A Synopsis

On

"STUDY, ANALYSIS AND DESIGN OF ADAPTIVE SOFTWARE ALGORITHMS FOR APPLIED AUTOMATED SYSTEM DEVELOPMENT AND TESTING PATTERNS IN THE AREA OF HIGH PERFORMANCE RUN TIME DYNAMIC STORAGE IN NETWORK CLOUD ENVIRONMENT"

By

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(In Hindi) **विकास कुमार चौधरी**

2. Title:

"STUDY, ANALYSIS AND DESIGN OF ADAPTIVE SOFTWARE ALGORITHMS FOR APPLIED AUTOMATED SYSTEM DEVELOPMENT AND TESTING PATTERNS IN THE AREA OF HIGH PERFORMANCE RUN TIME DYNAMIC STORAGE IN NETWORK CLOUD ENVIRONMENT"

3. Location:

Institute: Pacific Academy of Higher Education and Research, Udaipur (Raj.)

Geographical Area of Investigation: Pune, Maharashtra

4. Importance of proposed Investigation:

The problems in building systems that must exhibit robustness to a changing environment; embedding significant COTS/Community Sourced independently evolving components; problems building systems that involve user scripting and 'plug-ability'.

In proposed design the researcher will study to evaluate and estimation of the run time dynamic network characteristics and behavioral changes occurred due to applications fine tuning its network resources on server platform due to various reasons.

Here the importance is make and work the system using one interface application adaptive to environment so that the estimation matrix database from testing environment can be exported to the automated testing tool work on adaptive methodology and adaptive approach and same can be applied to change test strategies to finalize inputs of the network component under test (network node, NIC, HBA, etc..) With respect to the run time characteristics obtained thorough feedback mechanism.

There are various plugs and play hardware devices i.e. USB devices. Same way there should be plug and play software systems and it is possible only if software is designed on adaptive patterns. The current proposed investigation will try to find out how the adaptive patterns be implemented in automated software systems. In short, problems building the sort of systems we are called on to construct all the time.

We need to develop engineering models and methods for assembling software systems that can dynamically adapt to context and can ‘account for themselves’. Here the Software development is no longer garage ‘design and make’. Most software products and services are embedded in a network of complex inter-product and inter-supplier dependencies. Software is the result of the operation of a 'supply chain' that must be designed and forms part of an 'ecosystem' that must be accommodated. Rethinking software production requires a new discipline of business model and software system co-design.

Therefore Importance of adaptive system varies on the basis of application and environment and it will come with design algorithm and methodologies and code base libraries of adaptive nature intelligent enough to understand their execution environment and input from the user so that program simulate itself as per the nature of (storage networking) protocol, High Performance Networking Systems and can give adequate result/throughput for high performance storage and control systems.

Following problem sources put force on importance of proposed investigation:

- Improper Analysis: happens mostly due to miss-communication between end-users and system analysts.
- Inconsistent System Requirements Specification of automated applications.
- Incomplete or Obsolete or Ambiguous Design of automated Systems.
- Incomplete, Inconsistent Automated Test Plan.
- Improper Feature, Load Tests.
- Continuously changing run time dynamic networking environment.

5. Scope of the proposed study:

Due to complexities in modern high performance computing and high performance storage networking systems because of using multilayered protocol for data transfer on high speed (e.g. Fiber Optics, Ethernet) medium, becoming more complex over the years. As a result there has been as need for automation of functions to cope with this increased complexity.

Although several recommendations have been made to develop some sort of automation frameworks and thereby using of various programming techniques for developing automated programs those can be used across platforms.

These techniques has started in use with some new human factors issues and concerns, for example, the ability to intervene effectively when an automated subsystem fails is one of the key issues in automated control systems. Other difficulties that operators of automated systems may face include loss of system awareness and manual skills degradation. These kinds of problems may be characteristic of complex systems in which automation is implemented in a fixed or "static" manner.

In contrast, systems in which automated aids are implemented dynamically, in response to changing task demands on the operator, may be less vulnerable to such problems. It has been proposed that systems with adaptive automation are superior to conventional automation because they provide for regulation of user workload and vigilance, maintenance of skill levels, and task involvement.

