is set in such a way that minimizes the chance of missing or counting twice. Although the obtained results are promising, the algorithm still needs further modifications. Because the accuracy of the method decreases when there is so much rush on the roads. it also provides a dissatisfactory result on the roads where rickshaws are plenty. The reason behind it is occlusion of the traffic. As the rickshaw pullers do not develop a habit of maintaining lanes, it causes occlusion. Heavy traffic condition also causes occlusion. A sufficient number of experiments have been carried out on different data set. Experimental results demonstrate that the proposed method provides an acceptable and satisfactory result in counting vehicles and classifying road condition in terms of accuracy, robustness and execution time.

Table IV: Counting Accuracy by Proposed Method

Road Name	Duration of Video (Mins)	Actual Count	Count by Proposed Method	Accuracy
Kalshi Road	6.23	288	270	93.75%
Kalshi Road	9.25	396	375	94.70%
Matikata Overbridge	3.23	114	105	92.10%
Shahbagh	5.52	244	231	94.64%
BUET	4.49	87	96	89.65%

Table V: Traffic Condition of Some Roads in Different Time

Road Name	Duration of Video (Mins)	Time	Traffic Condition
Kalshi Road	6.23	12.00 PM	Moderate
Kalshi Road	20.21	9.00 AM	Heavy
Matikata Over-bridge	3.23	12.00 PM	Free
Shahbagh	5.52	2.00 PM	Busy
Shahbagh	5.52	4.00 PM	Heavy

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An Efficient Automated Attendance Entering System by Eliminating Counterfeit Signatures using Kolmogorov Smirnov Test

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Abstract- Maintaining the attendance database of thousands of students has become a tedious task in the universities in Sri Lanka. This paper comprises of 3 phases: signature extraction, signature recognition, and signature verification to automate the process. We applied necessary image processing techniques, and extracted useful features from each signature. Support Vector Machine (SVM), multiclass Support Vector Machine and Kolmogorov Smirnov test is used to signature classification, recognition, and verification respectively. The described method in this report represents an effective and accurate approach to automatic signature recognition and verification. It is capable of matching, classifying, and verifying the test signatures with the database of 83.33%, 100%, and 100% accuracy respectively.

Keywords: image processing, kolmogorov smirnov test, machine learning, support vector machine.

GJCST-G Classification: K.3.0

Strictly as per the compliance and regulations of:

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K.M.L.P. Weerasinghe [α] & B.H. Sudantha [σ]

Abstract- Maintaining the attendance database of thousands of students has become a tedious task in the universities in Sri Lanka. This paper comprises of 3 phases: signature extraction, signature recognition, and signature verification to automate the process. We applied necessary image processing techniques, and extracted useful features from each signature. Support Vector Machine (SVM), multiclass Support Vector Machine and Kolmogorov Smirnov test is used to signature classification, recognition, and verification respectively. The described method in this report represents an effective and accurate approach to automatic signature recognition and verification. It is capable of matching, classifying, and verifying the test signatures with the database of 83.33%, 100%, and 100% accuracy respectively.

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I. Introduction

Attendance records are very essential in the academic activities of universities. Almost all the universities in Sri Lanka, signatures of candidates are taken in lectures, practical sessions, during examinations, etc. to verify the presence of the real candidate.

The paper-based attendance sheet is passed in each session to take the signature of each student.

For later evaluations, attendance records should enter to the excel sheets and entering student's attendance into the excel sheets for each of the subjects which are very crucial, time-consuming process.

Automated student's attendance entering system can be used to simplify this task. Many attempts are made to automate this process with success to a certain extent. Many of these systems make use of sophisticated biometric equipment while some others use Barcodes and Radio Frequency Identity Cards [5]. Handwritten signatures considered the most natural method of authenticating a person's identity. However they are handled as images and recognized using computer vision and machine learning techniques. With modern computers, it is needed to develop fast algorithms for signature extraction, recognition, and verification. But even today the majorly used system is to take the signature of present candidates and then manually enter these records into the computer. In this study, the process has automated by developing a system which uses image processing techniques to update the attendance records automatically. To build up such a system signature extraction, recognition and verification are essential. Another task is the identification of counterfeit signatures. If we count the number of signatures and the number of heads during a lecture, practical session or in examinations, they should be the same. But sometimes some students sign for their colleagues or replaced by other students. Therefore, identification of counterfeit signatures is very much essential in this type of situations.

