

Improving Reliance And Efficiency In Scheduling By Development of Hybrid Intelligent Agent

Thesis submitted in partial fulfillment of the requirements for the award of degree of

**Master of Engineering
in
Computer Science and Engineering**

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June 2014


CERTIFICATE

I hereby certify that the work which is being presented in the thesis entitled, "*Development of Hybrid Intelligent Agent based Scheduler cum Mailer Android Application*", in partial fulfillment of the requirements for the award of degree of Master of Engineering in *Computer Science and Engineering* submitted in Computer Science and Engineering Department of Thapar University, Patiala, is an authentic record of my own work carried out under the supervision of *Dr. Shivani Goel* and refers other researcher's work which are duly listed in the reference section.

The matter presented in the thesis has not been submitted for award of any other degree of this or any other University.


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ACKNOWLEDGEMENT

The completion of any task would not be successful without thanking the people who made the work possible and gave their consistence directions and encouragement to secure a remarkable success.

In the first note I wish to acknowledge the benevolence of omnipotent God who gave me strength and encouragement to cross all the hurdles and obstacles and shower his grace and love on me.

With the sense of respect and heartiest regard, I express my sincere feelings to my guide **Dr. Shivani Goel**, Assistant Professor, Computer Science and Engineering Department, Thapar University for her expert guidance, unmatched co-operation, and encouraging attitude.

I am grateful to **Dr. Deepak Garg**, Head of Department, and **Dr. Ashutosh Mishra**, P.G. Coordinator, Computer Science and Engineering Department, Thapar University for the motivation and inspiration.

Last but not the least I would like to thanks my parents and friends for their cooperation which helped me in doing this thesis.

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ABSTRACT

The thesis includes the research work where it describes the development of a hybrid intelligent agent in an android application called scheduler cum emailer. The intelligent agents are the software programs that do some of the intelligent tasks on the human behalf and acts as its personal assistants to whom user can rely and trust. The intelligent agents are loyal and perform all the tasks to accomplish its designed goal without any mistake. The hybrid intelligent agent developed is the combination of the three types of agents namely: Task agent, triggering agent and goal based agent. The thesis consists of the detailed study of the different types of agents which has been proposed by different researchers and developers. Also, a number of applications and services have been included to give an overview that how the intelligent agents can facilitate and automate the real life human activities by which users can perform his task more easily, timely and efficiently avoiding repetitive and mindless work. The research work includes the application's salient features and all the intelligent tasks it performs for the user to make the application more useful and user friendly. The application developed uses the android platform and run only on the android phones. Also the architecture of the application and the proper flow chart of the processing and execution of the algorithm are given which gives the deep insight of how the application is used and works. The application developed is user friendly, easy to use, reliable, efficient, time saving and reduces efforts.

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ABBREVIATIONS

1. **AI** Artificial Intelligence
2. **KBR** Knowledge Based Robot
3. **ISR** Intelligent Software Robot
4. **DE** Discrete Environment
5. **CE** Continuous Environment
6. **SA** Single Agent
7. **MA** Multi Agent
8. **PA** Personal Assistant
9. **IDE** Integrated Development Environment
10. **ADT** Android Development Tools
11. **SDK** Software Development Kit

CHAPTER 1: INTRODUCTION

1.1. Motivation

Artificial intelligence is the field of computer science which is growing continuously from decades giving astonishing and fruitful results which are always for the betterment of the human being. Artificial intelligence techniques have made possible to study and develop the applications and systems which can automate the various tasks and functions which was earlier very difficult to perform and accomplish by the human being. These past results and applications came and became the motivation to choose artificial intelligence as the main domain for the thesis where more useful and interesting services can be developed to perform the day to day life tasks with ease and more efficiency. The research in the field defined is more interesting and worth working as the work done takes the real human in account and the person can associate himself with the developed services in real environment.

1.2. Artificial intelligence

Artificial intelligence deals with the machines and software's intelligence which is also a very reputed and important branch of computer science that studies, researches and develops smart and intelligent machines and software. Major AI researchers, authors and textbooks defines the field as "The study and design of the intelligent agents" where the intelligent agent is a system software program which perceives its surrounding environment and takes actions that increases and maximizes its chances of success to achieve it designed goals [1]. AI research can be subdivided into several major topic areas. Artificial intelligence (AI) includes fields like Robotics, Genetic algorithm, Expert system, Image processing, Knowledge Representation, Machine learning, natural language processing, Intelligent agents and many others [1]. The researchers have done lot of work in different fields of artificial intelligence in making day to day life applications more reliable, convenient, satisfactory and trustworthy. Users can now rely on machines for their work. They can let machines to do work on their behalf without their guidance and undoubtedly machines do the work with more efficiently and in less

time. The machines are always loyal and trustworthy to human beings and perform the tasks as and when instructed by its users. Intelligent agent is a field which comes under artificial intelligence where the intelligent software programs are defined and developed into the applications where they can perform intelligent tasks. Robotics is also an important field of artificial intelligence where the robot is a kind of intelligent agent which acts intelligently like a human being performing the functions as performed by a normal intelligent person. There are various areas where the intelligence of the artificial intelligent techniques is used. Some of these areas are: Banks and finance, Computer Science and Engineering, Hospitals and Medicines, Manufacturing industry, Telecommunication, Gaming, etc [2].

1.3. Automation Vs Manual Systems

In today's life the human beings wants everything to be automated as the automation increases the sense of reliability, efficiency and accuracy. Also the automated systems have the following features that holds the reason for demand of this technology in the industry [3]:

- **Time Saving:** The automatic system speeds up the operations and thus saves lots of time.
- **Effort Saving:** The system saves the human effort on the laborious tasks.
- **Efficient:** These systems perform the function with more consistency and accuracy, there by increases the system's efficiency.
- **Reliance:** The users can rely on the systems for performing the tasks without bothering how it will happen.
- **Safety:** The automatic systems also have the feature of safety from the way they are safe from the human errors and are prone to be more accurate.

Also the comparison between the automated systems and manual system on the basis of the different features which they posses have been given in the table 1.1, it states the difference between the two types of systems and clearly justifies why the automatic system are better than manual systems.

Table 1.1: Comparison of Automated Systems and Manual Systems

Automated System	Manual System
<ul style="list-style-type: none"> • Consistent • Efficient • Uniform and reliable • Time Saving 	<ul style="list-style-type: none"> • Inconsistency may be there • Possibly inefficient • Subject to errors • Time Consuming

The automation in the systems can be achieved through the fields of the artificial intelligence where the techniques can be used to develop the systems which are intelligent enough to work automatically and on the behalf of the human. The intelligent agent is one of the techniques which deals with this automatic technology and aims in making the system intelligent and automatic. The intelligent agent has been briefly described and discussed in the following sections.

1.4. Intelligent Agent

An intelligent agent is a kind of software program which is independent, unmonitored and once designed runs autonomously without the assistance of any human being to achieve its goals or complete its task. It observes the environment and takes the actions to increase the chance of success [4]. The intelligent agents collaborate with the other agents to complete the tasks which have a great use in the artificial intelligence field as these intelligent agents makes any real time application intelligent as they perform the functions automatically without any guidance. Intelligent software agents work in background to perform the function whether application is opened or not but the agents always trigger whenever their conditions are satisfied there by giving the outputs in backend which appears whenever the function is performed. An agent is an application technology of the artificial intelligence where the agent decided the use of intelligent function and various factors are there which affects the application of the agent. For example by what amount the agent should be intelligent and by what amount the function can be handled manually by the users, what all intelligent function should be added, etc [5]. An agent has goals, can observe the environment in which the agent is running and perform some specific functions [6]. Figure 1.1 shows the interaction the agents with the

environment where the agent observe environment and according to the goals which it has to achieve performs the function

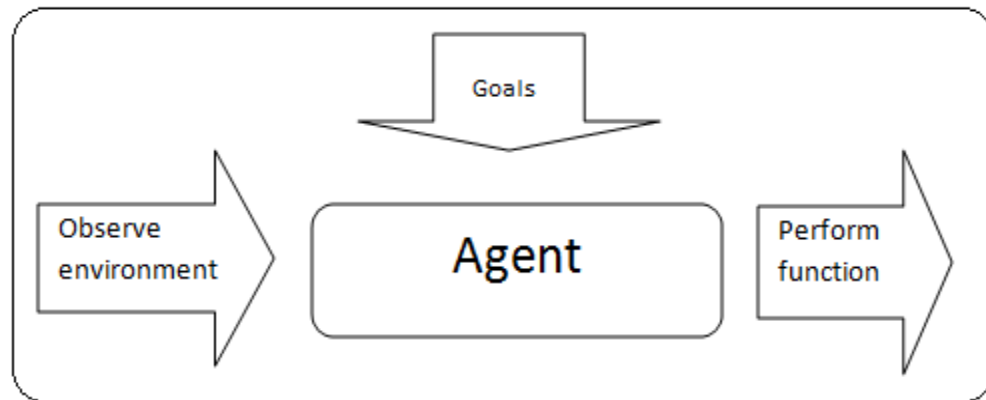


Fig.1.1. Interaction of agent with the environment

1.4.1. Characteristics of the intelligent agent

The intelligent agent is software program and to call a software program as an intelligent agent following are the primary characteristics that the agent should have [7] [8]:

- **Autonomy:** This characteristic means the intelligent agents are automatic and they perform the functionality automatically without any human assistance.
- **Proactiveness:** This is the characteristics where the agents take and performs various actions so as to achieve its objectives.
- **Reactivity:** It is the ability where the agent observes and perceives its surrounding environment and timely reacts to it.
- **Social ability:** This characteristic an agent holds when it has the ability to interact with other surrounding agents in the environment to achieve or satisfy its objectives.

