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Design and Implementation of Multimedia Content on Smartphone for Learning Automata Theory

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Abstract

Alternative methods of learning that will provide an avenue for students to construct knowledge independently has become the yearning of all and sundry. Computers are revolutionizing the educational institutions as well as the industries. Above all, one aspect of computer i.e multimedia capability has made them to be referred to as the harbinger of success. Multimedia systems offer flexible, robust and all encompassing learning experience. Combination of both multimedia and traditional form of learning will go a long way in improving the quality of learning in our society. This research work deals with the analysis, design and implementation of multimedia content on Smartphone or Android platform in particular for learning Automata Theory. The system is easy to use with a rich user friendly interface.It allow users to design an automaton and also simulate the behavior of the automaton to see whether it accepts or rejects an input string.Among the contribution of this work is the use of an existing technologies to improve learning, increase material retention and encourage active participation of students.It also meet the active learning preferences of engineering and science students. In order to ascertain the effectiveness of the system to serve as learning system and evaluation is carried out and a questionnaire is issued to the students. The result shows a great acceptance of the content by the students community. Due to the flexibility and modular nature of the system, it can support several courses.

Dedication

To my lovely fiancée (Khadijah) who stood by me through thick and thin.

Acknowledgement

All praise is due to Allah the lord of the worlds. I seek his blessing upon the noble prophet (S.A.W).
I will like to seize this opportunity to express my profound gratitude and deep regards to my guide Mohamed Hamada for his exemplary guidance, monitoring and constant encouragement throughout the course of this thesis.The blessing, help and guidance given by him time to time shall carry me a long way in the journey of life on which I am about to embark. A great thank you to my amiable instructors: Mamadou Kaba Traore, Kola Babalola, Lehel Csato, Olukotun for their unrelenting support. I would like to thank Nafisa Abdullahi who serves to be a sister, friend, and an advisor for her kind support through out my stay in AUST.
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Thank you all.

Yusuf Sahabi Ali.

CHAPTER 1

Introduction

This chapter gives a brief background of the research work at hand. It states the aims and objectives of the work, research questions and expected contributions.The structure of the work is presented here.

1.1 Background

Information technology has now become the driving force in every aspect of human life. Now and then, new technologies are are emerging and changing the way we carry out our daily activities. One area in particular that is at the point of transformation or revolution is the educational sector. Emphasis are shifting from a dependent learning to a more realistic form of learning which is the independent learning. The idea of life long learning come to being in other for the society to move with the pace of global age.

Governments all over the world are clamoring for mass participation in education with the slogan "No child should be left behind". Recent studies reveals that all is well with the clarion call as many are now part of the educational system at different levels. But one thing is left to be desired, the quality of education. All the reforms are targeted on mass participation.Thus, increasing the number of students per class, hence making the instructors less productive. The question then, can advances in information and communication technologies (ICT) and related areas such as multimedia, etc, improve the quality of learning. A multimedia refers to any computer-mediated software or interactive applications that integrate texts, color, graphical images, animations, audio sound and full motion video in a single application. Multimedia learning system consist of animation and narration which offer a potential venue for improving student understanding [2].

According to [1], “people can learn more deeply from word and pictures than from words alone”. By “words” mayer means either text or spoken words, and by “pictures” he means illustrations, photos, animations or videos. In spite of all this benefit attached to multimedia learning systems most designers tend to forget the learning principles that are involved in the design. Thus, they are carried away by the technology driven idea than pedagogy.

The Multimedia system we are developing takes care of most if not all of the problems of the traditional learning method and also takes into consideration the pedagogical principles. Thus, providing the missing ingredient in almost all educational reforms “improving quality”.

The principles of learning theories consists of many approaches or ways to explain how people learn. They provide enough knowledge to enable critical examination of the use of computer as a learning tool. The spectrum extremes of the learning theories consist of the behaviorists’ and constructivists’ studies. The behaviorism, as a learning approach, is usually referred to as a change in behavior. The main stress of the behaviorism is put on the perceptive learning indicators. Constructivism is recognized as a unique learning theory. As a learning theory, it focuses on the student’s ability to mentally construct the significance of his environment and to create his own learning. The teacher act as a facilitator who encourages students to discover principles for themselves and to construct knowledge by working to solve realistic problems [4].

Learning science research reveals that science and engineering students are more of active and sensing learners, and engineering educators are recognizing the need for more active and collaborative learning pedagogy [5]. By active learners we mean those that learn through practice i.e by doing. Also, sensing learners tend to learn through their senses.

In this regard, we realize that the traditional method of teaching i.e face-to-face does not favor or motivate students with active learning preferences as most of their courses are abstract in nature. Therefore, in our design we adopt the constructivist approach of learning theory [4]. This approach has a number of basic design principles which include :

- Teachers act as facilitators not as knowledge transmitters. This means knowledge must be actively constructed by learners, not passively transmitted by teachers.
- To motivate learners and get them actively involved in knowledge construction, learning activities should focus on a set of motivating problems and examples that have application in real world.
- Learning should take place in a collaborative environment.
- Assessment procedures should be embedded in the learning process and should consider learners' individual orientation.

The concepts of the theory of automata has an important use in designing and analyzing computational models of several software and hardware applications [3]. These concepts are abstract in nature and hence used to be taught by a traditional lecture-driven style, which is suitable for learners with reflective preferences. Since computer engineering learners tend to have strong active preferences, a lecture-driven style is less motivating for them [3]. The system designed will tackle this issue and meet the need for those with active learning preferences . The system can also be used in collaboration with other forms of learning which will effectively increase students retention and motivation. Hence, the idea of blended learning. The system takes care of various topics in the theory of automata which include Deterministic automata, Non deterministic automata, Regular expressions, Automat conversions,e.t.c . The topics will be implemented in the java language and integrated in android Smartphones.

Most of the applications developed for learning theory of automata are desktop based. For example The system developed in [3] is meant to run on a desktop. In [7] students are confined to their desktop computers for the entire learning process. Also in [6] the student can get carried away by the idea of saying "I am just playing a game" which would ultimately defeat the aim of the tool. This research therefore tend to leverage on the pervasiveness of android smartphones and their varieties to capture the minds of students to learn with these devices. To show the effectiveness of our system as a model of collaborative learning tool, several classroom experiments were carried out. The preliminary results of these experiments showed that using our environment not only improved the learners' performance but also improved their motivation to actively participate in the learning process of the related subjects and seek more knowledge on their own.

1.2 Aims and Objectives

This Thesis work is put forward to provide solutions to the problems associated to the traditional method of learning and to improve the design strategies employed for multimedia systems in general and for Theory of Automata in particular. The choice of this topic is as a result of its importance in the scientific arena. The theory of automata has so much significance in both the hardware and software world. The course is also abstract by its nature especially when thought in the traditional method. The idea of providing a multimedia system for the theory of automata will have a far reaching audience than any form of learning because of the creative and effective way of communicating information. Also due to the active learning preference of those in the science and engineering field the need for an interactive and collaborative learning system is much desired. The involvement of the student in learning process help them to construct knowledge. The system can be used for active and collaborative learning not just for automata theory but can also be implemented for other related courses . It focuses on the following issues:

- Detailed literature study of "state of the art" in learning systems for science education and theory of automata in particular.
- Brief background on the usage of computers in automata instruction.
- Problems associated with the design of a Multimedia Learning System for automata theory.

- Proposal of a better Multimedia Learning System for Autamata theory.

1.3 Motivation

The motivational factor to this research work are as outlined below:

- The growing market of smartphone.
- Abstract nature of the course.
- Desire for learning to be carried out everywhere.
- Need for improving students motivation to learn difficult courses.
- Growing need for active and collaborative participation by students in the learning processes.

1.4 Research Questions

- What is the best possible approach for addressing teaching and learning problems ?
- How do we improve the quality of education at all levels ?
- What do we want the students to learn ?
- How can students be motivated to study an important and difficult aspect of computing like Theory of Automata.
- How do we inspire the students to learn in an independent manner ?
- What learning theory would be applied ?
- What is the implications of using a learning system ?

1.5 Methodolgy

The research methodology applied in this work is to first carry out a literature review of related materials in order not to re-invent the wheel. A viable platform (Android) is chosen for the development of the system on smartphones. The learning preferences of the students is taking into consideration during the design phase. Finally, an evaluation is carried out using a questionnaire from a sample population in African University of Science and Technology, Abuja and Ahmadu Bello University Zaria to ascertain the viability of the system as a learning tool.

1.6 Expected Contribution

This research work is expected to make the following contributions to the body knowledge;

- Motivate students to study abstract courses like theory of Automata.
- A new approach to computer-based learning within an active and collaborative instruction-led process.
- Motivate students to learn independently according to their own learning preferences.
- Provide solution to the absence of professional instructors.
- Bridge the educational gap between the privileged and the less privileged.
- Improve the quality of education.

1.7 Thesis Structure

Chapter 2

Gives a brief background of the Theory of Automata, the use of technologies in automata instruction and the motivation for choosing to develop a Multimedia Learning System for the Theory of automata.

Chapter 3

Describe the problems associated with the design of Multimedia Learning Systems for Theory of automata as well as a detailed analysis of the previous proposals to answering the research problem discussed in this thesis.

Chapter 4

Presents our proposed solution to the problem stated in Chapter 3 coupled with the design principles employed, their implementation, and results. Also contains a detailed description of our Integrated Environment and its various components.

Chapter 5

Finishes up with conclusions, summary of contributions, difficulties encountered and future research.

CHAPTER 2

Brief Review of the state of Automata Theory

In this chapter, we give a detailed explanation of the theory of automata i.e looking at the teaching styles, ICT contribution, its applications,etc. The motivating factor for this research work is also given.

We will be ill-advised to go through the research work without giving an X-ray of the Theory of automata. Giving full details of the course is beyond the scope of this research work. But a good segment of the course would be covered in this research work.

2.1 Background

In theoretical computer science, automata theory is the study of mathematical objects called abstract machines or automata and the computational problems that can be solved using them. Automata come from the Greek word $\alpha\vartheta\tau o\mu\alpha\tau\alpha$ meaning "self-acting or acting of one's own will". The figure below illustrates a finite state machine or automaton, which belongs to one well-known variety of automatons. This automaton consists of states (represented in the figure by circles), and transitions (represented by arrows). As the automaton sees a symbol of input, it makes a transition (or jump) to another state, according to its transition function (which takes the current state and the recent symbol as its inputs) [8].

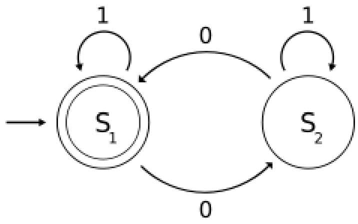

Figure 2.1: finite state machine

Automata theory is also closely related to formal language theory. An automaton is a finite representation of a formal language that may be an infinite set. Automata are often classified by the class of formal languages they are able to recognize. They are used in compiler design, parsing and formal verification [8].

An automaton is represented formally by a 5-tuple (Q, $\sum$, δ, q_0, F), where:

- Q is a finite set of states.
- $\sum$ is a finite set of symbols, called the alphabet of the automaton.
- δ is the transition function, that is, δ: Q $\times \sum \rightarrow$ Q.
- q $_0$ is the start state, that is, the state of the automaton before any input has been processed, where $q_0 \in$ Q.
- F is a set of states of Q (i.e. F $\subseteq$ Q) called accept states.

Finite state machines or automata are divided into three classes based on their transition function. They are as depicted in the diagram below.

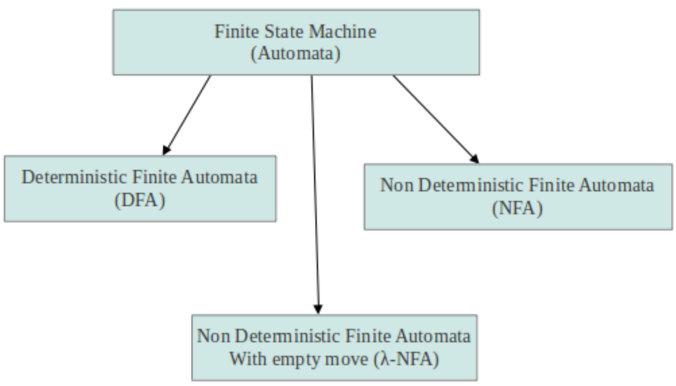

Figure 2.2: Types of finite state machine

Deterministic Finite Automata (DFA)

For a given current state and an input symbol, if an automaton can only jump to one and only one state then it is said to be deterministic automaton. The diagram below shows a deterministic automaton.