The handwritten signature is a prevalent way of authenticity. Despite its known weaknesses, and development of cryptographic and biometric techniques, it is still the most commonly used way of authentication when dealing with paper documents and forms. In this thesis, we focus on the application of biometric recognition for automatic student authentication, in particular making use of handwritten signatures, which are one of the most socially accepted biometric traits.

In education, signatures are used for attendance control, either to lectures or exams, but not for authentication. With the rapid deployment of dynamic signature extraction, recognition and verification automated students attendance entering system has been used for student authentication. Also, the use of this technology can be extended to different administrative services within the education system to add a higher security level to the traditional procedures of authentication.

Signature matching has been used in areas such as extraction [4], recognition [16] and verification [7]. While signature extraction aims to find document images that contain signatures [4], and signature recognition tries to find the corresponding signer of a test sample given a database of signature exemplars from different signers [2], signature verification deals with confirming the authenticity of a signature, i.e., decides whether a sample signature is genuine or forgery by comparing it with stored reference signatures. From the viewpoint of automating the attendance entering system, it involves machine learning from a

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population of signatures. In this study person, dependent learning is used in signature verification phase, so that there are only genuine signatures in the database. This technique is called special-learning. In special-learning, a person's signature is learnt from multiple samples of only that person's signature, where within-person similarities are learnt to identify the signature is genuine or counterfeit.

The rest of this article is organized as follows. Section II mentioned the current achievements in this domain. Section III gives a general description of the proposed method. In section IV, discuss the results and discussions. In section V, provides the conclusions.

II. Literature Review

Ritesh Banka [1] has presented a new approach for the extraction of signature and handwritten regions from official binary document images. He proposed a new two-level scale invariant classification technique to extract the gray-scale handwritten area from the scanned document.

Ogul and coworkers [4] described a discriminative framework to extract the signature from a bank service application document. This is based on the classification of segmented image regions using a set of representative features. The segmentation is done using a two-phase connected component labeling approach. Then evaluate solely and combined effects of several feature representation schemes in distinguishing signature and non-signature segments over a Support Vector Machine classifier.

Gupta [6] has done a cursive signature extraction and verification. In his research, he presented a new approach, based on connected component analysis and geometric properties of labeled regions.

Manesh [15] proposed a method to automatically identify the signature in the scanned document images using a simple region growing algorithm.

Offline handwritten signature verification using ANN [10][13][17] was another concern on this research paper. Sisodia [17] implemented a Static Signature Verification System with four stages such as image pre-processing, feature extraction, classification and decision making. Classifier used an ANN with Error Back Propagation algorithm to attain the result. The relevant features used by the classification are centroid, length and width of the signature in the 200×100 pixels' image box, quadrant areas, one dimensional first and second derivatives of the image and global slant angle. Menu Bhatia [15] was used maximum horizontal and vertical histogram, the center of mass, normalized are of signature, aspect ratio, tri surface feature, six-fold surface feature and transition feature as the extracted features from the candidate signature.

In contrast to the previous research, some have also used HMM and Graphometric features [8][9] and conjunction with neural network and support vector machines [12]. Abdullah [3] proposes a new method for signature recognition using Delaunay triangulation.

Rupali Mehra and coworkers [13] present Surf features and neural-fuzzy techniques based recognition of offline signatures system that is trained with low-resolution scanned signature images. Gautam [17] has used SIFT and Delaunay triangulation for image matching in their research.

Woods [5] considered image area, vertical center, and the horizontal center of the signature, maximum vertical projection, maximum horizontal projection, vertical projection peaks, horizontal projection peaks, number of edge points, number of cross-points and Hough transform for feature extraction of each signature. Extracted values of each signature images from the database of 150 are given to the feed forward neural network (trained using back propagation gradient descent learning).

Gulzar and coworkers [10] present neural network based recognition of offline handwritten signature system that is trained with low- resolution scanned signature images. And also Prashanth C.R. [21] presents DWT based offline signature verification using angular features (DOSVAF). The signature is resized, and Discrete Wavelet Transform (DWT) is applied on the blocks to extract the features.