There are some other characteristics that the intelligent agent may have:

- **Set and forget capability:** An agent has the capability of continually working tirelessly. The agent continuously works in foreground or in background to achieve the goal set for it even after its execution completes.
- **Goal driven:** Agents are goal driven and has the characteristic of always working towards achieving their goals or completing their desired tasks.

- **Veracity:** Agents always provide accurate information timely.
- **Benevolence:** Different agents do not fight with other and always try to do what they are asked to perform without interfering in other agent's performance.
- **Learning/adaptation:** An agent has the characteristic of learning with time.
- **Mobility:** An agent has ability to move around the environment.
- **Rationality:** Agents performs their set of given tasks to complete their goal.

1.4.2. Importance of Intelligent Agent Technology

As time is growing, the importance of intelligent agent technology is growing with time. It has been introduced in the artificial intelligence field decades ago and still maintains its importance in the field [9]. There have been many reasons and features that the intelligent agents provide due to which they hold such an important place and position in research area:

- **Time Saving:** In the fast growing society, the users need various ways to minimize the time to do some personal tasks. For example scheduling, shopping day to day groceries, travel planning etc.
- **Reducing effort:** The software agent reduces efforts of the users by performing the tasks on their behalf without the user's assistance automatically and effortlessly.
- **Increasing efficiency:** As the software agents are automatic and computerized, they also show their efficiency in their work and are very systematic and trust worthy.
- **Repetitive task execution:** Software agents can also be designed for performing the repetitive tasks which are needed to be performed every day and required lots of effort and no mind. Agents can help in doing those kind of tasks without any mistake and without any break.
- **Domain Expert:** Expert domain agents can very expertly take decisions and rule the world with their expert database and decisions which can also show their flavor of experience which they have earned through learning.
- **Search and retrieval:** Manually it becomes very hard to search a single data in the millions of stored data. Thereby, the agents performs the hard, time consuming,

repetitive tasks of inspecting, retrieving, filtering and reporting back the information for the large databases to the users.

- **Data mining:** Software agents can also perform data mining by finding pattern and relationships and then performing accordingly.
- **Improves productivity:** The software agents are the agent who helps to improve the productivity by offloading the effort on the tedious, complex and mindless tasks which earlier uselessly took lots of time and effort to perform manually. By automating those tasks makes it very useful in improving productivity.

1.4.3. Various Myths about the intelligent agents

There are various myths about the agents i.e. software agents are nowhere different from the software programs, agents and objects are synonym to each other and expert systems are also known as software agents or the intelligent agents [10]. But this is not true and can be clarified as follows:

- The software agents are very much different from the software programs. The software programs lack the ability to assess and react to the environment and modify their behavior accordingly. They do not have a goal oriented and autonomous approach to problem solving. These characteristics distinguish traditional programs from agents whose key feature is the presence of autonomy.
- The agent is also not an object. There is a lot difference between the two. An agent poses the capability of autonomous behavior while objects do not have any such capability. For example, if agent 1 requests agent 2 to perform an action then agent 2 may choose to perform or not to perform this action. Thereby, the decision to perform a given action rests with agents. In the case of object systems, the decision is taken by the object that invokes the method.
- Expert systems are not the software agents both have diversity in way of doing the things or performing their functionality. An expert system is a system that is considered to be an expert when it comes to solving problems or giving advice in some knowledge rich domain. Expert systems have a knowledge base which has the knowledge of a certain domain and codes this knowledge as rules and facts. Expert

systems are based on the fact that previous knowledge of a certain application exists and that we can acquire this knowledge from samples or interviews with the domain experts and then code this gathered knowledge into the knowledge database. But the experts are not capable of interacting with their environments and do not display reactive, proactive behavior or social abilities such as cooperation, coordination and negotiation which software agents do have.

Table 1.2 shows the difference between the software programs and the software/intelligent agents on the basis of different parameters like nature, interactivity, flexibility, autonomy, concurrency, manipulation.

Table 1.2: Comparison between software agents and software programs

Parameters	Software Programs	Software Agents
Nature(Static or Dynamic)	Software programs have static nature.	Software agents are of dynamic nature.
Manipulation	Software programs require the user's assistance in each step, they perform but only when user initiates.	Software agents are autonomous, once stated always works in completion of goal either in background or foreground.
Interactivity	These are non interactive	Software agents are interactive in nature.
Mobility	Software programs stays at one place	These may be mobile moving between the servers for gathering and giving information.
Flexibility	Software programs are not flexible and do not change unless manually changed by the	Software agents have the characteristic of adapting and learning.

	human being.	
Concurrency	Software programs cannot work concurrently on multi tasks	The software agents are intelligent programs which can also perform multi tasks concurrently.
Temporal continuity	Software programs run only one time when they are started and stop when the execution completes or the task completes and will only start again when these are called again	Software agents run continuously when started and are persistence to run over time.
Intelligence	Software programs are not intelligent and do whatever user asks it do even if user is wrong.	Software agents acts intelligently by understanding what user actually wants to do, they are based upon rules which also changes with time.

1.5. Thesis Outline

The thesis has been organized into six chapters namely: Introduction, Literature Review, Problem statement, Implementation, Snapshots of the application and Conclusion and Future Scope. Chapter 1 gives the brief introduction about the domain of the topic which is artificial intelligence and intelligent agents. Various myths and characteristics about the software agents are discussed. Chapter 2 is the literature review which contains the main research and study part of the thesis. It contains different types of intelligent agent which has been developed so far on the basis of various classifications. A number of examples and application of the intelligent agents has also be given and discussed. Chapter 3 explains the problem statement which includes the gaps in the study and what all the

research work application proposes to do to fill those gaps. Chapter 4 gives the full implementation and demonstration of the application through architectures, flow charts and brief introduction of the platform. Chapter 5 includes the results and snapshots of the proposed application in a systematic and sorted manner. Lastly chapter 6 includes the conclusion and the future scope of the research work.

CHAPTER 2: LITERATURE REVIEW

2.1. Intelligent Agent: Introduction

An intelligent agent can be defined as the intelligent software who adapts to learn and improve it by interacting with its environments using its knowledge base. Through this process the intelligent agent gains and improves its decision making ability from the experience. Also an agent perceives the environment through its sensors and then achieves the goals designed for it to achieve by acting on its environment through actuators. Agent always tries to maximize the performance measure [11]. There are various parameters on the basis of which an agent can be tested as efficient and useful. For example in case of a vacuum cleaner agent whose work is to clean the room efficiently can be measured according to the parameters like amount of dirt it has cleaned up, amount of electricity the vacuum agent is consuming, amount of time taken, amount of noise generated, amount of assistance it is requiring etc. Figure 2.1 shows the environment and agent interaction.