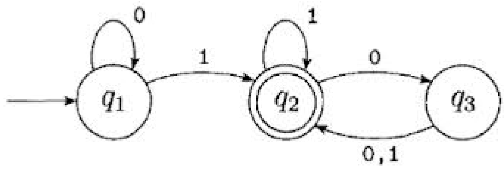

Figure 2.3: Deterministic finite automaton

Non Deterministic Finite Automata (NFA)

An NFA, similar to a DFA, consumes a string of input symbols. For each input symbol it transitions to a new state until all input symbols have been consumed. Unlike a DFA, it is non-deterministic in that, for any input symbol, its next state may be any one of several possible states. Thus, in the formal definition, the next state is an element of the power set of states. This element, itself a set, represents some subset of all possible states to be considered at once [9].

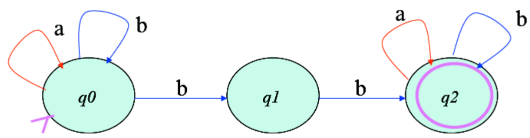

Figure 2.4: Non deterministic finite automaton

Non Deterministic Automata with empty move (λ-NFA)

A λ-NFA, similar to an NFA, consumes a string of input symbols. For each input symbol it transitions to a new state until all input symbols have been consumed. It can also move from one state to another without consuming any string. Unlike a DFA, it is non-deterministic in that, for any input symbol, its next state may be any one of several possible states. Thus, in the formal definition, the next state is an element of the power set of states. This element, itself a set, represents some subset of all possible states to be considered at once.

Regular Expressions (RE)

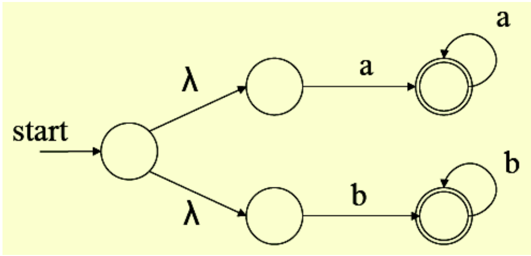

Figure 2.5: Non deterministic finite automaton with empty move (λ-NFA)

Regular expressions were designed to represent regular languages with a mathematical tool, a tool built from a set of primitives and operations. This representation involves a combination of strings of symbols from some alphabet $\sum$, parentheses and the operators $+$, $\times$, and * [10]. But one might ask, what is a regular language? The regular languages are those languages that can be constructed from the "big three" set operations viz., (a) Union (b) Concatenation (c) Kleene star. A regular language is defined as follows [10].

Definition

Let $\sum$ be an alphabet. The class of "regular languages" over $\sum$ is defined inductively as follows: (a) $\emptyset$ is a regular language

(b) For each $\sigma \in$,{ σ } is a regular language

(c) For any natural number n ≥ 2 if L_1, L_2, ...L_n are regular languages, then so is $L_1 \cup L_2 \cup ... ... \cup L_n$.

(d) For any natural number n ≥ 2, if L_1, L_2, ...L_n are regular languages, then so is L_1 o L_2 o ... ... o L_n .

(e) If L is a regular language, then so is L*.

(f) Nothing else is a regular language unless its construction follows from rules (a) to (e).

Examples:

(i) $\emptyset$ is a regular language (by rule (a))

(ii) L = {a, ab } is a language over S = {a, b } because, both {a } and {b } are regular languages by rule (b). By rule (d) it follows that {a } o {b } = { ab } is a regular language. Using rule (c), we see that { a } $\cup$ { ab } = L is a regular language.

(iii) The language over the alphabet {0,1 } where strings contain an even number of 0's can be constructed by (1*((01*)(01*))*) or simply 1*(01* 01*)*.

Any automaton can be converted from one form to another as depicted by fig. 6 below.

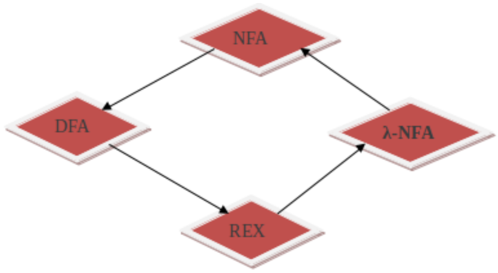

Figure 2.6: Automata conversions

Instructors are facing a great deal of challenge in teaching theoretical courses to students as most students would prefer to have a visual representation of most concepts. Theory of automata falls into such category.

The method employed in teaching automata theory in our institutions left so much to be desired as students have different learning preference. This old method or traditional method of teaching does not take into cognizance the differences in the learning preferences of individuals as all students are judged as having common learning style. There are five different learning styles or preferences for which educators need to be aware of, and these are:

- Active versus Reflective learners.
- Sensing versus Intuitive learners.
- Visual versus Auditory learners.
- Sequential versus Global learners.
- Inductive versus Deductive learners

These learning styles play a significant role in the performance of students. This is because students with visual learning preference would find it difficult to cope with a class meant for auditory learners and vice versa. This information may sound trivial but has a great impact on learning outcomes.

Science students are known to favor Kinaesthetic/active learning style [11].

The traditional form of teaching accompanied with the abstract nature of some courses poses a great deal of challenge to the students as only the brightest among the bright students were able to scale through in terms of knowledge gained and grades. Most of the students lost their drive and motivation thereby making the course more challenging. This leads to many students dropping out of the course or worst of all changing their major in its entirety. Providing visual content has been a great challenge for the instructors.

2.2 Use of ICT facilities in teaching Automata Theory

In the wake of 1981, a group of pioneers [12] announced that: ”We are at the onset of a major revolution in education, a revolution of the printing press. The computer will be the instrument of this revolution...By year 2000, the major way of learning at all levels in almost all subject areas will be through the interactive use of computers“. This statement may sound like a fiction but it is already on its way to becoming reality. There seems to be many hurdles on the way, but for the optimist, there is a sign of light at the end of the tunnel as personal computers (PC) are becoming cheaper and cheaper as time goes by.

The pervasiveness of the PC has given rise to many software tools developed to aid in teaching, learning and research. Open Courseware is now fully integrated into the teaching of various courses such as Automata theory. These online courses are gradually becoming part and parcel of the new educational paradigm which is shaping the 21st century.

Also, software tools purposely developed for the teaching of automata theory includes; JFLAP, VAS TAGS, Turing's world. All these tools will be discussed in details in later chapters.

2.3 Some Applications of Automata Theory

Each model in automata theory plays important roles in several applied areas. Finite automata are used in text processing (stringology) like pattern matching to determine the occurrence of one string. For example the backward DAWG uses a finite automaton called Directed Acyclic Word Graph. Also in compilers design, finite automata are used to capture the logic of lexical analysis [18]. It is also used in hardware design [1]. Context-free grammars (CFGs) are used in programming languages and artificial intelligence. Originally, CFGs were used in the study of the human languages. Cellular automata are used in the field of biology, the most common example being John Conway's Game if Life. Some other examples which could be explained using automata theory in biology include mollusk and pine cones growth and pigmentation patterns. Going further, a theory suggesting that the whole universe is computed by some sort of a discrete automaton is advocated by some scientists. The idea originated in the work of Konrad Zuse, and was popularized in America by Edward Fredkin [8].

2.4 Some Automata Simulators

Automata simulators are pedagogical tools used to teach, learn and research automata theory. An automata simulator takes as input the description of an automaton and then simulates its working for an arbitrary input string. The description of the automaton can be entered in several ways. An automaton can be defined in a symbolic language or its specification may be entered in a predesigned form or its transition diagram may be drawn by clicking and dragging the mouse. Well known automata simulators include Turing's World, JFLAP, VAS, TAGS and SimStudio [8].

2.5 Motivation for Developing Multimedia Content on Smartphone for learning Automata Theory

2.5.1 Abstract Nature of the Course

One of the greatest motivating factors that led to the development of this content for the system is the nature of the course as it is considered a theoretical and hence difficult to understand. It is a well known fact that students prefer having courses taught with a visual illustration of concepts. This idea gives them (students) a sense of participation and reduces the abstract nature of the courses to the barest minimum. We try to visualize the concepts in the course for students and instructors alike to foster learning and also increase retention and motivation. The simulation carried out by the students will help them in grasping the idea in a concrete way.

2.5.2 Pervasiveness of Mobile Devices

Also the choice of android as a platform is as a result of the pervasiveness of the mobile device all over the globe. Students tend to spend more on Smartphone nowadays that on their books. Figure 7 [13] below shows the rate at which mobile devices are championing the global market.

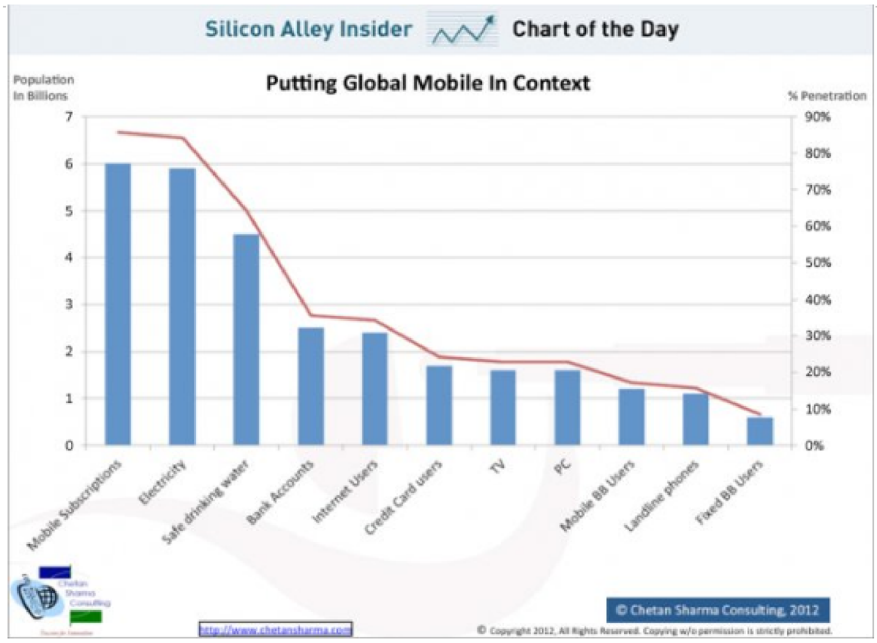

Figure 2.7: Mobile market

From figure 7, it can be seen that more people have mobile phones subscription than Electricity and Drinking water. The decision to choose mobile phone is not a far fetched idea. Therefore, we decided to use that as an opportunity to drive home our goal of motivating students to learn in the comfort of their homes. They also tend to learn anywhere, everywhere, and all the time.

2.5.3 Active Learning Preference of Science Students

Science students favour active learning because it gives them the chance to interact and work on problems independently. As opposed to the all traditional method where the students are reduced to mere robot waiting for inputs from the master. They only regurgitate on what they are spoon fed with. This greatly affects the performance of students as well as their motivation.

CHAPTER 3

State of the art of learning systems in general and automata theory in particular

In this chapter, a literature review is carried out in almost all aspect automata theory which include, teaching style, available simulators etc. We also looked at factors affecting the adoption of multimedia learning systems.

3.1 State of the art of learning systems in general and automata theory in particular

The onset of the computer revolution has ushered in a lot of changes in the way teaching and learning began to be carried out in the classroom. It brought about a change in the curricular of many Institutions of learning and the introduction of various technologies to aid in the dissemination of knowledge. This change in curricular and methods of dissemination of knowledge coupled with technological advances resulted in the creation of specialized kinds of instruction vehicles or knowledge portals called Integrated Learning Systems (ILS) used for educational purposes [7].

Visualization and collaboration are valuable active learning techniques that can improve mastery of difficult concepts. In almost all institutions students have utmost fear for theoretical courses. Most of them go through those courses and narrowly pass them with little understanding of the concept which will later come back to haunt them. One of those courses is the Theory of Automata. The course is based on sound theory and as such very difficult and abstract to students because they cannot easily visualize the concept put forward to them. As a result of this, many learning systems have been developed to minimize the complexity or steepness of the learning curve. But some of which suffer from one or more flaws that makes them less than ideal as learning tools, particularly for less advanced students. Almost all of them have been designed for advance students, under the assumption that the students have already grasped the basic concepts.

Integrated learning systems which have now become popularly known as Virtual Learning Environments began to come to the surface. These systems combined multimedia, hypermedia (in which graphics, audio, video, plain text and hyperlinks intertwine to create a generally non-linear medium of information), and also simulators into one integrated system which made provision for active and collaborative learning. From its inception, one of the aims of the World Wide Web was to open up access to information and break down the barriers between content creators and content consumers. Hypermedia can be contrasted with the much broader term, multimedia in that it takes a rather non-linear approach to the presentation of information whereas multimedia is a descriptive term for non-interactive linear presentations as well as hypermedia. With the changes that began to take place within the classroom environment at the onset of the computer revolution, some teachers began to enhance the learning experience of their students by providing not only "face-to-face" sessions within allotted periods to scheduled groups but also made available their course notes on personalized static WebPages which could be accessed by the students from any computer as long as they had an Internet connection [7].