Adaptive automation has been proposed as a means for further increasing the number and flexibility of levels of automation in the high performance networked systems. One outcome of this concept is that the adaptive system could select its own level of automation, depending upon the operating environment and system performance. The feasibility of this approach and its impact on operator and system performance is poorly understood. At present, the only consensus in the design of adaptive automation systems seems to be that the philosophy of the user's role in the system will be critical.

Typically, it is argued that the user must interact with the automation as a control system, and as such provides consent to the level of automation assumed by the system. For adaptive automation to work, the system must utilize an accurate operator-state classifier for the real-time assessment. Operator state classifiers, such as discriminate analysis and artificial neural networks.

How an accuracy of 70% to 85% in real-time? An important part to properly implementing adaptive automation is figuring out how big a workload needs to be to require intervention. There has been various effect/essence of Adaptive Automated Testing Tools and Test Strategies in run time dynamic network testing environment.

This proposed investigation does critical Study and performance/usability statistics of various Implementatins of automated (open source)software testing tool used in high performance different/networking environment/technologies. Further study tries to understand the applications and design of open source automation frameworks and their selection criteria in Technical Organizations to design automated software testing and Adaptive Automated Test Strategies

In proposed design and study, there will be an evaluation and estimation of the network characteristics and behavioral changes occurred due to applications fine tuning its network resources on server platform. To make the system adaptive to environment the estimation matrix database will be exported to the testing tool and adaptive approach will be applied to change test strategies to finalize matrix database of the network component under test (network node, NIC, HBA, etc..) With respect to the run time characteristics obtained thorough feedback mechanism.

The peripheral situations affect the performance of systems; therefore, though one-shot human-centered automation (HCA) designs might provide better results than the systems designed based on the "automate it as possible" philosophy.

Following Points are keeping in mind to take this study further:

- **Scalability**: Devise a software and hardware architecture that scales up by a some factor. That is, an application's storage and processing capacity can automatically grow by a factor of a million, doing jobs faster just by adding more resources.
- **The Turing Test**: Build a computer system processing task in less time.
- **Trouble-Free Systems**: Build a system used by people each day and yet administered and managed by a single part-time person.
- **Secure System**: Assure that adaptivre automated algorithm automatethe system in a way that only services authorized users, service cannot be denied by unauthorized users, and information cannot be stolen
- **AlwaysUp**: Assure that the system is always available. **Automatic Programmer**: Devise a specification language or user interface that:
    - makes it easy for people to express designs (1,000x easier),

  - computers can compile/Interpret, andcan describe all applications
  - The system should reason about application, asking questions about exception cases and incomplete specification. But it should not be onerous to use.

- **Formalizing Common Sense for minimum input consideration**
- **Machine Readable Specification and design**
- **Automatic Code Verification: i.e. Profiling Tools**
- **Automatic Feature and Load Testing**
- **Automatic Action Tracking : i.e. Switching Throughput**
- **Automatic Problem discovery and Recovery**

6. Review of work already done on the subject:

In our research work, it is proposed to discuss how an adaptive algorithm can simulate itself according to system environment and its parameters. Now As per review of literature, researcher needs to see how much work already done in this area.

As **Huey-Min Wu, Bor-Chen Kuo and Jinn-Min Yang** submitted research paper on Evaluating Knowledge Structure-based Adaptive Testing Algorithms. They developed a theoretical mathematical model called computerized adaptive test (CAT) for the students. Hence adaptive algorithm based on knowledge structure and called it, knowledge-structure-based adaptive testing (KSAT) algorithms. As per their findings the following are several major interfaces of system. The user management interface in is multi-functional. It allows new users to have access to creating new user accounts, creating multiple new user accounts, importing accounts from other sources such as Excel, and giving access to the database. The test administration interface displays the items and allows the examinees to answer the items presented. Since the KSAT system is an adaptive test, only one item per screen is presented.

The group profile interface in displays the group result of the exam. For example, in some concept of the interface, x students passed and y students failed test 1. Instructors can then take this information and understand the distribution of students' knowledge states and identify the strengths and weaknesses within a group. This information can be utilized for remedial instruction. Upon completion of the test, the student receives a personalized profile including name, scores, percentile, utilization of test items, date taken, and so forth.