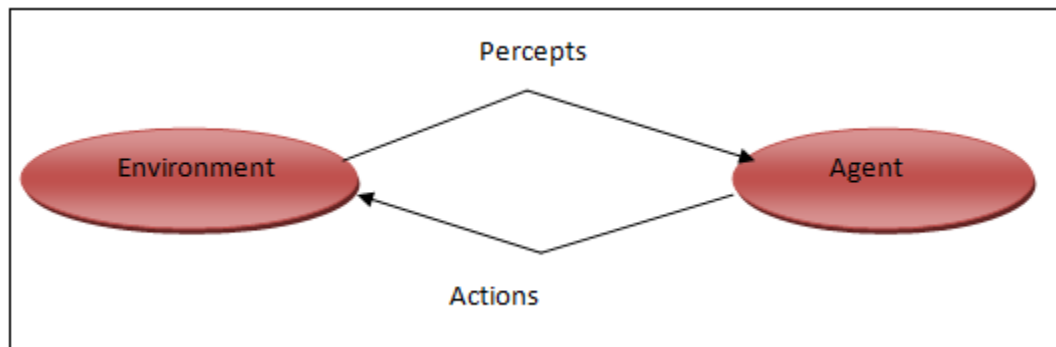


Fig.2.1. Implementation of mapping from percept sequence to actions between environment and agents

The intelligent agents are also called by various names which are given to them by the researchers to popular their brand of intelligent agency which are software robot, knowbot (knowledge-based robot), softbot (intelligent software robot), taskbot (task-based robot), autonomous agent, personal assistant, and digital proxy [12].

There are a number of definitions which have been defined and proposed for the intelligent agents from decades by different researchers and authors. Some of the proposed definitions are as follows:

- “An agent is anything which acts on its environment with the help of the effectors and can perceive its environment through sensors” [13].
- “Agents which are autonomous can also be called as computational systems which perform in the dynamic complex environment, where they can sense and act autonomously and thereby can achieve a set of goals and tasks”[14].
- “An intelligent agent is nothing else but a software who can act like an assistance to a human where it can only perform the tasks that an assistant performs like automatically doing repetitive tasks, reminding you of the tasks they forgot, summarizing the large complex data intelligently, learning from you and assisting you by doing its calculations”[15].
- “Agent is a piece of software which uses the information attained from its environment to perform in an intelligent and suitable manner to successfully complete its tasks. The agent software based upon the changes occurring in its environment should learn itself, so that the agent can always give the useful and suitable results”[16].
- “ An autonomous agent software is situated within the system where it interacts with the environment and acts on it, completes its own goals within the time limit designed and effects whatever it observes and senses in the future”[17].

2.2. Classification of agents

A lot of research work has been done and the agents have been studied and discovered various types of agents which can be classified on the basis of 3 categories. The categories defined have various further types of agents under them. The first category classifies the agents on the basis of the characteristics that the agent possesses during their execution. Then the classification under second category includes agents on the basis of the perceived intelligence and capabilities where as last category broadly classifies the agent into either single agent or multi agents. The figure 2.2 shows the types of classified agents:

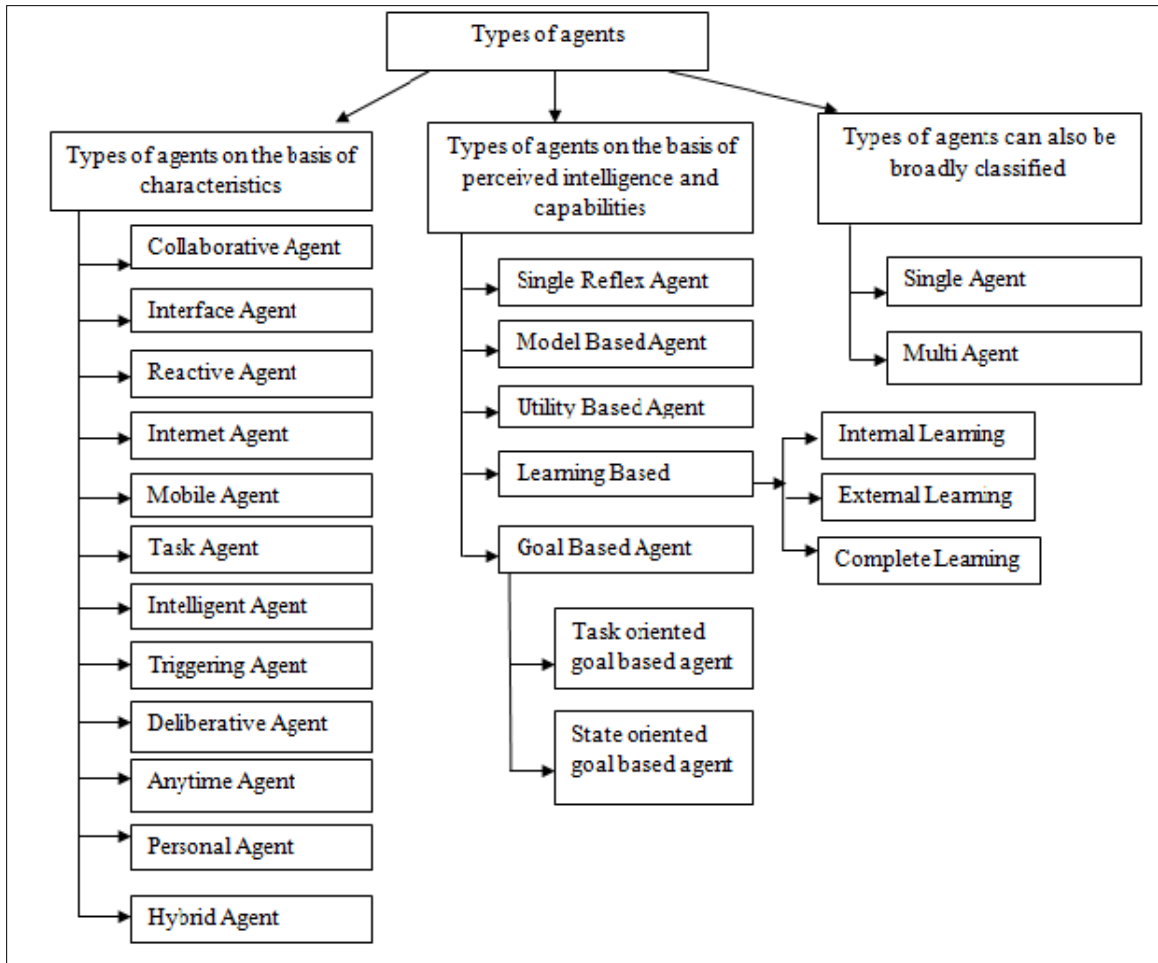


Fig.2.2. Classification of different types of agents

2.2.1. Classification on the basis of characteristics

The classification based upon the characteristics can be classified into a number of agents namely: Collaborative agent, Interface agent, Reactive agent etc which are briefly explained here:

- **Collaborative agents:** The collaborative agent has the characteristics of communicating, autonomy and reasoning which run in the multi agent environment and takes help of the other agents to complete their tasks.
- **Interface agents:** The interface agents are the agents who have the whole responsibility of interacting and communicating with the user, have the responsibility

of taking the queries for the task to perform and giving back the results to them. These agents has the characteristics of learning, autonomy and proactively.

- **Reactive agents:** The reactive agents are the type of agents which have the predefined rules for every situation thereby making it difficult and expensive for the complex environments. But these kinds of agents react in no time but their decisions are deprived of long term reasoning and have the reactivity as its characteristics.
- **Internet agents:** Internet agents are the kind of agents which are used to gain the information from the internet and perform the specified tasks. Internet agents have the characteristics of learning, autonomy, proactively and mobility.
- **Mobile agents:** Mobile agents are the agents who can move in the environment to perform their specified tasks and show the characteristic of mobility.
- **Task agents:** The task agents perform where its main goal of an agent is to perform a set of designed tasks mentioned in its task domain.
- **Intelligent agents:** The agent which acts as intelligent by having various intelligent characteristics is known as an intelligent agent.
- **Learning agents:** Learning agents are the agents which learn while performing tasks, whenever it encounters a situation which it had never before it just learns from it.
- **Triggering agents:** The triggering agents are the agents which have the capability of attaining the long term goals by reacting as fast and efficiently as the reactive agents but are also dependent on the predefined rules designed by the programmer and cannot react in the situations which are not foreseen by the programmer or being learned earlier.
- **Deliberative agents:** Unlike triggering agents and reactive agents the deliberative agent also react effectively in the unforeseen situations but are very slow and takes a lot of time for giving reaction.
- **Anytime agents:** Anytime agents are the agents which provide good reaction and a perfect planning process for every situation whether that situation is pre planned or not. The planning process becomes more intelligent with more time given to the agent for processing. For gaming environment these kinds of agents are very useful.

- **Personal agents:** The agent has the main characteristic of working only for one user at the particular time in the working environment which means that this kind of agent only works in benefit of a single user [18].
- **Hybrid agents:** Hybrid agents are the agents which are the combination of the one or more agents showing the hybrid characteristics.