Assignments and tutorials were also added to these personalized WebPages to be done by the students and returned when they were due.

Advocates for the use of hypermedia in enhancing the learning process justified their view point with the fact that the human brain processes information by free association in an intrinsically non-linear way [14].

For example the Open Courseware Consortium [15] is a community of over 250 universities and associated organizations worldwide committed to advancing Open Courseware sharing and its impact on global educational opportunity. Open Courseware is just another name for materials on virtual learning environment. Videos and other lecture materials are made available online for all and sundry. These gestures by the community tend to free up necessary materials for students and instructors alike to further research activities. It also eliminates the geographical barriers that hinder collaborative research and learning. Distance learning is also made possible as students from all parts of the globe can have access to materials and also register for courses. At the end of the day, a certificate will be issued to such student. The Open Courseware is fast becoming an avenue for students to test their skills and improve their knowledge at all level. The only issue is that students are not given the chance to actively participate. They only have to listen all day long for the instructor. As a result of some of these flaws learning systems are coming into the fore to tackle these problems.

Various learning tools were developed to increase student motivation towards learning abstract courses like the theory of automata.
For example in [16], Chuda used a Learning management system (LMS) Moodle to incorporate animations that visualize concrete examples of models such as finite automata, pushdown automata, Turing machine. The design is meant to simulate the behaviour of automaton with given inputs. The system provides visual display of the series of operations in automata theory with the use of graphical user interface.

In [14] a learning system for Chinese characters on Smartphone was developed to give foreign individuals and local students the opportunity to learn how to write Chinese characters. Learning how to write Chinese character is a difficult task but pronunciation is the most difficult. The system caters for both speaking and the writing of the characters which improve the students writing as well as pronunciation. The system has given room for international students to practice and learn Chinese without the help of an instructor.

In [17] JFLAP is developed, which is rich software for experimenting with formal language topics including non deterministic finite automata, non deterministic pushdown automata, multi-tape Turing machines etc. This software allows for the conversion of automata from one form to the other. It is said in the website that JFLAP aid in learning the basic concepts of Formal languages and Automata theory. States of automata are drawn using drag and drop and connected using the lines provided. Inputs are inserted to the designed automata to test for acceptance or rejection.
There is also jFAST (Java Finite Automata Simulation Tool) [18], a graphical software tool with an emphasis on introductory level finite state machine topics. It is designed to be a complementary alternative to the more advanced and widely used JFLAP tool developed at Duke University [19, 20]. The jFAST software enables teachers to create simple or complex FSMs that could then be displayed to students via a classroom projector. jFAST also allows teachers to distribute FSMs to students via email, with students then able to actively learn through hands-on manipulation and visual simulation. Students can create their own FSMs using the familiar and intuitive drag-and-drop graphical user interface conventions of modern computing.

Mohamed Hamada's environment [3] integrates a set of visual tools to support interactive and collaborative learning in the theory of computation course. This environment provides a single interface, web-based, all-in-one, stand-alone application based on Java 2D technology of Sun Microsystems [21] which can be adapted for similar courses.
In [22] the Turing's World allows users to build, debug and run sophisticated Turing machines in a graphical environment. This system does not look all good especially for novice students because it assumes some level of experience.

Also, in TAGS [13] a software tool for teaching different aspect of transducer automata theory. TAGS allow simulation of both Moores and Mealy transducer automata. The student can define an arbitrary transducer automaton in an interactive way, being able to simulate and trace its behaviour by means of different view.

Awodele O. et al [8] studied the integration of e-learning in the Nigerian Education System. In their work, they proposed a web-based system called CITADEL e-learning system based on HTML, ADOBE FIREWORKS, PHP, JAVASCRIPT and MySQL. The proposed system provides functionality that caters for visual, sensing and active learning preference types. Courses from any discipline can be implemented on the platform by the lecturer as well as student and course progress monitored from a standard administrative report.

Also due to the importance of virtual reality, heavy 3D immersive Microworlds have been developed [25] as a means of providing enhanced social interaction amongst learners which is essential in the learning process. In these Microworlds (which are basically 3D VLEs), the presence of learners by proxy is made possible through avatars which are controlled in real-time by the learners. These environments are equipped with tools such as whiteboards for internal group discussions as well as chats and other means of communication. Common place technologies such as Java 3D and VRML (Virtual Reality Mark-up Language) are used in the development process.

Rodger [26] has shown that teachers can use this tools: during lecture, the instructor can use a computer to demonstrate how to use the tools, and to solve problems with input from the class; students can use the tools in labs or to work on assignments, and those students who want more practice can use the tools to reproduce examples illustrated in lecture or to create their own examples, receiving immediate feedback.

Critical factor of using visualization is motivation. The e-learning equation [26] can be given as:

$$E = m^2c$$

where m is motivation, c is content, and E is e-learning outcomes. When we are motivated, the tendency to learn increases and this greatly improve student performance. Motivated by these works and most especially Mohamed Hamada's approach, the present study proposes a Multimedia Content on Smartphone for learning Automata Theory. The proposed system is designed to tackle the problems associated with the systems presented in this section as well provide sufficient motivation for students. The related works presented above will be analyzed in the following Chapter of this work and the problem statement justified.

3.2 Some problems of Related work

The Open Courseware discussed in section 3.1 requires the users to register before accessing the lectures, video and other materials. The students can only listen to the lectures without participating actively or even passively in the learning process. Also, lack of adequate internet facilities in most developing countries tends to hinder the progress of this giant repository of information which would immensely in the areas of research and learning.

In JFLAP [17] certain level of the knowledge or mastery of automata theory is required for the user to take full advantage of the system. It is advanced software compared to most of the other software. It does not provide a good user interface for displaying and simulating the automaton. This limits the systems efficiency as the novice has no chance to take advantage of the system.

In jFAST [18] the interface used for the process gets cumbersome as the automaton gets large. The design and simulation interface is not user friendly. The menu bar attached to the simulation interface is not descriptive.

TAGS [23] is the most difficult to use compared to the other software as the level of knowledge required is high in order to use the software. The less experienced student finds it very difficult to take full advantage of the software. It is difficult to set up and use. There is also lack of teacher to student guidance which is very necessary in shaping the students ideas in any introductory course in all the software. Also the lack of social interaction when using hypermedia based educational websites is a major problem as it does not favour collaborative learning or Problem-based learning which is present in the classroom environment.

3.3 Justification of research question

From our analysis of the reviewed literature, we see that the importance of our research question cannot be overemphasized. This question still remains unanswered and that is the purpose of this work. Since it is now obvious that we are not re-inventing the wheel, a learning environment which will be easy to use and easy to learn for new users with a clear workflow of learning activities is paramount. This will provide an environment which can be used for automata theory instruction in most schools in Africa, especially in areas where there are no laboratories or the traditional methods of instruction have been maxed out with no significant results. Thus this questions still remains a very important question to be answered. In the next Chapter we will propose our own solution in an attempt to answer this very important question.

3.4 Justification of the use of Android among other platforms

The use of Android in this research work is not a far fetched idea. This is because the samrtphone market is being dominated by android and also an open source. Android and apple's iOS continued their dominance of the smartphone market in the first quarter of 2013, accounting for combined 92.3% of all smartphone shipments. But of the two, it was google's android that capture the most of the market [34].

According to market analyst group IDC, 162 million android handsets were shipped in Q1 compared to 90.3 million units shipped in the same quarter last year [34]. From the above explanation, it can be said that, we will be ill-advised to choose any other platform apart from android. The diagram below also shows the dominance of android over other platforms.

Operating system	1Q13 Shipment volume	1Q13 Market Share	1Q12 Shipment volume	1Q12 Market Share	Year over Year Change
Android	162.1	75.0%	90.3	59.1%	79.5%
iOS	37.4	17.3%	35.1	23.0%	6.6%
Windows Phone	7.0	3.2%	3.0	2.0%	133.3%
BlackBerry OS	6.3	2.9%	9.7	6.4%	-35.1%
Linux	2.1	1.0%	3.6	2.4%	-41.7%
Symbian	1.2	0.6%	10.4	6.8%	-88.5%
Others	0.1	0.0%	0.6	0.4%	-83.3%
Total	216.2	100.0%	152.7	100.0%	41.6%

Source: IDC Worldwide Quarterly Mobile Phone Tracker, May 2013.

3.5 Issues affecting the use of Multimedia System for Automata

Multimedia is one of the most dynamic industries in the world today. It refers to the use of different types of audiovisual data, or media, in computer applications. These media often referred to as digital media, include images, animations, video clips and sound clips. They are found in complex systems, e.g. computer games, e-Learning systems, medical informatics systems, and systems which model complex phenomena such as traffic flow within an urban area [27].

The use of multimedia in industries has been extensive, as it has been effective in increasing productivity and retention rates, where research has shown that people remember 20 % of what they see, 40 % of what they see and hear, but about 75 % of what they see an

There are several factors affecting the design and usage of multimedia system. Some of which are listed below:

3.5.1 Attitude towards technology

An individual attitude towards an object determines the rate at which that objects would be accepted by that person. Some instructors and students suffer from what is called technophobia. This is referred to as the fear of the use of technology. This fear greatly affects the utilization of ICT in our academic institutions.

3.5.2 Staff Development

Lack of developmental initiative in relation to staff in our institutions. Most instructors are left alone with their self development as the government pays no attention to the plight of the institutions.

3.5.3 Complete shift of paradigm

Most of the fears emanating from the institutions are that instructors will find it very difficult to cope with the development. And as a result they tend to wage a war campaign towards the adoption of multimedia learning in the institutions.

3.5.4 Replacing the former methods of instruction with the computer

A third reason for which critics rejected the use of computers for instruction was the fear that computers would completely replace everything in the current environment such as textbooks, the teacher and the laboratory. These people had seen the representations of this various instruments of learning such as the textbooks in the virtual space could be the content developed in any form, the teacher could be the student who is now in charge of his own learning and the laboratory which could be constructed as virtual labs with simulators which the students could interact with by changing various parameters to get desired results. As a result of this changes taking place the general fear was that the extensive usage of these learning systems would render the former entities redundant or even useless in the new approach. This also created a major divide which had to be taken care of in the design of learning systems for instruction. Instructional software designers had to be wary of the fact that computers were not meant to replace textbooks and neither were they meant to replace the teacher or laboratories. The design models had to clearly capture this so that they could work in sync with each other and not otherwise [7].

3.5.5 Forgetting the students' point of view in favour of designers

Lastly, another major challenge that surrounded the design of Multimedia Learning Systems for instruction was the possibility for instructional software designers to easily forget the students' point of view in favour theirs in the design process. It is true that computers make it possible to approach topics from a perspective different to the traditional approach and certainly much more exciting. Due to the differences in the mental models between the learner and the designer, the propensity for the designer to produce something which may be intellectual engaging to him and a rip off to the student is very high [7].

CHAPTER 4

Paradigm shift: A Multimedia Learning System for Autmata Theory

We looked at the principle of design employed in this work as well as the implementation details of the system in this chapter. A system state diagram is also provided.

4.1 Paradigm shift: A Multimedia Learning System for Autmata Theory

The choice of automata theory as the course for this multimedia system is not a far fetched idea. This is because, as students, it is believed that any course involving abstract concepts are difficult to grasp let alone comprehend the concept.
Also the importance of the subject cannot be overemphasized as it forms a bedrock in the area of computation and software development. Its application in numerous areas of endeavour have given rise to debates on how best to teach the course as so much failure or little understanding is demonstrated by those who took the course. So much thought was giving to this problem, but at the end we realize that the studies of learning preference will help in bringing the best possible solution to our greatest challenge.

Students learn in many ways- by seeing and hearing; reflecting and acting; reasoning logically and intuitively; memorizing and visualizing and drawing analogies and building mathematical models; steadily and in fits and starts. Teaching methods also vary. Some instructors lecture, others demonstrate or discuss; some focus on principles and others on applications; some emphasize memory and others understanding. How much a given student learns in a class is governed in part by that student's native ability and prior preparation but also by the compatibility of his or her learning style and the instructor's teaching style [28].