There are several strategies by which adaptive automation can be implemented **(Morrison & Gluckman, 1994; Rouse & Rouse, 1983).**

<u>One set of strategies addresses system functionality</u>. For instance, entire tasks can be allocated to either the system or the operator, or a specific task can be partitioned so that the system and operator each share responsibility for unique portions of the task. Alternatively, a task could be transformed to a different format to make it easier (or more challenging) for the operator to perform.

<u>A second set of strategies</u> concerns the triggering mechanism for shifting among modes or levels of automation **(Parasuraman et al., 1992; Scerbo, Freeman, & Mikulka, 2003).** One approach relies on goal-based strategies. Specifically, changes among modes or levels of automation are triggered by a set of criteria or external events. Thus, the system might invoke the automatic mode only during specific tasks or when if it detects an emergency situation. Another approach would be to use real-time measures of operator performance to invoke the changes in automation.

<u>A third approach</u> uses models of operator performance or workload to drive the adaptive logic **(Hancock & Chignell, 1987; Rouse, Geddes & Curry, 1987, 1988).** For example, a system could estimate current and future states of an operator’s activities, intentions, resources, and performance. Information about the operator, the system, and the outside world could then be interpreted with respect to the operator’s goals and current actions to determine the need for adaptive aiding. Finally, psycho-physiological measures that reflect operator workload can also be used to trigger changes among modes.

Billings (1991) instead focuses his attention on <u>automation at work</u>: how automation may correctly perform some activities or parts of them, how automation may interact with humans or support them in their tasks.

Billing (ibidem) defines LoA infunctional terms: a level of automation corresponds to the set of function that an operatorcan autonomously control in a standard situation united to system ability at providinganswer and solutions, at acting properly according to the proposed solution, and to checkthe results of its actions.

Tightly coupled with Billings definition are Rouse’s observations (1988): the adaptiveautomation provides variable levels of support to human control activities in complexsystems, according to the situation. Moreover, the situation is defined by the task featuresand by the psychophysical status of human operator. As a consequence, the human machineinteraction should depend on what has to be automated, and on how and when.

There are several studies reviewing empirical researches about AA **(Parasuraman, 1993), (Hilburn et al., 1993), (Scallen et al., 1995), (Parasuraman et al., 1996), (Kaber, 1997), (Kaber & Riley, 1999)** that focused on the performance effects of Dynamic Function Allocation (DFA) in complex systems, specifically monitoring and psychomotor functions. These studies brought into evidence that AA significantly improves monitoringand tracking task performance in multiple task scenarios, as compared to static automationand strictly manual control conditions.

A further development for AA systems is the Neuroergonomics approach, which usespsychophysiological measures to trigger changes in the state of automation. Studies have shown that this approach can facilitate operator performance **(Scerbo, 1996).** Less work has been conducted to establish the impact of AA on cognitive function performance (e.g.,decision-making) or to make comparisons of human-machine system performance whenAA is applied to various information processing functions **(Kaber et al., 2002)**.

Scerbo (1996) specifies that the AA canstart different types of automation, in relation with the context (system and operator).An integration to this conclusion is provided by Kaber and Riley (1999), which defined adaptive automation as a programming or a pre-definition of the control assignment between human and system, in order to improve the human performance.

Human performance is in fact a crucial aspect of the functioning of complex system. As a consequence, the human operator should be involved in the control task, in order to avoid the out-of-the-loop performance.

As stated by **Norman (1989)**, without appropriate feedback people are indeed out-of-the-loop;they may not know if their requests have been received, if the actions are being performedproperly, or if problems are occurring. Sharing the functions control is not only a matter of quantitative task to accomplish, but it involves the responsibility of the whole operation execution.

The dynamic function allocation (DFA) is a peculiar aspect of AA **(Kaber et al, 2001)**. Itbasically consists of assigning the authority on specific functions to either the humanoperator or the automated system, depending on the overall context (i.e. operator's state andouter conditions) and on a defined set of criteria. DFA should therefore be designed bytaking into account both the human and the system status, and considering the means forallowing context recognition.