2.2.2. Classification on the basis of perceived intelligence and capability

Second category includes the classification on the basis of perceived intelligence and capability. It is possible to group agents into simple reflex agents, model based reflex agent, goal based agents, utility based agents and learning agents which can be explained as the following [7]:

- **Simple reflex agents:** Simple reflex agents are the agent who act on the basis of the current percept only and responds immediately. Its function depends upon the condition action rule and only succeeds when the environment is fully observable.
- **Model Based reflex agent:** Model based reflex agents are the agents which can also handle partially observable environments and functions on the basis of the information on how the world behaves and works.
- **Goal Based agent:** Goal based agent is a model based agent and works to achieve its goal. It works by storing information regarding situations that are desirable and later allowing the agent to choose one which reaches a goal state from a number of possibilities.
- **Utility Based agent:** Utility based agent is the agent which defines the measure by which it can be measured that how much desirable a state is to achieve the goal [9] i.e. it defines a utility function which maps each state with its utility for achieving the goal.
- **Learning Agent:** The learning agents are the agents which learn and adapt to the changing conditions which is through the interaction with the environment. This is the unique feature which makes agents more interesting. Consider an example of an education system where you employ the tutor agents to teach student or help them to do their homework. At this situation the agents will not only be teaching but also be

learning through its experiences while interacting with the environment for the betterment as a human teacher does.

The learning agent is also classified to further 3 types [19]:

- **Internal learning Agent:** In this type of learning agents, the learning or adaption is only internal and the external actions or behavior do not showcase any adaptive smartness.
- **External learning Agent:** In this type of learning agents, the internal systems of it do not show any adaptive or learning behavior but the adaptive nature is reflected in their external actions which are driven by the environmental changes.
- **Complete learning Agent:** In this scenario the learning agent showcases the internal as well as the external learning characteristics which means the agent have internal system as well as the external system as adaptive and shows its visible effects.

Goal based intelligent agents models which are also defined under this category can be classified further into two types: one is the task oriented goal based intelligent agent and other is the state oriented based intelligent agent. The task oriented based intelligent agents perform intelligently according to the task oriented domain where the goal of an agent is to perform a set of tasks mentioned in its domain. For example in the proposed application the agent has the goal to notify the users of the scheduled meetings for the day. The agent's goal is specified as a set of tasks:

- Check if there if any meeting scheduled for the current date.
- If there is a scheduled meeting matches the current date then gives the notification for the scheduled meeting for the user
- If there is no scheduled meeting for the current date then don't prompt any of the notification
- Once the notification is prompted the all the current date meetings are shown.

There by, the task oriented goal has a fixed list of tasks. When those tasks are completed the goal is reached. State oriented goal based intelligent agents perform according to the state oriented domain where the goal is the final state which is to be attained through a

sequence of fixed set of the states. For example, if we design an algorithm there are various states through which the algorithm passes to reach its final state and produce the results. The task oriented goal based and state oriented goal based works on the basis on the set of the tasks and the states, the sequence of the tasks or states are finite and agents goal can only dignified on the basis of the fact that whether that the goal is reached or not. Along with these two kinds of the goal based agents which are used in the real time areas as it is very tedious and difficult to define a finite set of states or tasks in a complex environment as everything is so unpredictable. So, to remove that kind of problem a composite state goal model is defined which consists of the states, transition and arcs [20]. In this kind of the approach the overall goal and the sub goals are presented by the composite state objects in various levels of the hierarchical structure where the composite state objects can be further divided into other state objects which are linked with transitions. The firing rules of the transition and the goal measurement facilitates the dynamic nature of the agent's goal. With this kind of model the agents are able to achieve the goal and behavior autonomously. Also it increases the flexibility as it supports achieving the partial goal.

Goal based agents also work in various other ways, while studying this king of agent one scenario came into account where the goal adoption of the intelligent agent was based on the motivation. The motivation is the word which comes into account whenever there is a need to attain the goal. Whenever a person needs to achieve his goals he needs motivation and want to achieve his goal for his satisfaction. Similarly, in these scenarios the intelligent agent works to attain the satisfaction of the motions and the agent attains the preferred states which are the goal states in order to increase the overall satisfaction of the agents. In these kinds there are no pre defined rules, list of tasks or any set of states which should be stated before the execution of the program but the goal adoption is based upon the motivation measurement where there should be increased in the satisfaction level whenever a new goal is attained. This satisfaction value is given as the utility values which are associated with each of the states are not static but are dynamic based upon how much increase in satisfaction the state will give to the overall satisfaction level of the motivations. These utility values for each state also decays with time and decreases accordingly on the basis of the equation [21]. The agent attains the state which has the

highest utility value at a given time among all the states there by increasing the satisfaction level of the agent. These kinds of agents move or attain the states so that their satisfaction level always remains around 1 not below it. Higher the state can provide the satisfaction more useful it is for an agent. The goals adoption strategy continues as long as the satisfaction index is below 1 and once it reaches 1 till always checks that the satisfaction index should maintain its level. In these situations only one goal can be attained at a particular time and the next goal can only be attained once the previous one has completed all its execution. The preferred states attained also depends upon various things one on the basis of the utility value, another on the basis that the state with smaller cost/satisfaction index and duration/satisfaction index.

2.2.3. Broad Classification

In last category the agents are classified broadly as the single agent and the multi agent system which can be explained briefly as follows:

- **Single-Agent System:** In a single agent system, there is only one agent who lives in the environment, models and interacts with itself and the environment. In the single agent system, the agent considers all other agents present in the environment as the part of the environment only. Figure 2.3 shows the interaction of the agent with the environment, single agent's sensors and effectors are connected to the environment and agent has its own goals, actions and knowledge domain.

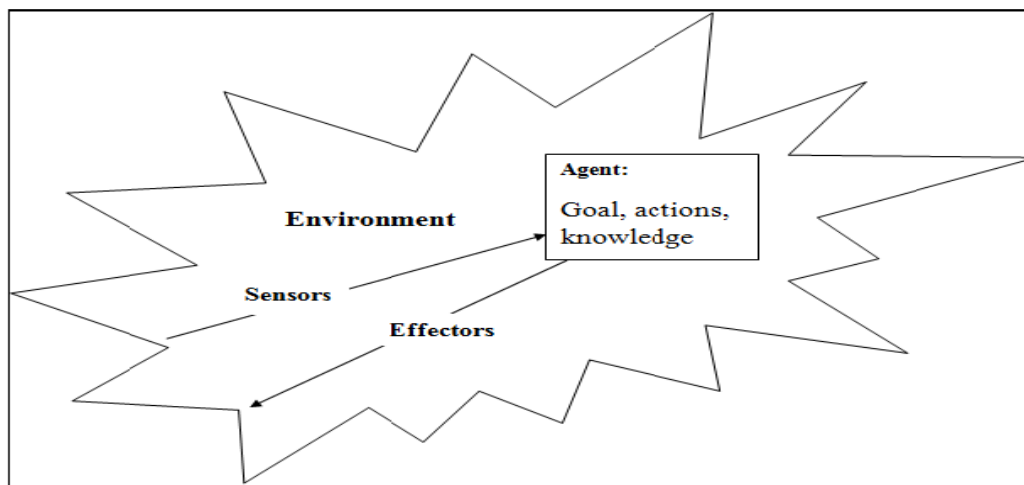


Fig.2.3. Single agent system

- Multi Agent System:** A multi agent system is a system which consists of various agents in the system communicating with each other to achieve the goal as it was becoming complex and difficult for an individual agent system in the environment. The interaction between the agents in the environments are of various kinds: pure independency where all the agents are independent to each other and has no communication between them; mutual independency where both agents are mutually dependent on each other, unilateral independency where one agent depend on second agent but vice versa is not true; and finally reciprocal where first agent depend on second agent for some goals and second agent on first agent for some other goals. Figure 2.4 shows the multi agent system architecture.