Mismatches exist between common learning styles of engineering students and traditional teaching styles of engineering instructors. In consequence, students become bored and inattentive in class, do poorly on tests, get discouraged about the courses, the curriculum, and themselves, and in some cases change to other curricula or drop out of school. instructors, confronted by low test grades, unresponsive or hostile classes, poor attendance and dropouts, know something is not working; they may become overly critical of their students (making things even worse) or begin to wonder if they are in the right profession. Most seriously, society loses potentially excellent engineers [28].

We therefore, adopt the Filder and Silverman model in the design of our system. But before we delve further into the design of the system, we will take a brief discussion of the adopted model. It help in the classification of different engineering learners into five categories:

Prefered Learning Style	Corresponding Teaching Style
Sensory Intuitive } perception	Concrete Abstract } content
Visual Auditory } input	Visual Verbal } presentation
Inductive Deductive } organization	Inductive Deductive } organization
Active Reflective } processing	Activetive Passive } student participation
Sequential Global } understanding	Sequential Global } perspective

Figure 4.1: Learning and teaching styles

4.1.1 Active versus Reflective learners

Active learning involves doing something in the external world with the information— discussing it or explaining it or testing it in some way—and reflective observation involves examining and manipulating the information introspectively. An ”active learner“ is someone who feels more comfortable with, or is better at, active experimentation than reflective observation, and conversely for a reflective learner.

4.1.2 Sensing versus Intuitive learners

Sensing involves observing, gathering data through the senses; intuition involves indirect perception by way of the unconscious-speculation, imagination, hunches. Everyone uses both faculties, but most people tend to favor one over the other [28].

Sensors like facts, data, and experimentation; intuitors prefer principles and theories. Sensors like solving problems by standard methods and dislike ”surprises“; intuitors like innovation and dislike repetition [28].

4.1.3 Visual versus Auditory learners

The ways people receive information may be divided into three categories, sometimes referred to as modalities: visual -sights, pictures, diagrams, symbols; auditory - sounds, words; kinesthetic- taste, touch, and smell [28].

Visual learners remember best what they see: pictures, diagrams, flow charts, time lines, films, demonstrations. If something is simply said to them they will probably forget it. Auditory learners remember much of what they hear and more of what they hear and then say. They get a lot out of discussion, prefer verbal explanation to visual demonstration, and learn effectively by explaining things to others [28].

4.1.4 Inductive and Deductive learners

Induction is the natural human learning style. Babies do not come into life with a set of general principles but rather observe the world around them and draw inferences: ”If I throw my bottle and scream loudly, someone eventually shows up.“ Most of what we learn on our own (as opposed to in class) originates in a real situation or problem that needs to be addressed and solved, not in a general principle; deduction may be part of the solution process but it is never the entire process. On the other hand, deduction is the natural human teaching style, at least for technical subjects at the college level. Stating the governing principles and working down to the applications is an efficient and elegant way to organize and present material that is already understood [28].

4.1.5 Sequential versus Global learners

Some students are comfortable with this system; they learn sequentially, mastering the material more or less as it is presented. Others, however, cannot learn in this manner. They learn in fits and starts: they may be lost for days or weeks, unable to solve even the simplest problems or show the most rudimentary understanding, until suddenly they ”get it“-the light bulb flashes, the jigsaw puzzle comes together. They may then understand the material well enough to they apply it to problems that leave most of the sequential learners baffled. These are the global learners. Sequential learners follow linear reasoning processes when solving problems; global learners make intuitive leaps and may be unable to explain how they came up with solutions [28].

A study of the above model revealed that (MEST) learners tend to have strong active, sensing, visual and sequential learning preferences. This in turn help us to build our system towards this preference.

4.2 Design Principles

Several design principles exists and are always applied to various projects. But in this research work the principle of design that we adhered to are as giving below.

4.2.1 Teachers as facilitators not as knowledge transmitters

In the traditional method of learning, teachers are the main focus of the style. They transmit knowledge to the students who sit like pets or robots and consume what ever is handed down to them by the teacher. This teacher -centered approach has a great effect to the learning system. Students are constraint to what the teacher provides. They are not encouraged to carry out their own research and find new solutions to certain problems. This can only be achieved by giving the student some level of participation in the class thereby making self dependent. The teachers only act as facilitators in the new system. In this system the students participate actively in their learning process. They simply learn with their level of motivation increasing at all levels.

4.2.2 Learning must take place in a collaborative environment

It is a general believe that learning is enhanced by collaboration between pairs. Critics of multimedia learning systems believe that, the collaborative ingredient needed in every learning set up is missing. To overcome this obstacle, We adopt the social constructivist approach to learning systems design which hinges on Interactive Engagement. Interactive Engagement is simply a brand name for teaching methods that are designed to promote conceptual understanding through interactive engagement of students in heads-on (always) and hands-on (usually) activities that yield immediate feedback through discussions with peers and/or instructors [7]. According to the Russian Psychologist Lev Vygotsky, for most individuals, learning is most effectively carried out via social interaction [29]. It is for this reason that our design fosters a collaborative environment in which learners can actively engage in the learning process.

4.2.3 Active involvement of learners is key

According to the work of Jean Piaget who proposed the constructivist account of learning in the first half of the 20th Century, science students must engage in active construction of their own extant scientific knowledge [30]. In order to motivate learners and get them actively involved in this knowledge construction, learning activities should be centered on real world problems that inspire learners.

4.2.4 Proper procedures for assessment

An assessment section is provided in the system to ascertain the level of comprehension on the part of the student and also for the instructors to know how to go about facilitating the learning process.

4.2.5 Implementation

The various components of the design were written in java for the android platform or to be more specific, Smartphones. This makes it a useful tool and interactive collaborative environment. The components were designed using android java with the eclipse IDE, while some are presented using HTML. The combination of both worlds help in providing a robust content.

4.3 Detailed description of our MLS content

In this section, we describe fully our MLS content environment designed in this work. Our environment contains six components which have been integrated into a single unit thereby improving the user-experience and also rendering a robust user interface. The components include the following: A video format lecture on the theory of automata, slide presentation for the same topic, hypertext introduction to Automata theory, Automata theory simulators, a help section on the usage of the system, and finally a quiz or self-assessment exercises. Detail discussion of all the components will be provided below:

4.3.1 Main menu or Welcome Screen

This is the first component of the entire system. It serves as the welcome page and also the activity page. There are six different sections embedded in this page.
First, we have the video image/button which is a link to a video lecture on the Theory of Automata with a detail description of the basis and also providing a rich user-experience.

Second, we incorporate a rich power point presentation of the course at hand. Giving the flexibility of learning, we try to provide the user with all encompassing experience within the learning system.

Third, the rich hypertext section is provided under the html option. It allows the users with preference for text only learning to have an option in our system.

Fourth, the simulation section is under the simulation option. It offers the provides the user with hands on and visual experience needed for the learning of the Theory of Automata. Lack of visual experience has been a major set-back in the learning process of such an abstract course. The user is giving a choice to choose either game simulation or normal simulation. Also, we have the help section were the user can see the details of how the system works. This gives a manual-like explanation of the system. Lastly, we have the quiz section where users assimilation will be put to test. This system would not have been a good learning system on the specific course without the evaluation section. Figure 9 below shows the look of the home page.

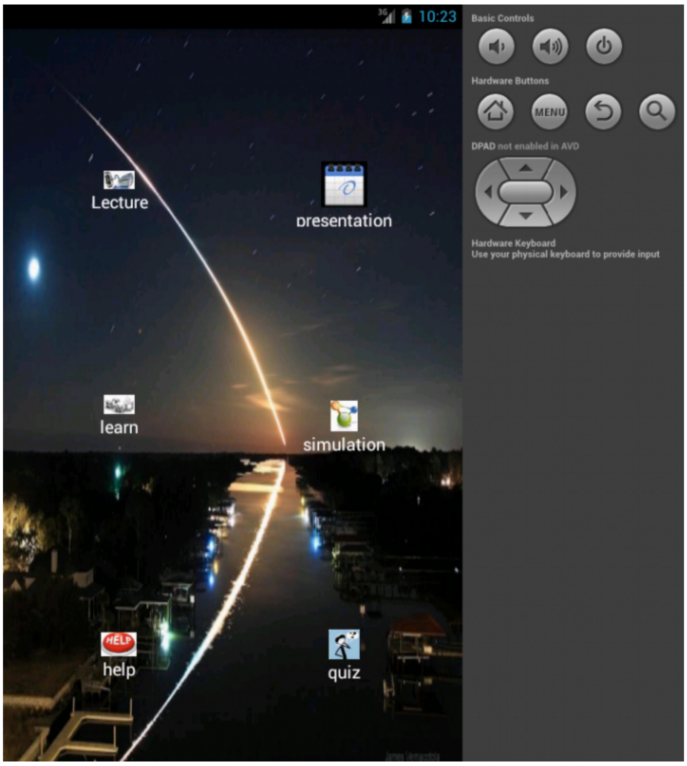

Figure 4.2: Home page

4.3.2 Automata lecture

As briefly discussed about the functionality of the video section. A detailed explanation and the realization is provided here. It presents a video lecture on the theory of automata by reknown scholars. The user is giving full control over the lecture. He can fast-forward, pause, replay e.t.c.This gives the user the opportunity to view lectures from all over the globe within a single system. This will reduce the problem of unqualified instructors in the field. Interactivity is the hallmark of our design. This component provide support for active learners. Figure 10 below shows the look of the video section.

Figure 4.3: Lecture component interface

4.3.3 Powerpoint presentation

In this section the user is provided with a powerpoint presentation for the basics of the course. It gives him the power to navigate through the pool of slides. The slides are a representation of the salient points needed for a proper understanding of the course. This component provide support for sensing and intuitive learners.Figure 11 below shows the look of the power point section.

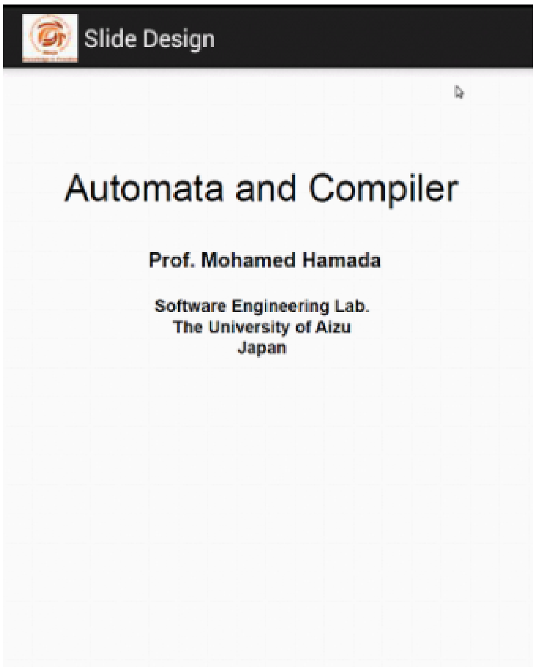

Figure 4.4: Slide presentation

4.3.4 Learn/HTML

The hypertext page is an option provided to fit various learning styles. Making the system student-centered will yield a great result in terms of improvement in performance and retention. Some students prefer a plain written text than power point presentation. Therefore, this system provide the much needed flexibility in the learning style. This component provide support for visual and intuitive learners. Figure 12 below shows a look of the html page:

4.3.5 Simulator

There are four types of simulation format provided by the system. The first one is presented in a game-like fashion where the user will choose a given regular expression and design an

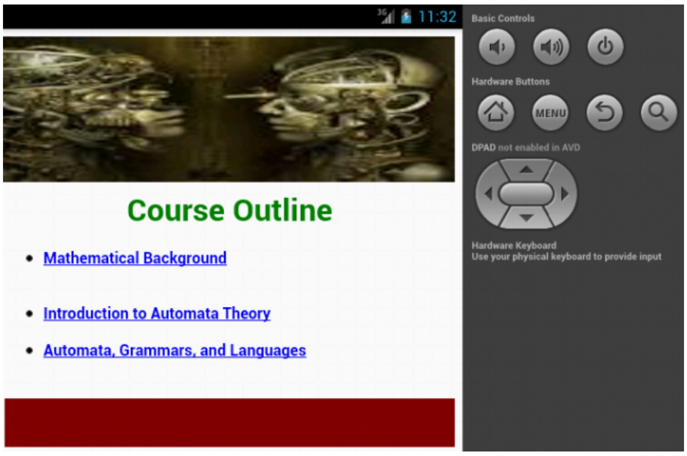

Figure 4.5: Html page

automaton that will accept that language. If he succeeds in the design the system will prompt him with an acceptance message. Otherwise, he receives a rejection message and asked to re-design the automaton. While in the second option, the user will design an automaton and provide some set of input string to test for either acceptance or rejection. The input will either be accepted or rejected based on the string provided by the user. In the third option, the user simulates the behavior of an elevator. The elevator starts in a waiting state. The user enters the elevator and presses the elevator buttons which refers to various floors in the building. Lastly, the final simulation is a syntax analyzer for the word ”then“. If the user enters ”then“ the system will prompt him with acceptance message else he will receive syntax error message. With the simulator in place the user will be able to visualize the design and operation of an automaton. This also improves motivation on the part of the student to learn. This component provide support for active learners.Figures below shows the look of the simulator components.