Vahid Kiani [11] proposes a new method for signature verification using local Radon Transform. The proposed method uses Radon Transform locally as feature extractor and Support Vector Machine (SVM) as the classifier. The main idea is using Radon Transform locally for line segments detection and feature extraction, against using it globally. The advantages of the proposed method are robustness to noise, size invariance and shift invariance. Having used a dataset of 600 signatures from 20 Persian writers, and another dataset of 924 signatures from 22 English writers, their system achieved good results.

In paper [8] a system is introduced that uses only global features. A discrete random transform which is a sinograph is calculated for each binary signature image at the range of $0 - 360$, which is a function of the total pixel in the image and the intensity per given pixel calculated using non-overlapping beams per angle for X number of angles. Due to this periodicity, it is a shift, rotation, and scale invariant. An HMM is used to model each writer signature. The method achieves an AER of 18.4% for a set of 440 genuine signatures from 32 writers with 132 skilled forgeries.

Support Vector Machines (SVMs) are machine learning algorithms that use a high dimensional feature space and estimate differences between classes of given data to generalize unseen data. The system in [15] uses global, directional and grid features of the

signature and SVM for classification and verification. The database of 1320 signatures is used from 70 writers. 40 writers are used for training with each signing eight signatures thus a total of 320 signatures for training. For initial testing, the approach uses eight original signatures and eight forgeries and achieves FRR 2% and FAR 11% [15].

III. Methodology

The main steps of this research consist of

- Signature extraction from attendance sheets based on morphological operations
- Separate signature, non- signature area using binary Support Vector Machine
- Signature recognition by training Error-Correcting Output Codes multiclass model using SVM
- Signature verification using Kolmogorov Smirnov test

A software package, Matlab2016b is used for this procedure.

a) *Signature Extraction from the Scanned Attendance Sheets*

An important task in the automated processing of scanned attendance sheets is to extract the signatures. Here both signature and non-signature area are extracted and classify them to separate signature area. The main steps in the signature extraction process are represented by Fig.1.

The main steps are:

- Image Pre-processing
- Classification using binary SVM

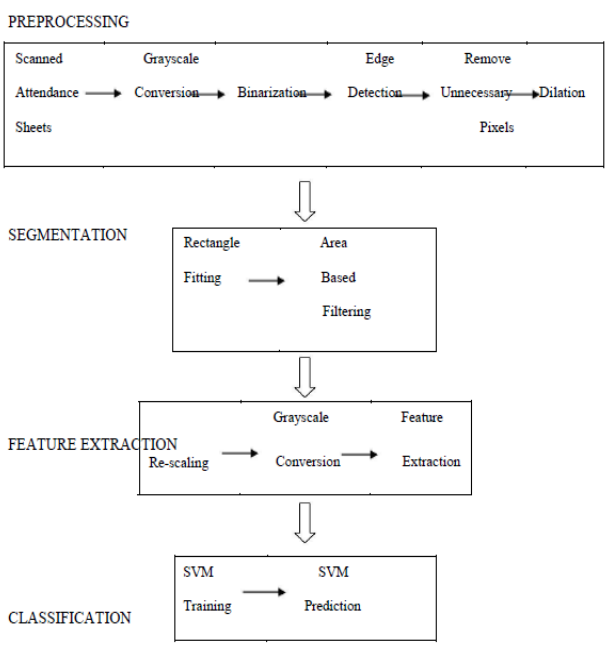

Fig. 1: A brief outline of signature extraction

b) *Image Pre-processing*

In the pre-processing phase gray conversion, image binarization, edge detection, remove unnecessary pixels, morphological dilation (close, thicken, bridge), image segmentation and cropping are performed.