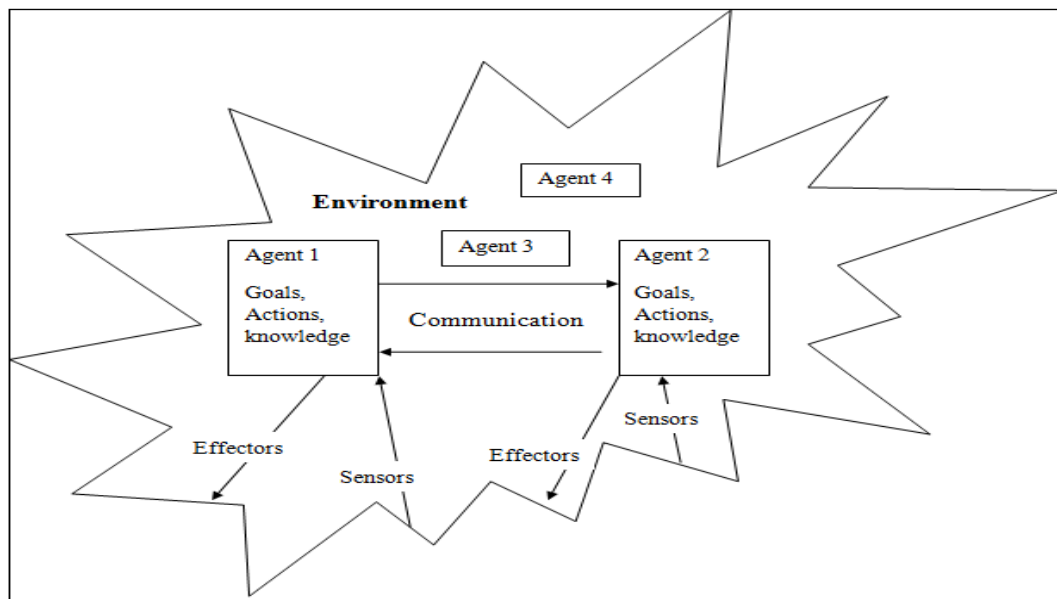


Fig.2.4. Multi agent systems

If in the process of solving the problems, we can perform the function using simple software programs then do the operations using the simple software programs and avoid using software agents or intelligent agents. If the stated problem can be solved by the single agent system then use that system and do not include the multi agent system as the multi agent system make the problem more complex and difficult. The multi agent systems are included in the scenarios where the problem cannot be solved by the single agents and the systems are more complex. Multi agents are included to solve those kinds of problems and to enhance the quality of the operations [22].

2.2.4. Other agent type classification

There are some other types of agents which have been defined but are not mentioned in the given figure 2.1. They have been discussed in the following sections.

2.2.4.1. Social intelligent agents

Socially intelligent agents are the kind of agents which uses the social intelligence to perform various functions in system [23]. This is very effective kind of agents which work efficiently in the real time applications having direct contact with the humans. The social intelligent agent acts as real human beings by simulating the social behavior.

There have been systems designed and implemented where the virtual characters simulate the social behavior of the human beings and act intelligently. These virtual characters are known as the socially intelligent agents. The social behavior of the people basically means the social expressions, facial responses, commenting and complementing on one's act which the social intelligent agent gives because of which users feels of interacting with the real person who can understand them and react accordingly. The social intelligent agents are of many types. One of them are the social intelligent agents which focus on giving the emotional support to the users while interacting with the system. The social intelligent agents have traits, states, social role and social rules as their distinct identities. The traits are the information which does not change with time and application which means that once a trait has been designed for a social intelligent agent it is application independent. The traits for an agent are its visible personality and social status.

The states are different for each socially intelligent agent which is the emotions and desires associated with each agent. The states of an agent are also independent of the application. These states are once designed and updated periodically using the determined social rules. With respect to the intelligent agent's traits and states the set of rules have been formed as the social roles. The social rules are the rules which define the rules for handling the states of an agent depending upon their states, traits and social roles. These rules govern the action which takes place according to their states, traits and their roles. It

has been noticed that the systems having socially intelligent agents have great effect on the behavior of the user and also on their performance which has been proved by once taking the support agents in one case and not taking them in other one. It has been observed that the user performed better in the first case. This shows that the supporter agents having the social behavior have a great effect on the interacting user's performance.

2.2.4.2. Functional and Structural level agents

The agent can also be classified on the basis of two types of level: Functional level and structural level. Both can be further classified into different types of agents. For functional level there are three types of agents: interface agents, information agents, and task agents. In case of structural level there are two types: Elementary agent and complex agent [24]. The complex tasks can be divided into various sub tasks in a recursive manner similarly the agent's structure can also be considered of forming by nested layers in a recursive manner.

The elementary agents are the agents which perform the primitive task where as the complex agents are the one which involve various agents of at least one lower layer. By involving various elementary agents which perform simple generic tasks complex agents are used to build to perform their complex tasks. The agents whether elementary or complex are distributed geographically where they interact with the other agents through the message passing which is formed in such a way that they can be used to share the information among the agents for completing their specified task.

The different types of agents which come under the functional level have different kinds of functionalities thereby are classified as three different types of agents. The interface agents are the agents who have the whole responsibility of interacting and communicating with the user, have the responsibility of taking the queries for the task to perform and giving back the results to them. The agents have the responsibility of determining the various tasks agents involved in querying the user query. Whereas the information agents are the agents which take care of providing and gathering the information from either from internet or from the system's database for performing

various operations. For example in a scheduler agent there are agents which fetching the meetings from the database matching the current system date and then display it for the user in the decreasing order of the functionality. And the task agents are the agents which perform the specific tasks who just simply interacts with all other kinds of agents to accomplish their job successfully. The only prime motive of this kind of agents is to perform the task given to it by interacting and communicating with other agents. These types of agents can be of elementary or complex type of agents which are the most useful agents for any application as they perform the major functionality in the system.

2.3. Environment Variants for agents

Various agents defined also possess different types of performance on the basis of various types of environment in which they have to work. There are various kinds of environment types in which the agents have to perform. When an agent is selected for an application or a system along with it the environment is also created in which agent works. The environment is created automatically when an application is build. Below are the different types of environments which have been explained briefly:

- **Accessible or inaccessible:** An accessible environment is the one where the agent can easily get the correct, complete and proper time information about the state of an environment. More inaccessible an environment is, more difficult it is to make the agents work within it.
- **Deterministic (or stochastic):** In the deterministic environment the next state of the environment is completely determined by the current state and the action executed by the agent.
- **Discrete (or continuous):** In this kind the state, time of environment, and the agent's percept's and actions have discrete values.
- **Episodic (or sequential):** In this an agent's experience is divided into atomic and independent episodes, where in each episode the agent perceives and performs one action.

- **Fully observable (or partially observable):** Agent sensors give it access to the complete state of the environment at each point of time which means agent has the access or knowledge about the full environment space .
- **Static (or dynamic):** Environment is static and agent has to perform in this kind of environment where nothing is changing.
- **Single agent (or multi agents):** Only one agent acts in an environment.

Different real life applications have been taken and examined against the different types of agents which are then summarized in table 2.1 showing the type of environment that games or agent possess in their system.

Table 2.1: Types of environments present in different application

Environment Types	Cross Word Puzzle	Chess	Solitaire	Taxi Driving	Medical Agent	Online Shopping agent	Tutor agent	Scheduler Agent
FO/PO	FO	FO	PO	PO	PO	PO	PO	FO
DP/ST	DP	ST	DP*	ST	ST	PO	ST	ST
EP/SQ	SQ	SQ	SQ	SQ	SQ	SQ	SQ	SQ
SC/DY	SC	SC	SC	DY	DY	Semi SC	DY	DY
DE/CE	DE	DE	DE	CE	CE	DE	DE	CE
SA/MA	SA	MA	SA	MA	SA	MA	MA	SA

FO-Fully Observable; PO –Partially Observable; DP-Deterministic; ST-Stochastic;

EP-Episodic; SQ-sequential; SC-Static; DY- Dynamic; DE-Discrete Environment; CE- Continuous Environment; SA-Single Agent; MA-Multi Agent, DP*-Deterministic after cards have been dealt

The real world is partial, stochastic, episodic, dynamic, and continuous multi agents. An intelligent agent designing involves the designing or role of four things: PEAS: P-Performance measure; E-Environment; A-Actuators; S-Sensors. Below are some of the examples along with their PEAS:

- PEAS for Medical diagnosis system:
Performance measure: Healthy patient, minimize costs;
Environment: Patient, hospital, staff, doctors;
Actuators: Tests, diagnoses, treatments, referrals;
Sensors: Entry of symptoms, findings, patient's answers.
- PEAS for Automated taxi driver:
Performance measure: Safe, fast, legal, comfortable trip, maximize profits;
Environment: Roads, other traffic, pedestrians, customers;
Actuators: Steering wheel, accelerator, brake, signal, horn;
Sensors: Cameras, sonar, speedometer, GPS, odometer, engine sensors, keyboard.
- PEAS for Internet shopping agent:
Performance measure: Price, quality, appropriateness, efficiency; Environment:
Current and future WWW sites, vendors, shippers;
Actuators: Display to user, follow URL, fill in the form;
Sensors: HTML pages (text, graphics, scripts).
- PEAS for Scheduler agent:
Performance measure: Continuity, automaticity, timely, trustworthiness;
Environment: system on which the application is running;
Actuators: Notifications, prompt messages, alarm ringing;
Sensors: change of date and time, event generator.