Focusing on the participation and the autonomy that humans and machines may have ineach task to be performed there is some debate. Some researches face the crucial issue of theauthority that each part should have in controlling the system. Historically, humans playedHuman-Computer Interaction, New Developments the role of the supervisory control i.e. the machine decides about the actions and the humans evaluate these decisions; depending on this assessment, control on the actions is either regained by human operators or provided **(Sheridan, 1992)**.In this effort a crucial role is played by the human skills and abilities and by the systems natural limits **(Parasuramanet al., 2000)**.

There is a clear difference between the AA approach and the Level of Automation **(Kaber &Endsley, ibidem)**.

By contrast with the traditional view of automation that is shortly a fixedand highly regulated process designed to eliminate human interaction, AA is designed toexpect and anticipate changes under active control of a developer while maintaining precisecontrol of all background variables not currently of interest **(Kay, 2006)**.

AA is based on the dynamic allocation of the control of the whole task or of some parts, crossing along time manual and automated phases. The Levels of automation instead allow only a static function assignment, because the task level of automation is established in the design phase **(Kaber & Endsley, ibidem)**.

AA allows users to experiment with variables seen as key parameters in a system while preventing undesired secondary effects that could unexpectedly arise from variations in parameters not under study, which in manual systems might not be precisely controlled.

The Adaptive Automation Design Consideration.From this point of view it is possible to state that Work systems perform functions or units of work. Roles, instead, are more difficult to define. They make sense to consider it as an activity that can be performed either by human or machine **(Harrison,Johnson, Wright, 2001)**.

The York Method (developed at the Department of Computer Science, University of York):provides theoretical instruments to define functions, rules and scenarios, and thenrepresents them by some specific grids. The aim is to decide which functions are suitable to which rules, considering different scenarios **(Calefato, Montanari, Tango 2007)**.

“A function may be separable from all roles, and technically feasible and cost effective to automate, in which case the function may be totally automated.

Alternatively it is possible that the function maps entirely to one of the roles, and is infeasible to automate, in which case the function is totally performed within that role. In most cases however functions fit into neither category.

In this situation the function is to be partially automated” **(Harrison, Johnson, Wright, 2001)**. Functions and roles have to be set into one or more scenarios.

In taking into account the driving scenario, it has to be measured the driver’s competences in tasks critical to performance and safety.These concept can be clarified by an example belonging to the automotive domain. We canhypnotize to have to design a preventive safety system.In order to design the application,the driving scenario and its corresponding manoeuvres have been broken down into functions and sub-functions in order to outline which functions have to be performed manually, automatically or both.

Secondly, system and driver’s roles have been combined with functions in order to outline which functions suite best to which roles, considering the given scenarios.The scenarios have been selected in order to measure the driver workload and situation awareness. Consequentially the selected scenario shows the whole behaviourof the system, along the seven LoA implemented **(Calefato, Montanari, Tango 2007)**.

Recently, Mozer (2004) described his experiences living in an adaptive home of his own creation. The home was designed to regulate air and water temperature and lighting. The automation monitors the inhabitant’s activities and makes inferences about the inhabitant’s behavior, predicts future needs, and adjusts the temperature or lighting accordingly. When the automation fails to meet the user's expectations, the user can set the controls manually.

The heart of the adaptive home is the adaptive control of home environment (ACHE) and functions to balance two goals:

1) User desires and
2) Energy conservation.

Because these two goals can conflict with one another, the system uses a reinforcement learning algorithm to establish an optimal control policy. With respect to lighting, the ACHE controls multiple, independent light fixtures, each with multiple levels of intensity. The ACHE encompasses a learning controller that selects light settings based on current states. The controller receives information about an event change that is moderated by a cost evaluator. A state estimator generates high-level information about inhabitant patterns and integrates it with output from an occupancy model as well as information regarding levels of natural light available to make decisions about changes in the control settings. The state estimator also receives input from an anticipator module that uses neural nets to predict which zones are likely to be inhabited within the next two seconds. Thus, if the inhabitant is moving within the home, the ACHE can anticipate the route and adjust the lights before he arrives at his destination. **Mozer (2004)** recorded the energy costs and as well as costs of discomfort (i.e., incorrect predictions and control settings) for a month and found that both decreased and converged within about 24 days.