Fig. 2: Apply Pre-processing Techniques for Scanned Attendance Sheets

c) *Classification using Binary SVM*

After extracting the images from attendance sheets, the segmented images should be classified using a set of representative features. Here used features of segmented images in distinguishing signature and non-signature segments over a binary SVM classifier.

d) *Signature Recognition*

Signature recognition is a writer identification problem, whose objective is to find the author of a test signature given a database of signature exemplars from different signers. They are composed of special characters and flourishes, and therefore most of the time they can be unreadable. Also, intrapersonal variations and interpersonal differences make it necessary to analyze them as complete images and not as letters and words put together [15]. The signature acquisition, Pre-processing of signatures, Feature extraction, Train and test an Error Correcting Output Codes (ECOC) multiclass model using SVM are the main steps of signature recognition.

e) *Signature Acquisition*

Handwritten signatures are taken from 103 students who followed Statistical Inference-I course module in semester-I of academic year 2014/2015, in Faculty of Applied Sciences, Wayamba University of Sri Lanka. Seven signatures are taken from each student so that 721 are used in signature recognition phase.

Fig. 3: Sample Signature Database

f) Pre-processing of Signatures

Gray conversion, Image binarization, Remove unnecessary pixels, Thinning and Data area cropping are performed in the pre-processing phase:

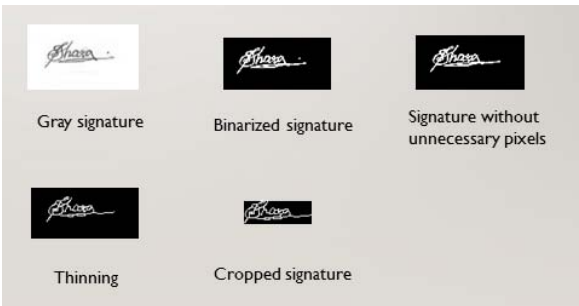

Fig. 4: Apply Pre-processing Techniques for Signatures

g) Feature Extraction of Signatures

Before the feature extraction process to increase the accuracy of the system signature image is partitioned into four equal parts and extract features from each part. So, that the number of features which can be used to train the model has been increased.

Fig. 5: Partitioned Signature into 4 Parts

The choice of the features that provided to the classifiers of the system is essential. In this work, global and local features are used. Pure width, pure height, baseline shift, kurtosis, skewness, maximum vertical projection, maximum horizontal projection, vertical center of mass and horizontal center of mass, Hough transform, etc. are used as global features.

To increase the accuracy of the system grid based features are also extracted from the handwritten signatures as local features. Here Histogram Orient Gradient (HOG) features are extracted as grid features and combine them with global features in the recognition process. The total number of extracted HOG features is 2592.

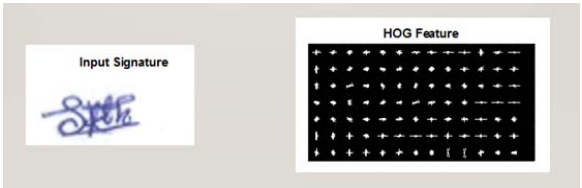

Fig. 6: HOG features extracted from one signature

Local and global features of images are given to *error-correcting output code multiclass model* (ECOC) to train it, so that particular signature image is recognized. ECOC classification requires a coding design, which determines the classes that the binary learners train on, and a decoding scheme, which ensures how the results (predictions) of the binary classifiers are aggregated. Suppose that there are three classes, the coding design is one vs. one, the decoding scheme uses loss *g*, and the learners are SVMs. To build the classification model, ECOC follows following steps.

A one vs. one coding design is:

	Class 1	Class 2	Class 3
Learner 1	1	1	0
Learner 2	-1	0	1
Learner 3	0	-1	-1

Learner 1 trains on observations having Class 1 and Class 2, and treats Class 1 as the positive class, and Class 2 as the negative class. The other learners are trained similarly. Let *M* be the coding design matrix with elements m_{kl}, and s_l be the predicted classification score for the positive class of learner *l*.

A new observation is assigned to the class () that minimizes the aggregation of the losses for the *L* binary learners. That is,

$$\hat{k} = \underset{k}{\operatorname{argmin}} \frac{\sum_{l=1}^{L} |m_{kl}|\, g(m_{kl}, s_l)}{\sum_{l=1}^{L} |m_{kl}|}$$

ECOC models can be used to improve the classification accuracy, even compared to other multiclass models.