2.4. Applications of intelligent agents

Various applications have been introduced from past many years in this field of intelligent agents by the researchers. Some of them have been discussed in the next few sections.

2.4.1. Intelligent agent application in hospital scheduling system

Hospitals or the local clinics always struggle for booking the various appointments with their patients and appoints a person who acts to perform the same function which causes a waste of time and also has the problem of who will be working if the person appointed for the job is on leave. So, to avoid these kinds of problems this important work of the hospitals and clinics can be made automatic where the patients or junior staff whoso ever wants to meet the doctor can book an appointment for himself on his phone. The intelligent agents have been introduced very successfully in making the application which can schedule the hospital appointments [25]. It has been a very tedious task done by the human agent to schedule various appointments. Scheduling deals with giving the appointments to the staff and to his patients. The agent based system searches and fixes the appointment according to the available dates and also gives the confirmation for the date and time which has been booked for the user. The application is developed using the JADE-LEAP on android 2.2 which provides the robust and a user friendly interface solution for the patient and doctor. The challenge of the application is to reduce the patient's direct and indirect waiting time and to provide the most efficient use of hospital resources.

The application consists of 5 kinds of agents and 3 kinds of databases communicating with each other for performing the various functionalities required to be fulfilled. The various agents are namely: patient agent, appointment agent, main agent, schedule agent and the doctor agent. One agent interacts with its corresponding database for retrieval of the information and passes its information to the other agents in the system. The patient agent receives the appointment request and interfaces the patient agent with the appointment agent, it uses the patient database. The appointment agent communicates with the patient agent and the main agent which has the functionality of confirming appointment to the requesters. The main agent is the most useful and important agent which interfaces and communicates with the appointment agent, doctor agent and hospital main database. It has the main function to check the database for the doctor's available slots and check for the available dates. Doctor agent has the responsibility for notifying the doctor of his booked appointments. Last scheduler agent sends the

confirmation for the appointment after approving it from the doctor to the main agent. Application completes various needs for the appointments and does the scheduling for the appointment on the basis of some priority assigned. Even after performing so many satisfactory functionalities and application still has the loopholes and needs improvement as the application do not hold any emergency case appointment category, etc.

2.4.2. Scheduling student appointment based upon intelligent agent

This is another kind of intelligent agent based system which has been developed for scheduling various student appointments with the lecturer. The lecturer faces a lot of difficulty in scheduling their appointment with various students, staff, HODs etc. Some of the lecturers even appoint a human agent for handling the same but all lecturers cannot afford a personal assistance just for handling their appointments. So, taking into this into account an intelligent mobile agent application has been introduced where the students and staff can communicate with appropriate lecturer for fixing their appointments with him; which is done via various agents in the application on the basis of the priority of the work for which the person wants the appointment. The application is developed on the JADE-LEAP agent development kit on android 2.2 [26].

The system had been proposed in 2009, and deals with 4 kinds of agents namely: Student agent, Lecturer agent, HOD agent and Scheduling agent. The student agent is responsible for receiving the appointment requests by various students, canceling appointment and receiving confirmation from the lecturer is also the responsibility of this agent. The lecturer agent interfaces with the student agent and HOD agent and accepts various appointment requests by various staff and students. The HOD agent handles the staff appointment requests. The last scheduler agent is responsible for negotiating all the requests coming and giving different time and date slots available for the appointment request which are then approved by the lecturer and then confirmation is sent to various agents i.e. to student or HOD agent for confirming their slot of appointment. The approval of the appointments is on the basis of the priority which has been given to various types of work. The highest priority work will be given the highest preference for the available slot, there can be the scenario when the scheduler agent gives the available

slot to a student. When another student arrives requiring the same appointment slot with same lecture but having work with higher priority, the scheduler agent negotiates and according to the fuzzy preference rules, will cancel the appointment of the first student and books it for the student with higher priority work even if he arrived after the first student. Although the application is working intelligently and efficiently negotiates the appointments with the student and the lecturer on the basis of the fuzzy preferences and acts just like a human agent, it has the limitations as the application is only limited to student and lecturers but can be extended to include the staff appointments and head of department having meetings scheduled with junior staff and many other functionalities also.

2.4.3. Mobile Shopper Intelligent agent

An intelligent agent based mobile shopper has been proposed which has the main functionality of shopping on behalf of the customers. The agent gathers various information about the product which the user wants to purchase which means the price, brand, quality etc from various available stores based on the customer's preferences which he/she has selected to be there in their desired product. The intelligent agent replicates the job of a human being which he would do if he wants to buy a product. The proposed system basically consists of two kinds of agents namely: user agent and other is the coordinator store agent. The user agent interacts with the user and gathers all his preferences i.e. takes the input from the user asking him for the name, brand, price, quality, quantity, etc. of the product he want to purchase whereas the store coordinator agent has the responsibility of providing the information about its store's available list of products [27]. Mainly each store has only one store coordinator agent but there can also be conditions where each store can have more than one store coordinator agents. The agent developed in this system may be fuzzy in nature and can take fuzzy decisions in the future. The implementation of the functionality has been done using JADE-LEAP development kit.

The system basically consists of two agents but its architecture also contains various other major components which have an important role in making the functionality a

success. The main flow of the working goes as first the user enters his specifications which he wants in his product, which is then given to the user agent/shopper agent. The user agent converts the specification in a grammar which can be understood by both of the agents i.e. the shopper agent and the store coordinator agent. The store coordinator has full knowledge of all its store products; the converted user specification grammar is used to compare and match the specifications with the available list of product's specifications, once matched the results are shown back to the user for the approval. All these functionality is done automatically and efficiently by the agents of the system where the agent works like a human agent. By this kind of system which has been developed on phones, user can save his a lot of time by just letting agents know what he desires to buy, and then all is the responsibility of the agent to bring the product at the user's door step at his price and quality value.

2.4.4. B2C online shopping sales intelligent interface agent

With the increasing intelligent agent technology, the intelligent agents are very quickly entering the field of E-commerce, where the intelligent agents are used to help the customers to do the shopping more easily and comfortably as the intelligent agent not only do the auto searching for their product but also do bargaining with them. This system performing bargaining with the customers gives the full illusion of a real human sales person, which makes the shopping process more satisfactory and reliable. The intelligent agent provides a very user friendly communicating interface where the customers can very easily shop.

In the earlier discussed application, the intelligent was performing shopping for the customer and customer was not doing anything just giving his specification for the product. But in this application discussed the intelligent agent is now on the other end i.e. now the agent is acting in favor of the shopping store and has the responsibility for satisfying his customers. In a real store when we go for shopping the sales person performs whole of the shopping process. He has the whole responsibility of showing his different products, bargaining with the customers, negotiating the price and quality. The online intelligent agent system should also have all these features in it to influence the

customers and satisfy them. Proposed system consists of 4 intelligent agents and 3 databases to perform various functionalities [28]. The intelligent agents are namely: user interface agent, search agent, content agent and user profile agent. For bargaining, system consists of various kinds of algorithm for agent negotiation. The system proposed is not a real time system but is only the designed prototype which is only used to give the idea of how the intelligent shopping agent can be used in the shopping process giving the successful and satisfactory results without a human agent. The prototype provides the user interface where the user interacts with the agent and does the online shopping.

2.4.5. Education based intelligent Agent

The intelligent agent can be very efficiently and usefully can be used in the education system, where the agent can act as the tutor to the students where the teaching agent is not only teaching from its information database but is also learning side by side from its experiences. The teaching agent reacts exactly in the same manner as real human agent teacher teaches and interacts with his students. The teaching agent plots the characteristics for its each student which helps the agent to understand the student internally. The education system has a great effect on the student life, if a tutor completely understands his students he can teach them better; same strategy a teaching agent also follows. The teaching agent adapts the changing requirements and needs of the student; it adapts new teaching environment and styles [29]. This teaching agent system can be executed any time of the day when the student wants to study. The system consists of only a single agent who is the tutor agent which consists of the database which consists of its teaching data. This information of the database is adaptive which is updated and gets new information from the experience of the tutor agent, which means the tutor agent grows and becomes intelligent with its experience.