Mozer (2004) had some intriguing observations about his experiences living in the adaptive house. First, he found that he generated a mental model of the ACHE's model of his activities. Thus, he knew that if he were to work late at the office, the "house" would be expecting him home at the usual time and he often felt compelled to return home! Further, he admitted that he made a conscious effort to be more consistent in his activities. He developed a meta-awareness of his occupancy patterns and recognized that as he made his behavior more regular, it facilitated the operation of the ACHE, which in turn, helped it to save energy and maximize his comfort. In fact, Mozer claimed, "the ACHE trains the inhabitant, just as the inhabitant trains the ACHE".

Mozer (2004) also discovered the value of communication. At one point, he noticed a bug in the hardware and modified the system to broadcast a warning message throughout the house to reset the system. After the hardware problem had been addressed, however, he retained the warning message because it provided useful information about how his time was being spent. He argued that there were other situations where the user could benefit from being told about consequences of manual overrides.

The "horse-rider paradigm" is introduced at first time in 1990 by Connell andViola, then it was developed by **Flemish et al (2003)**, that named it "H-metaphor" and facedalso by **Norman (2007)**.

The "Horse-Rider paradigm" explains the relation between human and automation like the relation that a rider establishes with his/her horse: the human receives information about the actual system status through an osmotic exchange with it.Human intention and actions become the parameters the system uses to offer him the correct solution or answer to the faced context.

In this way it is possible to improve the human performance that represents the crucial hearth of the interaction in complex systems.Besides the operator is maintained in loop during the system control, in order to avoid or reduce the out-of-the-loop performance.

7. Research gaps identified in the proposed field of investigation:

Researcher has seen that As Huey-Min Wu, Bor-Chen Kuo and Jinn-Min Yang submitted research paper on "Evaluating Knowledge Structure-based Adaptive Testing Algorithms". In this automated adaptive tool have interface and as per the login to user that tool was easily distribute questionnaires to take the exams and even was able to display results, but the scope was limited to evaluation and it was not to adapt the nature of run time environment.

Morrison & Gluckman, 1994; Rouse & Rouse, 1983 discussed about different strategies, mainly interaction between operator and machine, where machine could estimate different states of an operator's activities, intentions, resources, and performance. Therefore same Information about the operator, the system, and the outside world could then be interpreted with respect to the goals and actions to determine the need for adaptive aiding, hence machine learning is proposed with regard to operator activities not as per dynamic environment.

Kaber et al, 2001, told that the dynamic function allocation (DFA) is a peculiar aspect of AA. It basically consists of assigning the authority on specific functions to either the human operator or the automated system.

The York Method (developed at the Department of Computer Science, University of York) tell about the design consideration and desire of control to automate.

The “Horse-Rider paradigm” explains the relation between human and automation like the relation that a rider establishes with his/her horse.

As per all above findings , they were able to success in their design criteria but no algorithmic solution was provided to select criteria for automated tools as per the adaptive nature of environment and no study was done to design algorithm adaptive as environemnt changes and their implementation criteria in run time dynamic environment.

The researcher observed that there in all previous studies, no implementations and design done towards applications verifying networking cloud/environment and component under test (network node, NIC, HBA, etc...) With respect to the run time characteristics obtained thorough feedback mechanism.

It is clear there are different approaches to develop adaptive algorithms, especially in the area of avionics, Neuro-ergonomics, Educations, robotics and missile/space and communications technology but nobody have considered enough to implementation in testing of high performance storage networking and control systems and even no appropriate automated tool being developed on the basis of adaptive philosophical theory to work and test the technological and networking systems and high performance control systems.

8. Objectives of the proposed study:

The objectives of the present study are as under:

(i) To study open source automated tools and based design algorithm and methodologies and simulation of code base libraries of adaptive nature intelligent enough to understand their execution environment.

(ii) To take input from the users for their feedback to make the algorithm in a way so that it simulate itself as per the nature of protocol and requirements

(iii) To Study the level of satisfaction of users before using automated (adaptive design and test pattern algorithm) software applications.

(iv) To Study the level of satisfaction of users after using automated (adaptive) software applications.

(v) To compare the level of satisfaction of users before and after using adaptive automated software testing tools.

(vi) To find problems in application of Adaptive Software in Technical Organizations.

(vii) Come up with engineering algorithm in terms of model and methods for assembling software systems that can dynamically adapt to context and can ‘account for them-selves’ specific to run time dynamic environment.