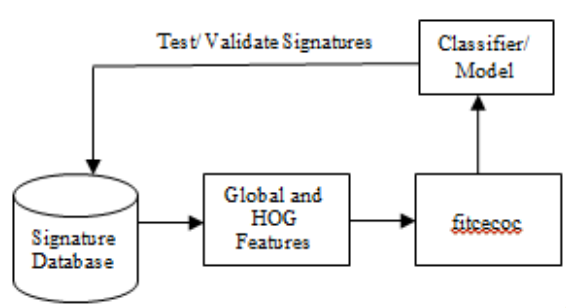

Fig. 7: Signature Recognition using Multiclass SVM

h) Signature Verification

The performance task of signature verification process is one of determining whether a questioned

signature is genuine or not. The image of a questioned signature is matched against multiple images of known signatures. Visual signature verification is naturally formulated as a machine learning task. The machine learning tasks can be stated as general learning (which is person-independent) or special learning (which is person-dependent), paralleling the learning tasks of the human questioned document examiner. In the case of general learning the goal is to learn from a large population of genuine and forged signature samples. The focus is on differentiating between genuine-genuine differences and genuine-forgery differences.

Special learning focuses on learning from genuine samples of a particular person. The focus is on learning the differences between members of the class of genuine. The verification task is a one-class problem of determining whether the questioned signature belongs to that class or not.

Using Kolmogorov Smirnov test correctly classified signatures are used to confirm the genuineness.

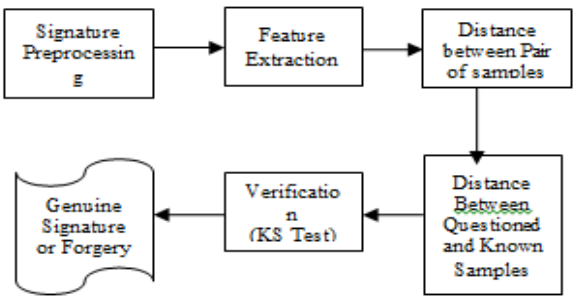

Fig. 8: Signature Verification using Kolmogorov Smirnov Test

If a given person has N samples, $\binom{N}{2}$defined as N! /N! (N-r)! pairs of samples can be compared as shown in Fig.8. Let N be the total number of samples and $N_{WD} = \binom{N}{2}$ be the total number of comparisons that can be made which also equals the length of the within-person distribution vector. The within-person distribution can be written as

$$D_W = (d_1, d_2, \ldots, d_{NWD})^T$$

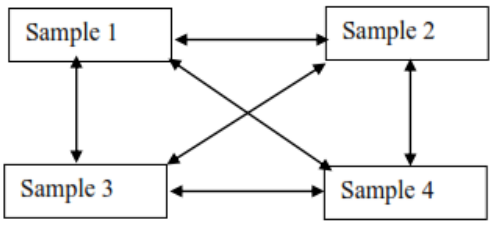

Fig. 9: Comparing All Possible Genuine-Genuine Pairs

Analogous to this, the questioned sample signatures can be compared with every one of the N knowns similarly to obtain the questioned vs. known distribution. The questioned vs. the known distribution is given by

$$D_{QK} = (d_1, d_2, \ldots, d_N)^T$$

where d_j is the distance between the questioned sample and the jth known sample, $j \in \{1,\ldots, N\}$.

i) Performance Evaluation

For unmatched signatures distance statistics is large and for matched signatures distance statistic is small. Since .004 is less than .20, the null hypothesis has been accepted. That is distributions are approximately same for matched signatures. In this study 0.01 has taken as the significance level.

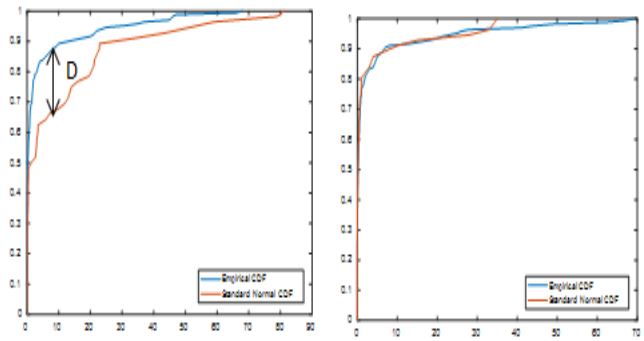

Fig. 10: Test Statistic for Unmatched and Matched Signatures

ALGORITHM:

Input = Signature image

Output = Conformation from system whether the signature is genuine or counterfeit.