2.4.6. Artificial market intelligent agent system

Until now we have seen that either the customer was acting as agent or a seller was performing tasks but in this scenario both customer and merchants are appointing the intelligent agent to perform tasks for them and a artificial market is created where the user who either wants to sell or buy the products will create an agent for himself who

would be having all the profiling knowledge about the user and perform the tasks for the user. In this system initially customer will create its agent and initializes it with the constraints, his general interests and preferences. The merchant will portrait himself through the agent specifying his constraints and details about the products which he provides [30]. Different agents communicate and interacts with each other share their data and do the tasks in favor of their user; i.e. either they give information about the available products or searches for a product according to the given specifications. The purchaser agent has its database which has the information about customer's choices, details of the seller agents from whom the customer buy his products, etc. This database can be updated and refined at any point of time whenever user wants to refine it. Whereas the seller agent has the database which contains the data about its regular or potential purchaser agent so that it can send them the advertisements about the new or promoted products, the detailed list of the available products specifications, etc. The database can be refined any time by the merchant as per his needs.

2.4.7. Human Resource Management emotional intelligent agent

The intelligent agents can be also used in the recruitment system where the intelligent agent emotionally checks the confidence level, their sincerity and many other things in the candidate who had come for the interview. The research tries to models the emotions of the candidate by modeling the facial expressions and the states of the emotions which changes according to the confidence and interests of the user [31]. The agent gives the positive and negative feedback on the basis of the emotional changes that a candidate experiences while answering the questions asked which shows his commitment or non commitment in his answers. The agent helps in judging a person whether he is correct person for recruitment or not. The agent identifies the facial expression on the basis of the facial expressions which the candidate shows and fuzzy inferences are used to model the analyzed movement into either a positive or negative feedback.

2.4.8. Different other agents to reduce work load

The intelligent agents can be called as the personal assistance of the user which can perform the tasks on the behalf of its user. The agents are not only the interacting bridge

between the users and the system but an efficient and a successful interface agent will be that which do not allow the user to perform any task and performs all the tasks on the user's behalf. The research shows that the agent can guide users in a variety of different ways like they can be used to perform tasks from the user's side. An agent can act as the tutor for the user. Agents can get information from different users by collaborating them and also the agents can be used to monitor events and functions. The agent can assist users in an infinite numbers of tasks like for finding out which movie, music or article are of user's interest; to sort the emails priority wise; to schedule the important meetings and many more applications are there which agents can be of great use. Wherever the agents are used by the user to assists them in performing their tasks they always tries to meet two conditions, first is the competence which means that the agent should have the full knowledge of whatever task it is performing. And second is Trust; the agent should be trustworthy where the users can trust the agents to leave an important work on them and believe that the work left on the agents will be completed with full attention and care.

In the below discussed examples the machine learning techniques are used to build the interface agents which means the agents developed are the learning interface agents; the agents were given very little amount of background knowledge which gradually learns more from other agents and the users [32]. There are four ways in which the interface agents learn:

- It observes and remembers the user's behavior and actions
- It learns on the basis of the feedback which it gets from its users
- It adapts through examples given by its users explicitly
- Lastly it can ask other agents to assist them in a particular condition.

2.4.8.1. Email agent

Email agent is one of the learning interface agents where the agent continuously looks forward for the user's actions and behavior. It stores the situation and action paired up conditions into its memory and whenever similar situation comes in front of the agent it reacts accordingly. The learning technique is based upon the Memory Based Reasoning and is implemented on Macintosh Common Lisp [32]. Now agent reacts differently in

various conditions on the basis of its confidence level for a particular situation. If the agent's confidence level is above the "do-it" threshold then the agent automatically do the task without asking the user for prior approval where as if the confidence level is at "tell me" then the user only gives it suggestion and user checks the agent's suggestion before doing any task which means now the agent asks for the permission from the user to perform the task. If the confidence level is even below the "tell me" level then the agent do not give any suggestion but only learns.

2.4.8.2. News filtering learning interface agent

News filtering learning interface agent is implemented on a UNIX platform in C++ language [32]. A user can make a number of news agents for himself each handling a type of user's interest by making them learn that how they should select the article of their interest. The finding of the user's interest articles is on the basis of the word matching from the various articles present on the internet which is also a disadvantage of this type of agent application. The user gives the positive or negative feedback for the article searched by the agent and next time the search by the agent is done accordingly.

2.4.8.3. Entertaining agent

This agent helps the user select its entertainment sources on the basis of the personified interests. In this every user makes agent which memories and remembers the music, movies, books , albums which its user has liked and has given positive feedback which then discusses and shares its liked things which other users agents. An agent accepts recommendations from other agents as they are correlated to each other as all the agent's user have similar likes and dislikes. By this type of recommendation the agent gets more entertaining stuff for its user by consulting various other agents. The agent share the item with other agents which their users have evaluated and are not yet evaluated by other agent's users. This has been implemented in Perl on UNIX platform [32]. This type of agent also has problems as it becomes difficult to notice that when the recommendations should start. Moreover the user starts only relying on the recommendation and do not discover any new items by themselves.

2.5. Intelligent agent's role on the performance of the learner user

In some of the applications the intelligent agents have a great role on their learner's performance. The intelligent agents have the great effect on the learner performance. An example has been discussed where they were given the intelligent agents of different natures, genders, characteristics [33]. A real time dynamic environment scenario has been created and agents act as their real time tutors or class teachers. The participants or the users of the system really liked the idea and had different views about the created software where they were amazed to interact with the agents as they were having the feeling as if they were interacting with their class room teacher but not to any artificial agents. They were interacting and were feeling that the agent were replying to their doubts with full concern and also remember their name, their old doubts and were replying according to that. But the gender difference in the agents had no effect on the performance of the participants. Users also found the system useful and interesting as they were feeling that they can have the assistance from the agents at any time, late night or early morning which would not be possible with the real tutors as they will only be available at a particular time not all the time. This makes it more helpful as they can do their assignments at any time of the day and can ask any time any number of questions without any hesitation. All these feelings make it useful and believe that the research in the areas of the agent can be more useful. Also the participants' freaks out when they feel that the software really acts like a human interacting responding, commenting etc like a real human. Researchers may further want to investigate the design of intelligent agents, examining variables such as gender, age, and appearance, and their impact on learning. But the system hardly shows any major difference between the changed genders i.e. between male and female agents.

CHAPTER 3: PROBLEM STATEMENT

Setting reminders and sending emails to the meeting members is a very common task of day to day life of a cooperate person where he has so many formal and informal meetings lined up. For those kinds of people an application is needed where they can perform all their work under one shelter with full ease i.e. the facility of scheduling meetings and emailing information about the meeting to other members simultaneously without switching to some other application or without opening the browser to increase the efficiency factor. Also, in this busy working world where there is no time for doing unnecessary work by the users which do not require any intelligence and wastes lots of time and effort; and is required to be done every day or repetitively many times like clearing the old date stuff should also be done automatically which could save time and effort. Proper reminders about the scheduled meetings should to given to the user and an automatic email to the users inbox should be send which could increase the reliability feature. The automatic system holds all the features which has been discussed earlier in the introduction section, that it makes the systems efficient, reliable, time and effort saving by allowing the users to do the only work which is important and doing all the inefficient work by itself. Thereby, there comes the need of designing an application which can automatically perform the tasks, thereby increasing its convenience, time efficiency, reliability and usability which was earlier missing when the tasks were not automated but were manual.

CHAPTER 4: PROPOSED SOLUTION

An android application called scheduler cum emailer has been given as the proposed solution which is developed using an intelligent agent who performs its main functionality automatically. The intelligent agents perform various important and intelligent tasks which makes the application different from so far developed reminders and task managers. The application performs the function of scheduling and emailing under one shelter; where the user can schedule his/her meetings as well as can email to the other members concerned about the meeting. The agent automatically deletes the old dated and useless scheduled meetings. It also daily reminds the user of his/her scheduled meetings of the day. The agent also has the responsibility of automatically emailing the user about his/her scheduled meeting once the user hits the schedule button. The application requires the internet connection for emailing the meetings notifications. The sections in this chapter include the android platform description in which the application is developed followed by the sections describing the architecture, flow charts and salient features of the proposed application.