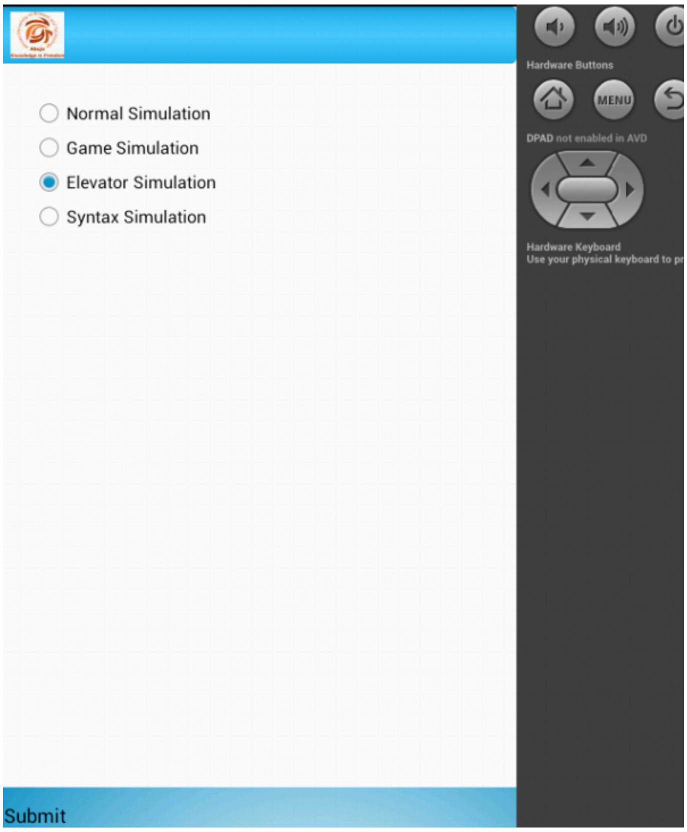

Figure 4.6: Simulation home

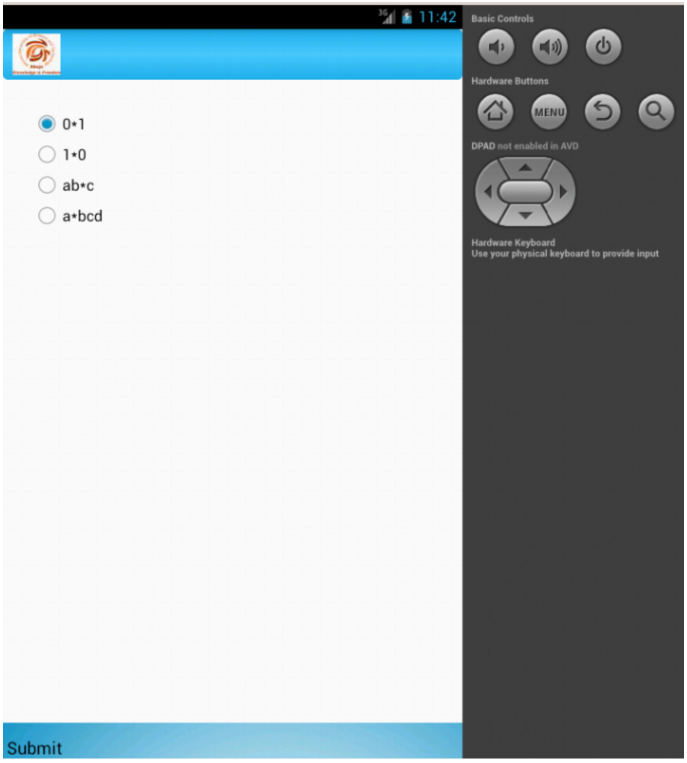

Figure 4.7: Regular expressions

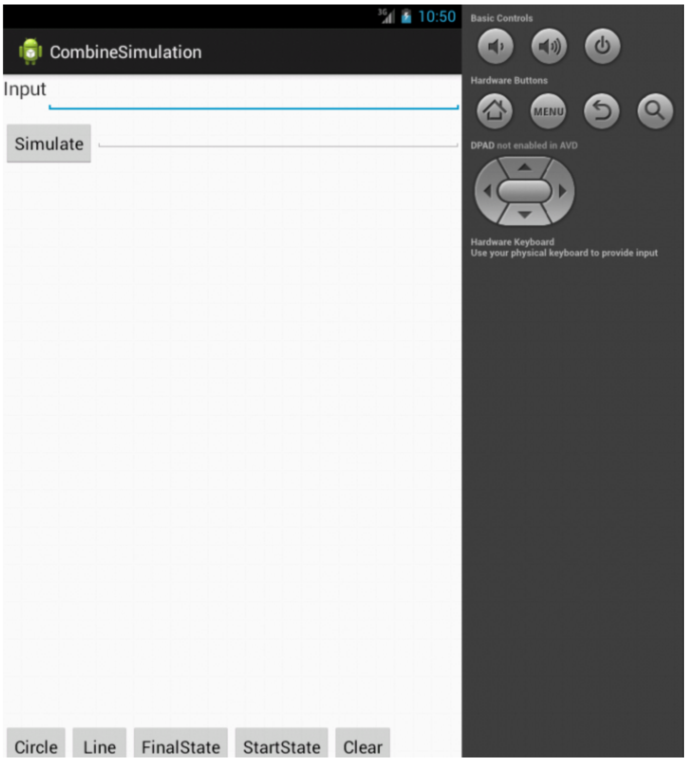

Figure 4.8: Simulation interface

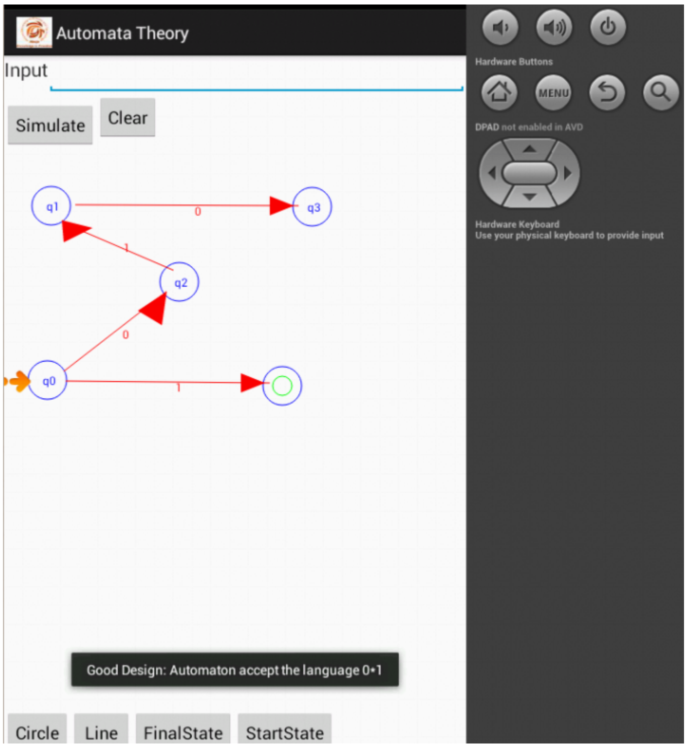

Figure 4.9: Simulation in practice

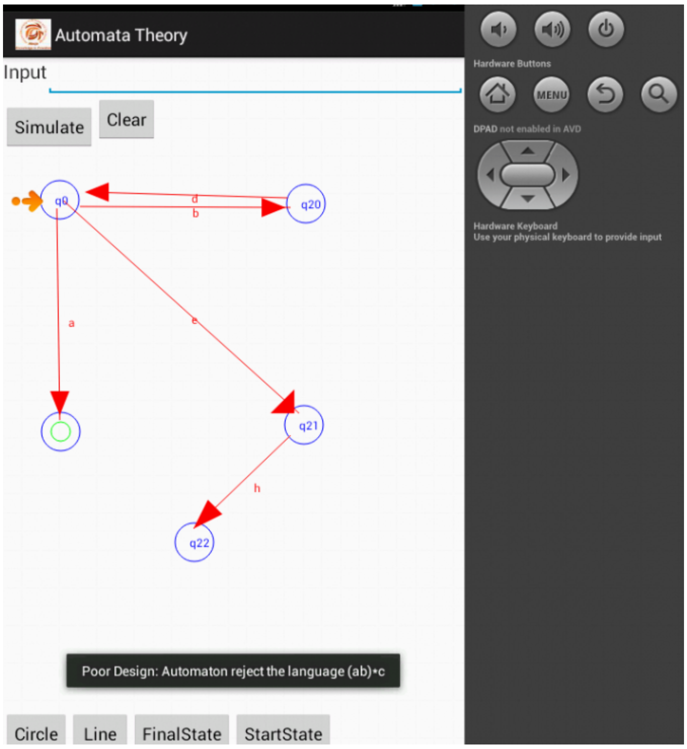

Figure 4.10: Simulation in practice

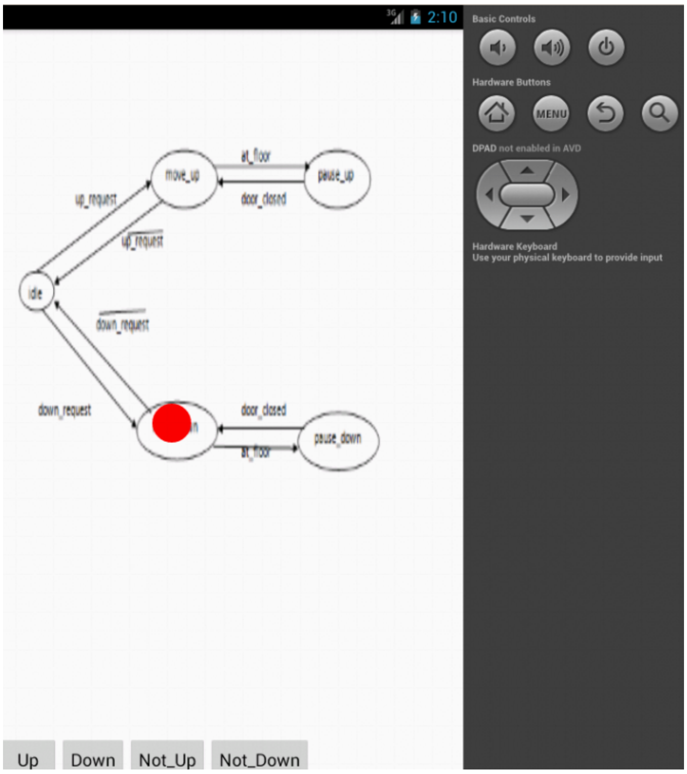

Figure 4.11: Elevator Simulation in practice

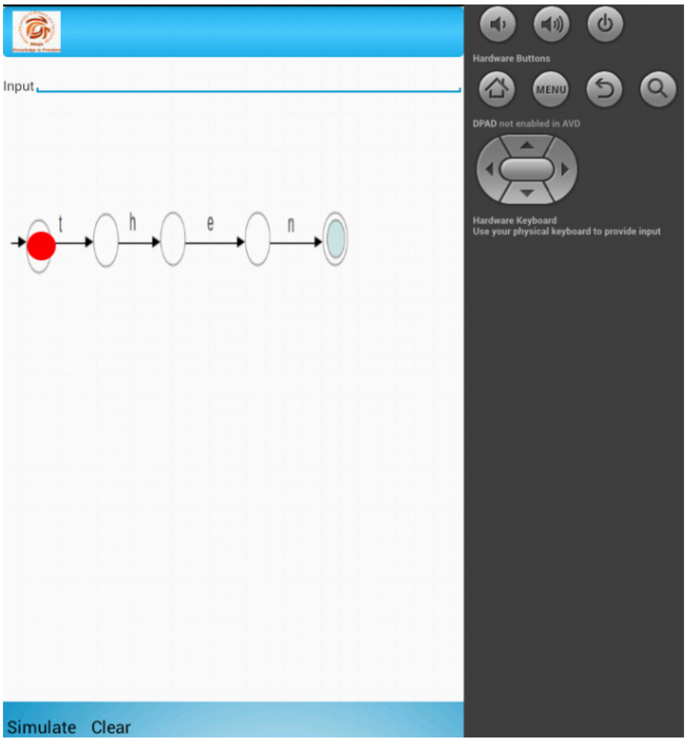

Figure 4.12: Syntax Simulation in practice

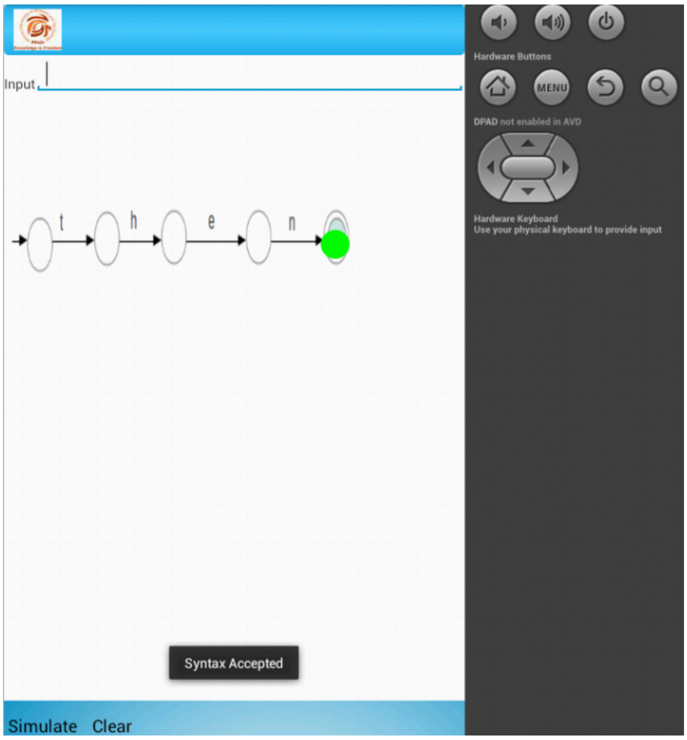

Figure 4.13: Syntax Simulation in practice

4.3.6 Quiz

This is the evaluation section of the system. After all the reading and hands-on activities the student is subjected to a quiz for which he will review his performance. The score of every question is displayed to him at every click on the submit button. The overall score is displayed at the end of the entire quiz. The figures below shows a sample quiz:

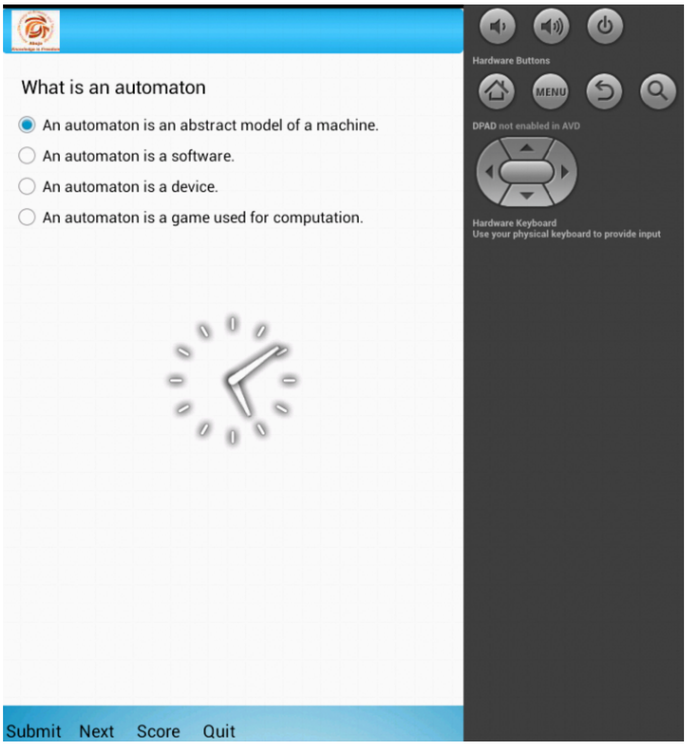

Figure 4.14: Quiz interface

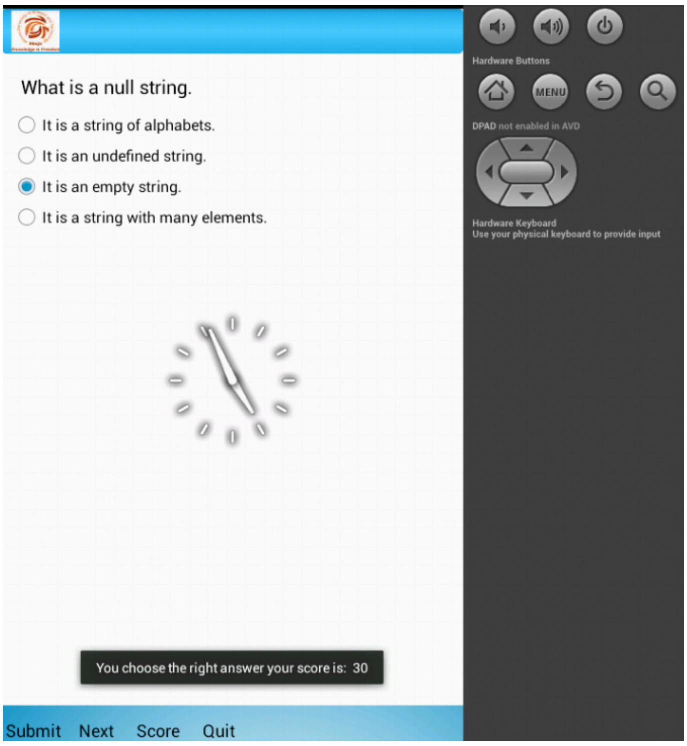

Figure 4.15: Quiz interface