Step 1: Acquire matched signature images from the signature recognition process

Step 2: Enhanced the signature images by pre-processing

Step 3: Create a feature vector by combining extracted features from the pre-processed signature images.

Step 4: Obtain the distances of features between every seven samples of the known signature in the database. (Results gave 21 × 8 matrices)

Step 5: Same has been done between the known sample and questioned sample. (Results gave 7 × 8)

Step 6: Apply KS test for two distributions and obtain the probability of similarity.

Step 7: Repeat step 1-7 to test all the signatures recognized by the system.

Step 8: If the probability is less than 0.01 the signature is identified as "Forge", otherwise as "Genuine".

Table 1: Sample Distance Distribution of Known Signature

1	2	3	4	5	6	7
0.44	0.68	0.52	0.87	1.01	0.81	0.93
1.67	2.44	1.93	2.95	3.27	2.80	3.09
122	98	139	67	38	69	43
0.27	0.54	0.67	0.08	0.30	0.40	0.28
0.048	0.07	0.05	0.1	0.12	0.09	0.10
0.10	0.16	0.12	0.21	0.24	0.19	0.22
5	7	9	7	8	5	5
0.03	0.06	0.04	0.08	0.09	0.07	0.08

Table 2: Sample Distance Distribution of Known vs. Questioned

1	2	3	4		19	20	21
0.24	0.08	0.43	0.57	…	0.19	0.07	0.11
0.77	0.26	1.27	1.59	…	0.46	0.18	0.28
24	17	55	84	…	31	5	26
0.26	0.39	0.18	0.03	…	0.09	0.01	0.11
0.03	0.00	0.05	0.07	…	0.03	0.01	0.01
0.06	0.02	0.11	0.14	…	0.05	0.02	0.03
2	4	2	3	…	3	3	0
0.02	0.00	0.04	0.05	…	0.01	0.00	0.01

j) Enter Data to Excel Sheets

After identifying whether a particular signature is genuine or forge the attendance records has been entered to the excel sheets. If the KS test identify the signature as genuine in verification process, '1' has been entered in front of the relevant student index number in the excel sheet.

IV. Results & Discussion

When extract the signatures from scanned attendance sheets in some situations there are some discontinuities in the signatures. In those situations, whole signature is not including in the bounded region as following figure (one signature is separated into parts).

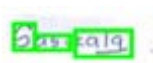

Fig. 11: Signature Image with Multiple Bounded Regions due to Discontinuity

To overcome that problem edge detection, morphological dilation, thicken and bridge has been used in pre-processing stage.

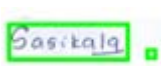

Fig. 12: Signature Image after Removing the Discontinuity

The errors we are trying to minimize in recognition and verification are: classifying one person's signature as belonging to another one and acceptance of a fake signature. Some signatures are misclassified by another student's signature due to some similarities between two signatures in the recognition process.

Fig. 13: Misclassification of a Signature

V. Conclusion

Today information technology has proved that there is a need to retrieve, search, query and store large amount of electronic information efficiently and accurately.

In signature extraction phase, the whole part of the signature not extracted due to some reasons. Those are: excessive dusty noise, logos, figures, printed and handwritten text etc., large ink- blobs joining disjoint characters or components, degradation of printed text due to poor quality of paper and ink, text overlapping the signature. By increasing the space between text and signatures, it could be avoided the overlapping of signatures with text. Proposed system is extracted signatures with 100% accuracy.

In recognition process the combination of global and local features are used to train the ECOC multiclass model using SVM. The accuracy is 83.33% and it suggest that the use of gradient-based feature sets with global features can serve the most reliable way of detecting signatures in signature recognition process.

A machine learning approach is used in signature verification process, because only the genuine signatures are in the registered student database. All signatures are identified as genuine with 100% accuracy. Finally, we can conclude that this system can be used in a university educational environment for automatic student authentication. Eventually, based on the methodologies employed in this report, it provides a promising stage for the development of an automated attendance entering system.

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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.

The Administration Rules

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

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

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

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

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

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

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