9. Research Methodology:

- **Hypotheses to be tested:**
  - There are limited software tools and applications available of adaptive nature for software testing in dynamic storage in network cloud environment.
  - There are limited problems and scope in technical organizations to use application Software based in advanced adaptive automated technology.
  - There is no significant change in level of satisfaction of users after implementing adaptive algorithm in their environment.

Sources of Information:

Sample: In the proposed study about ten open sources automated tools (specifically written in python or C++ programming language). based on different design and methodologies will be selected and will be studied; therefore 10 organizations using one or more open source automated tools will be selected by purposive sampling method from Pune (Maharashtra, India) for the study. There will be about five working Office Staff in an organization that is using automation to give the feedback. Experiments and Implementations will be mostly done in the same organization. It would give the usability and satisfaction level of the respondents would be the technical office staff or authorized person or open source community, open source software foundations and societies.

- **Tools and Techniques of Research:**

  - Coding an adaptive algorithm takes longer than developing a regular one, and can require some special considerations. Before a programmer creates an algorithm, he will usually develop a list of parameters to describe what it needs to do and how.
  - This Research will further focus on Keyword driven approach of automation and script preprocessing to get the knowledge of environment in advance.
  - Researcher will do experiments in storage network labs and Linux Based operating systems and Network protocols with python as a scripting language.
  - With an adaptive version, system will think about situations that could arise and set up the code so the adaptive algorithm can learn from its experiences

The two questionnaires will be prepared by researcher with the help of subject matter experts as a tool to collect the information. The first Questionnaire covers the aspect of applications of software (tools and algorithm) and the second questionnaire checks the level of satisfaction before and after using software solution.

For primary data tabulations, interpretation and conclusions will be drawn. Analysis of primary data various statistical techniques will be used and all statistical analysis will be done by computer through **SPSS** package. The researcher will use appropriate statistical techniques (SPSS) through computer software to compare the data in **Analysis of Collected Data.** Wherever needed photographs, graphs and charts will be prepared to give an eye view of the situation. With the help of conclusions drawn, suggestions will be made.

Limitations: The research is based on self-constructed questionnaire as well as study of automation tools and experiments done at work place and algorithm designs so the result is totally depends upon user's response towards questionnaire as well as experimental work and research study. Pune is chosen as study area, therefore as area wise it is limitation.

This Research Study will go from following phases:

Phase I: Extensive study and experiment with existing automated tools and test them on networking systems in Lab.

Phase II: Will Prepare self-constructed questionnaires; take feedback and come up with conclusion therefore prepare a mathematical model, philosophical approach and state machine to decide the environmental parameters and behavior of user, so that proposed algorithm can customize itself as per environment and needs of the user.

Phase III: Development of theory of algorithm as well as simulated code base and libraries for practical implementation in high performance storage networking systems. Also writing the research papers for publications in journals.

Phase IV: Analysis and refinement in the algorithm by practically run on different set of environment and different platforms, different set of available hardware/Cards and different operating systems to test the algorithm and code library for its perfect simulation

Phase V: Conclusions: will prepare drafted thesis report and presentation and will give practical demonstrations of the implantation of adaptive algorithm made.

This above mentioned activities scheduled and time which these may be achieved in 30 months. Researcher will work on the generic approach to solve and come up with philosophical approach in the area of current work environment as well as same will be useful for further study and practical implementation in technical environment .Researcher will further work in co-operation of respective guide/supervisor for this Ph.D. Thesis.

10. Chapter Plan

The study will go under following chapters simultaneous to the phases of study:

Chapter I: Introduction

Chapter II: Fundamentals of Automation:

Chapter III: Fundamentals of Storage and Cloud Networks:

Chapter IV: Fundamentals of Run Time, Dynamic Network Control Systems and Limitations

Chapter V: Adaptive Automation and Test Design Patterns

Chapter VI: Various Testing Tools

Chapter VII: Review of Literature

Chapter VIII: Analysis of Data

Chapter IX: Analysis and Design of Adaptive Algorithm

Chapter X: Summary, Conclusion & Recommendations

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Signature of the Candidate with Date

Outline Approved

Name & signature of supervisor with date & seal