4.3.7 Help

The help section gives the user a details on how the system works. All module descriptions and their operations are given here. The figures below shows the help menu.

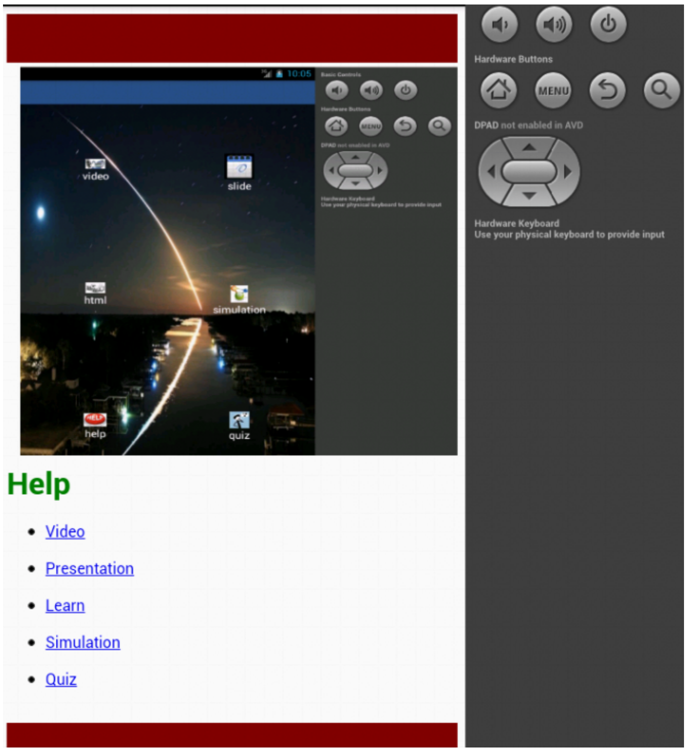

Figure 4.16: Help interface

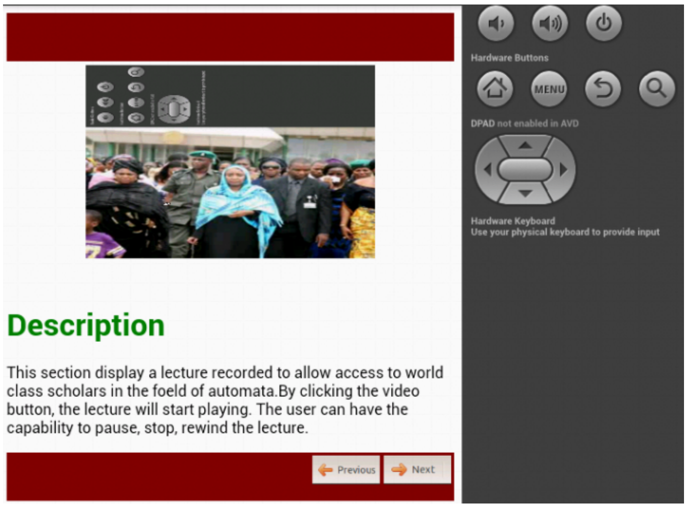

Figure 4.17: Video help

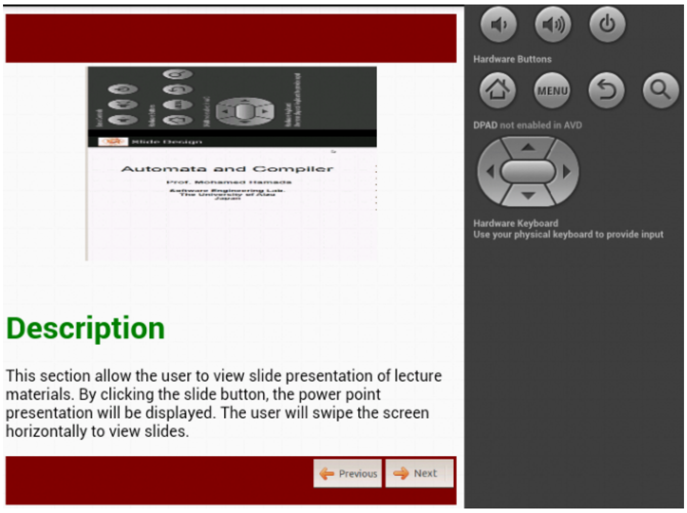

Figure 4.18: Presentation help

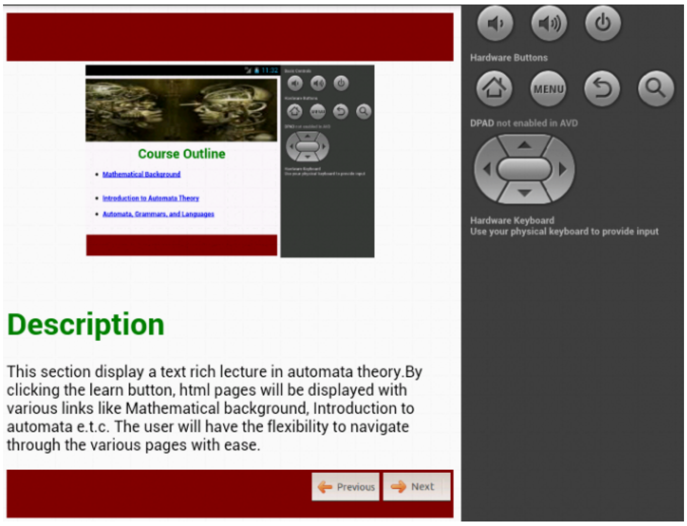

Figure 4.19: Text help

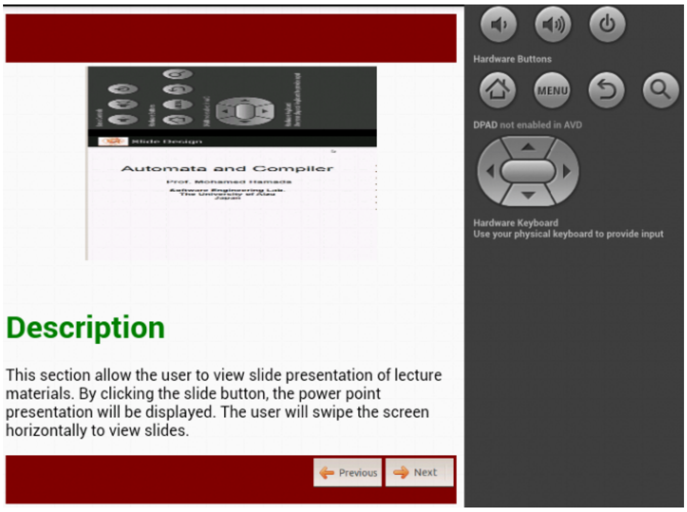

Figure 4.20: Presentation help

4.4 System State Diagram

In this section, we are going to look at the state diagram of the entire system. This will guide us as to the transitions the system encounters in the problem solution. We will start by looking at what a state diagram and other terms are.

A state diagram is a behaviour which specifies the sequence of states an object visits during its lifetime in response to events, together with the responses to those events [31]. An event is the specification of a significant occurrence. For a state machine, an event is the occurrence of stimulus that can trigger a state transition [31].

While a transition is a relationship between two states indicating that an object in the first state will, when a specified set of events and conditions are satisfied, perform certain actions and enter the second state [31]. The Figure below shows the system graphical user interface state diagram.

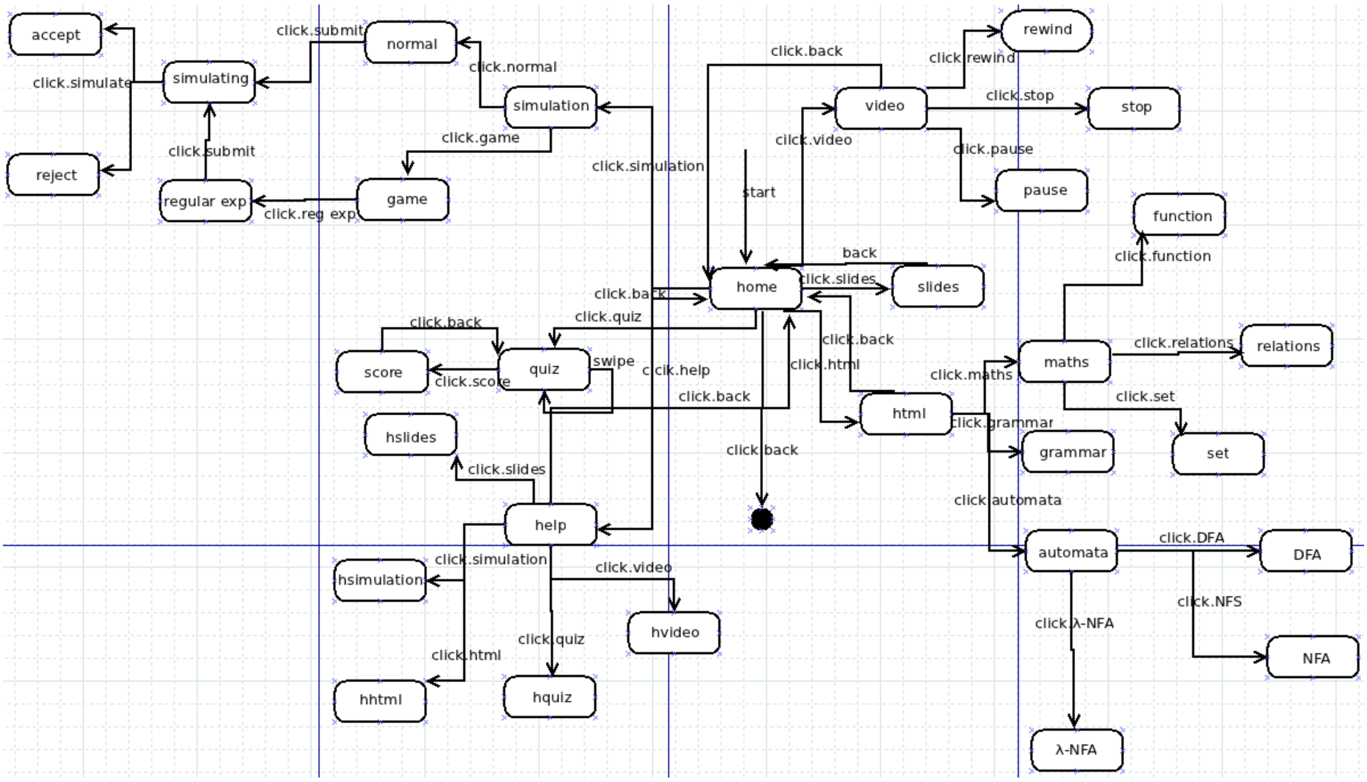

Figure 4.21: System gui state diagram

4.5 Learners Flowchart

A flowchart is a type of diagram that represents an algorithm or process, showing the steps as boxes of various kinds, and their order by connecting them with arrows. Flowcharts are used in analyzing, designing, documenting or managing a process or program in various fields [32].

The figure below shows a learners flowchart.

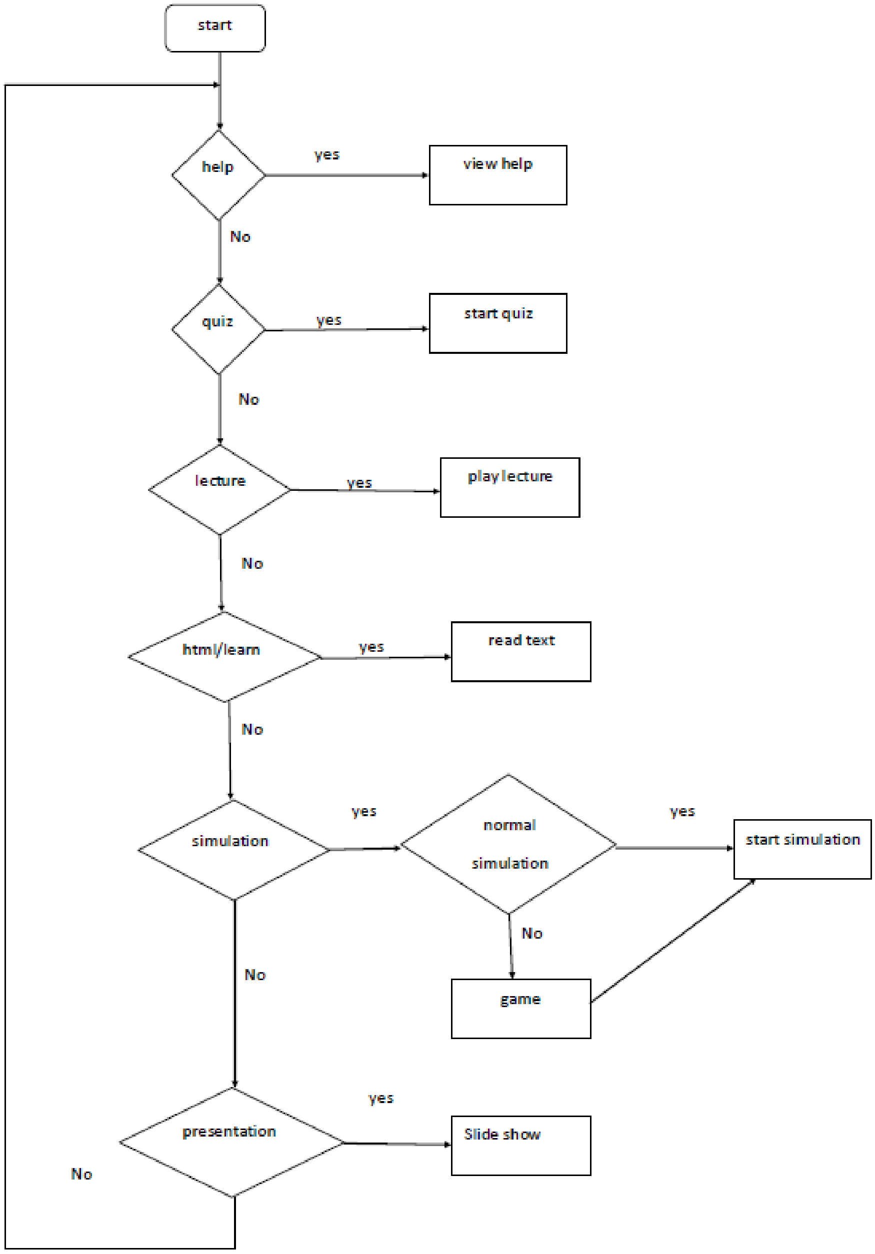

Figure 4.22: learners flowchart

4.6 Evaluation

Questionnaire

In order to ascertain the effectiveness of the content as a learning tool, a questionnaire is developed in this regard. The questionnaire is divided into five sections:

- Demorgraphic characteristics such as age, gender, field of study
- Advantages of multimedia systems .
- User friendliness of the system.
- Effectiveness of the system/content as a learning tool.
- Nature of the course i.e. Automata theory.

From 2-5, they are all measured using five-point likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Reliability of any survey is of paramount importance to every research. We carried out the reliability analysis to remove any bias from the the questions administered in the questionnaire. Some group of computer science students from African University of Science and Technology were sampled out for the pilot test. A total of 10 (N=10) questionnaires were distributed and the results collected. Another sample of students were taken from Ahmadu Bello University (ABU) Zaria for the analysis. A total of 150 (N=150) questionnaires were administered. We received 135 which are considered acceptable and the rest were discarded due to some errors discovered.

An internal consistency ("reliability") analysis were carried out to determine the cronbach alpha coefficient using the Statistical Package for Social Science (SPSS). The cronbach alpha coefficient was measured to be 0.822 for 11 items. It is believed that a cronbach alpha coefficient between 0.8 and 0.9 ($0.8 < \alpha < 0.9$) is a good internal consistency value [33]. This is because it indicates a good internal consistency of the items in the scale.

Results

At the end of the survey, a total of 160 questionnaires were administered. A total of 145 were collected while the rest were discarded due to some problems. A success rate of 90.625% was recorded. We recorded a total of 54.30% of male students and 45.70% of female students of those who filled the questionnaire. The remaining details can be seen from the diagrams below:

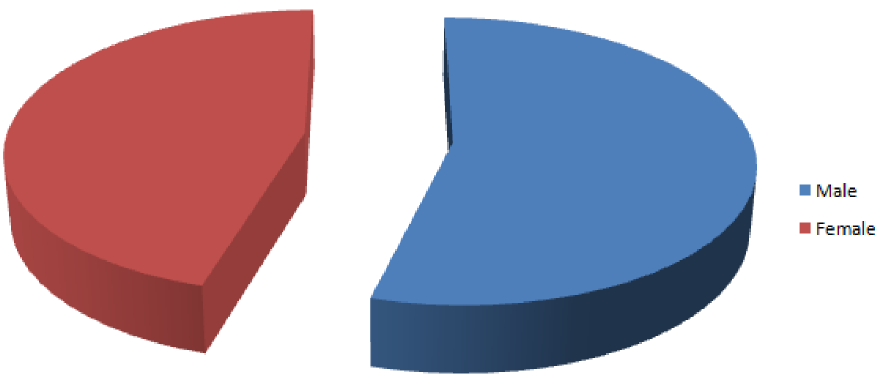

Figure 4.23: Male female ratio

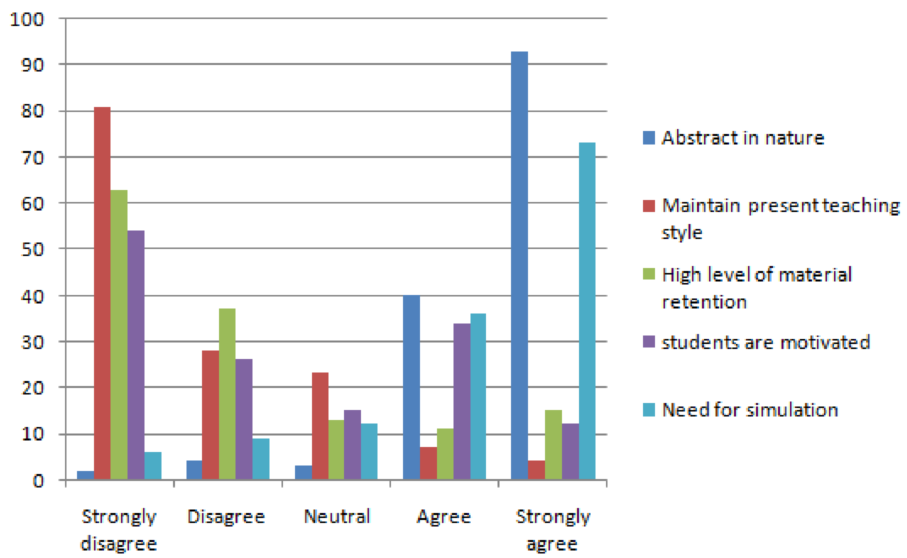

Figure 4.24: Nature of the course

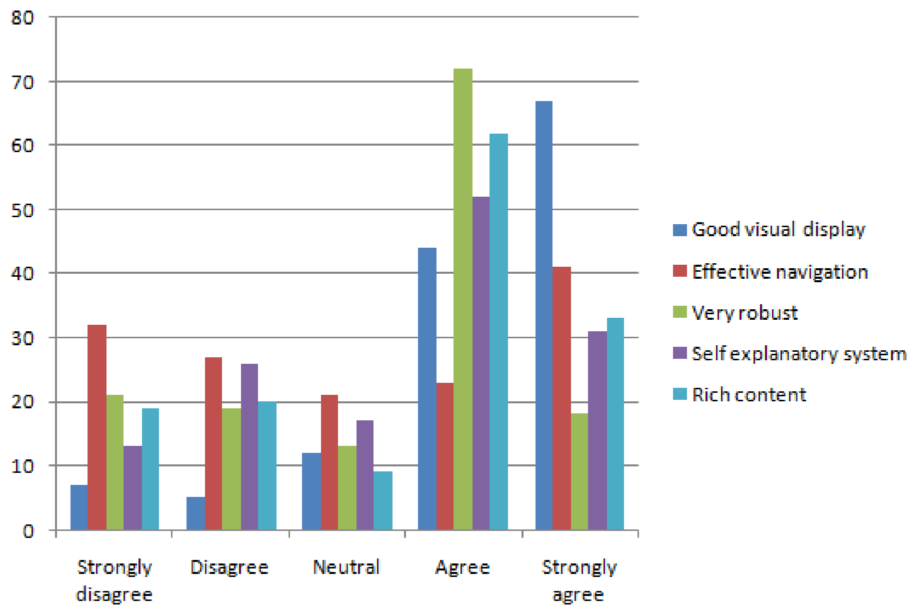

Figure 4.25: User friendliness of the content

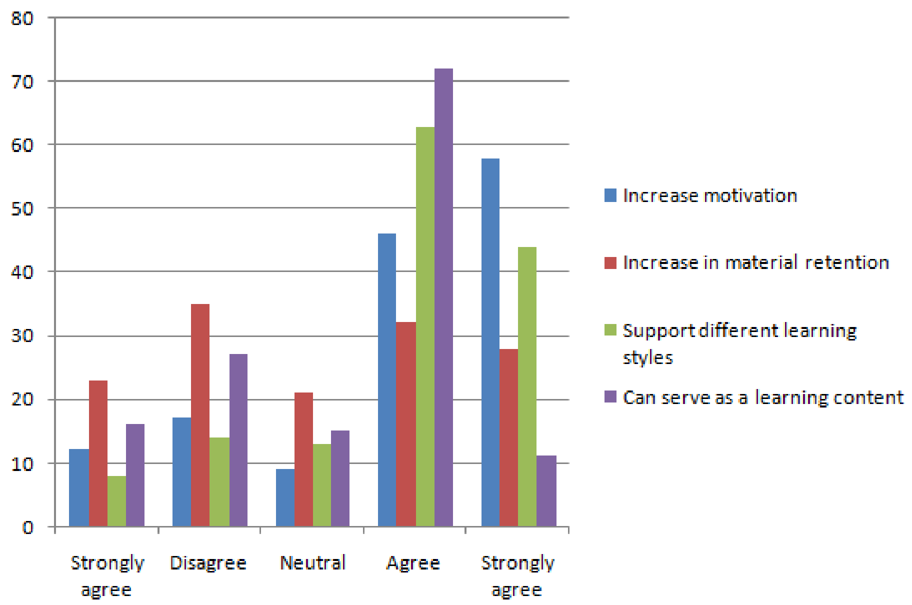

Figure 4.26: Effectiveness of the system

CHAPTER 5

Conclusion

A summary of the entire work is given here as well as the challenges encountered during the course of the work. Also a recommendation for future work is provided in this chapter.

5.1 Summary of work and results

This research is carried out in a modular manner. It answers the research questions provided in chapter 1. The answers to those questions are provided in all the chapters in the research work.

This work delivers a content on the Theory of Automata for a larger learning system on android platform. The system provides a robust interface for a user oriented experience as can be seen from the responses obtained from the questionnaire administered for evaluation. It also provides an interactive system for which the user will visualize and interact with the content. This is in consonant with the Chinese proverb "Tell me and I will forget, show me and I may remember,involve me and I will understand".Other courses can also be incorporated into the system. Also the system tries to reiterate the fact that "learning should no longer be limited to the four walls of a classroom".

5.2 Challenges

- One of the greatest challenge faced in this research work is the coordinate system. The coordinates pose a great challenge because when the user touch a portion of the screen to draw a view, it will be placed in a different location. We were able to overcome this problem by manipulating the entire coordinates.

- Building the simulator prove to be a herculean task as many sleepless nights were encountered. Transitions monitoring/recording requires a lot of decision making as to how it should be handled. We solve the problem by using identifiable lines and arrows to distinguish them from others.

- Drawing the arrows poses a great challenge. Arrows may fit for other views but will look awkward when it is used with other views. We have to take into considerations all possibilities of connection of arrows to all views.

- Time factor has also been a great challenge. The time management employed in this work help tremendously, but at the end it proves that time has always being our greatest enemy.

5.3 Future work

As regards the future, we intend to improve the simulator to be more user friendly in order to increase motivation. A visual example component would be incorporated to allow users view the examples in that area. An intelligent tutoring system (ITS) component will also be provided which will work like a normal human instructor to give the feel of social interaction. Also a more robust evaluation component will be provided to help in the motivation of students to learn.Conversions from the various forms of automata i.e DFA to NFA, NFA to DFA,RE to DFA etc. will be incorporated to give a total simulation experience to users. Improvement on portability will also be taking into considerations to make the application to run on all or most of mobile platforms like apple, blackberry, windows, symbian.

CHAPTER 6

Source Code

```
import android.app.Activity;
import android.content.Intent;
import android.os.Bundle;
import android.view.MotionEvent;
import android.view.View;
import android.view.View.OnClickListener;
import android.widget.Button;
import android.widget.EditText;
import android.widget.RelativeLayout;
import android.widget.Toast;

    public class GameDemo extends Activity implements OnClickListener {

    int counter =1;

    RelativeLayout laying;
EditText userInput,simulationInput;
Button button, buttonLine, buttonFinalState, buttonStartState, buttonSimulate, button-
```

```
Clear;
State state;
MyLine1 myLine1;
MyLine2 myLine2;
MyLine3 myLine3;
MyLine4 myLine4;
MyLine5 myLine5;

    FinalState finalState;
StartState startState;

    private static float x=100;
private static float y=100;
private static float startX=100;
private static float startY = 100;
private static float stopX = 0;
private static float stopY = startY;

    //trying to capture transition
private static int numberOfCircles=1;
private static int numberOfFinalState=0;
private static int numberOfStartState=0;
//private static int circleID;
private static String totalInput=" ";
int lineCounter = 1;
String input=" ";
String simInput=" ";
String value1=" ";
```

```
String zero_any_one="0*1";
String one_any_zero="1*0";
String ab_any_c="(ab)*c";
String any_a_bcd="a*bcd";

    @Override
protected void onCreate(Bundle savedInstanceState) {
super.onCreate(savedInstanceState);
setContentView(R.layout.game_demo);

    laying = (RelativeLayout) findViewById(R.id.layout);

    userInput = (EditText) findViewById(R.id.input);
//simulationInput = (EditText) findViewById(R.id.simulateinput);

    button = (Button) findViewById(R.id.circle);
buttonLine = (Button) findViewById(R.id.line);
buttonFinalState = (Button)findViewById(R.id.finalstate);
buttonSimulate = (Button) findViewById(R.id.simulate);
buttonStartState = (Button) findViewById(R.id.startstate);
buttonClear = (Button) findViewById(R.id.clear);

    //set listeners
button.setOnClickListener(this);
buttonLine.setOnClickListener(this);
buttonFinalState.setOnClickListener(this);
buttonSimulate.setOnClickListener(this);
buttonStartState.setOnClickListener(this);
```

```
buttonClear.setOnClickListener(this);

    Bundle extras = getIntent().getExtras();
if (extras == null) {
return;
}
// Get data via the key
value1 = extras.getString(Intent.EXTRA_TEXT);

    } //end onCreate

    public void addLine1ToView(String input) {
myLine1 = new MyLine1(this, startX, startY, stopX, stopY, input);
laying.addView(myLine1);

    } //end addLine1ToView

    public void addLine2ToView(String input){
myLine2 = new MyLine2(this, startX, startY, stopX, stopY, input);
laying.addView(myLine2);

    } //end addLine2ToView

    public void addLine3ToView(String input){
myLine3 = new MyLine3(this, startX, startY, stopX, stopY, input);
laying.addView(myLine3);

    } //end addLine3ToView
```

```
public void addLine4ToView(String input){
myLine4 = new MyLine4(this, startX, startY, stopX, stopY, input);
laying.addView(myLine4);

} //end addLine4ToView

public void addLine5ToView(String input){
myLine5 = new MyLine5(this, startX, startY, stopX, stopY, input);
laying.addView(myLine5);

} //end addLine5ToView

public void onClick(View view){
switch(view.getId()){
case R.id.circle:

state = new State(this, x, y, numberOfCircles);

laying.addView(state);
counter=1;

Toast toast1 = Toast.makeText(getApplicationContext(), "The radio button is: " +
value1, Toast.LENGTH_LONG);
toast1.show();
numberOfCircles++;
break;
```

```
case R.id.line:
String input=" ";

input = userInput.getText().toString();
totalInput = totalInput + input;
//trying
if(input.equals("")){

Toast toast = Toast.makeText(getApplicationContext(), "Enter a value for input", Toast.LENGTH_LO
toast.show();
break;
}

//testing for line counter and adding the line to view
if (lineCounter == 1){
addLine1ToView(input);

lineCounter++;
}

else if (lineCounter == 2){
addLine2ToView(input);

lineCounter++;
}

else if (lineCounter == 3){
addLine3ToView(input);
```

```
lineCounter++;
}

else if(lineCounter == 4){
addLine4ToView(input);
lineCounter++;
}

else if(lineCounter == 5){
addLine5ToView(input);
lineCounter++;

}

userInput.setText(" ");
Toast toast6 = Toast.makeText(getApplicationContext(), "The input entered by the user is :" + totalInput, Toast.LENGTH_LONG);
toast6.show();
break;

case R.id.finalstate:
if(numberOfFinalState == 0){
finalState = new FinalState(this, x,y);
laying.addView(finalState);
numberOfFinalState++;
break;
}
```

else{
Toast toast2 = Toast.makeText(getApplicationContext(), “There can only be one final state in an Automaton”, Toast.LENGTH_LONG);
toast2.show();
}
break;

case R.id.simulate:

//avoiding absence of start state
if(numberOfStartState ==0){
Toast toast = Toast.makeText(getApplicationContext(), “An automaton must contain a start state”, Toast.LENGTH_LONG);
toast.show();
break;

}

//avoiding absence of final state
else if (numberOfFinalState ==0){
Toast toast = Toast.makeText(getApplicationContext(), “An automaton must contain a final state”, Toast.LENGTH_LONG);
toast.show();
break;

}

```
//testing the new simulation
if(zero_any_one.equalsIgnoreCase(value1)){
if(simulationZero_Any_One()){
Toast toast = Toast.makeText(getApplicationContext(), "Good Design: Automaton accept
the language 0*1", Toast.LENGTH_LONG);
toast.show();

}
else {
Toast toast = Toast.makeText(getApplicationContext(), "Poor Design: Automaton reject
the language 0*1", Toast.LENGTH_LONG);
toast.show();
}

} //end if for zero_any_one

else if(one_any_zero.equalsIgnoreCase(value1)){
if(simulationOne_Any_Zero()){
Toast toast = Toast.makeText(getApplicationContext(), "Good Design: Automaton accept
the language 1*0", Toast.LENGTH_LONG);
toast.show();

}
else{
Toast toast = Toast.makeText(getApplicationContext(), "Poor Design: Automaton reject
the language 1*0", Toast.LENGTH_LONG);
toast.show();
}
```

```
}

    else if(ab_any_c.equalsIgnoreCase(value1)){
if(simulationAB_Any_C()){
Toast toast = Toast.makeText(getApplicationContext(), "Good Design: Automaton accept
the language (ab)*c", Toast.LENGTH_LONG);
toast.show();

    }
else {
Toast toast = Toast.makeText(getApplicationContext(), "Poor Design: Automaton reject
the language (ab)*c", Toast.LENGTH_LONG);
toast.show();
}
}

    break;

    case R.id.startstate:
if(numberOfStartState == 0){
startState = new StartState(this, x,y);
laying.addView(startState);
numberOfStartState++;
break;
}
else{
Toast toast2 = Toast.makeText(getApplicationContext(), "There can only be one start state
in an Automaton", Toast.LENGTH_LONG);
```

```
toast2.show();
}
break;

    case R.id.clear:
lineCounter = 1;
numberOfStartState = 0;
numberOfFinalState = 0;
totalInput=“ ”;
Intent intent = new Intent(this, GameSimulation.class);
startActivity(intent);

    } //end switch

    } //end onClick

    } //end class GameDemo
```

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