4.1. Android platform description

An android architecture consists of 5 layers: Applications and Widgets, Application framework, Libraries, Android Runtime and Linux kernel. Each layer has its own significance and functionalities. All the applications are written in the java programming language. An android application framework includes a set of views which can be used to build user friendly application with beautiful user interfaces, including grids, lists, buttons, radio buttons, menus, etc. [34]. Libraries layer includes a set of C/C++ libraries used by various components of the android system which also provides the support to its application framework. It consists of Media framework, SQLite database, SGL, SSL etc. whereas android runtime includes a set of core libraries and a Java virtual machine (Dalvik virtual machine). Linux kernel is located at bottom layer of android system and acts as middle layer between the hardware and the rest of the software stack [35]. Figure 4.1 shows the android architecture.

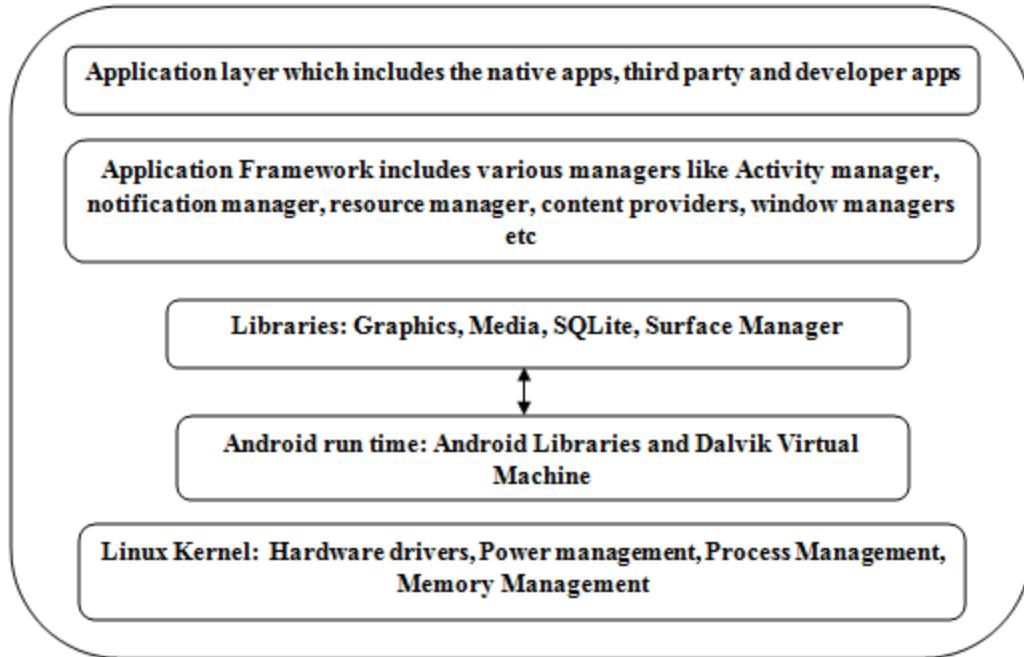


Fig.4.1. Android architecture having five layers

Dalvik virtual machine has various hardware features based upon the real mobile devices. In android system a tool named dex is included in the android SDK which converts the java class files into the .dex format. The .dex format combines all the class files of the java and deletes any of the repeated data in any of the java class file. The Dalvik virtual machine has several other features [36]:

- A separate Linux process is used for every instance, where a single Dalvik virtual machine on a single device could have any number of instances.
- An instance of the virtual machine is required to run an android application.
- The Dalvik virtual machine completely depends upon the operating system for management of memory, isolation of the process and support for the thread.

Figure 4.2 shows the position of Dalvik virtual machine in Android system.

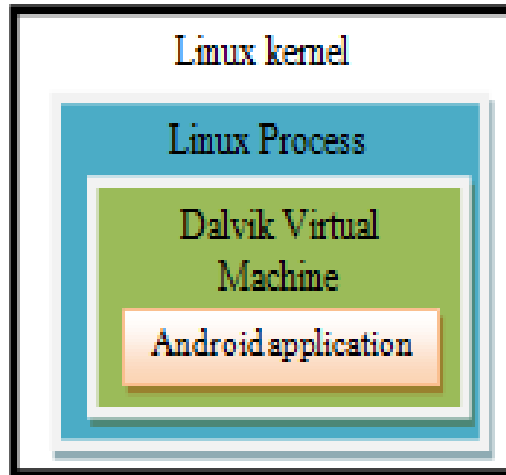


Fig.4.2. Position of Dalvik virtual machine in android system

In android application, when the application is executed there is no main() function, which means that there are multiple points of entry in the application and user can enter from any point as there is no fixed point. Every component has its own different entry point from where it can enter the application and can independently activates its component object, where the application can also use the component element belonging to any other different application. There are four different types of components of application: Activity, Service, Content providers and Broadcast receivers. The figure 4.3 shows the various android application components:

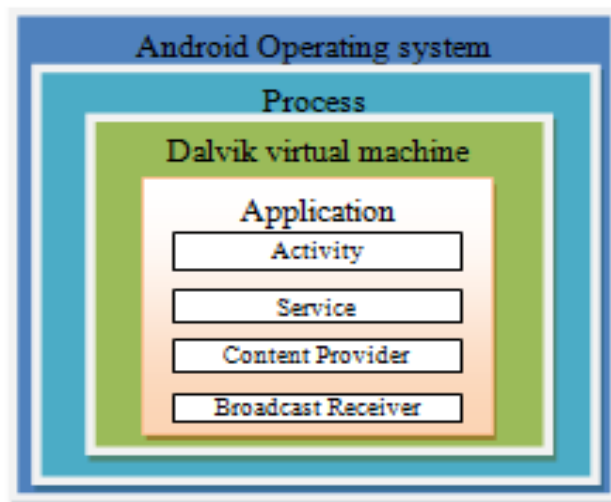


Fig.4.3. Android Application components

Each android application component type has a distinct purpose and has a distinct lifecycle that defines how the component is created and then destroyed. Following sections show the brief introduction about each of the components of the android application.

4.1.1. Activity

An activity is implemented as a subclass of Activity which is a single screen treated as a user interface through which the user interacts with the application. A number of activities are clubbed together to form one application where each activity is independent of any other activity, which means that any application can use any of the activity to perform its required functions. It all depends upon the developer that how he designs the application i.e. in which particular form activities are designed and what amount of activities are there in an application. In an application with multiple activities, typically, one activity is called as the main activity, which is the first activity which is shown to the user when the whole application is launched. Every activity then initiates or starts another activity so that it can perform different actions. In the android application scenario, when one activity starts the previous activity is paused or stopped where the stopped activity is preserved in a system stack called the “back-stack”. The figure 4.4 shows the lifecycle of an activity [34].

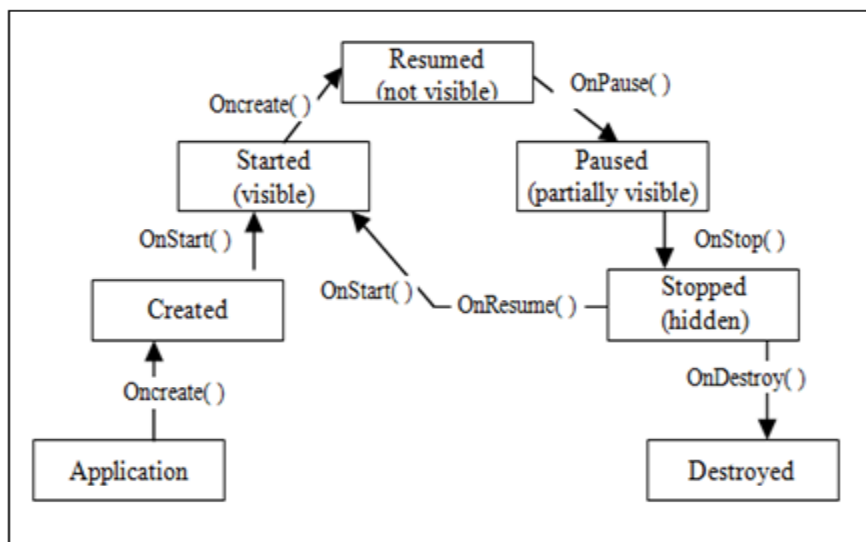


Fig.4.4.Lifecycle of an activity

4.1.2. Service

Service is a component that runs in the background to perform the function but it does not provide any user interface and is responsible for the long running operations in an application [37]. An activity connects or binds a service which is running. The activity communicates with the service when connected through the interface that the service is exposed to. The service android component like other components by default always runs in the main thread of an application.

4.1.3. Content Providers

A content provider is implemented as a subclass of content provider. It provides the facility for sharing data among android applications. The data to be shared can be in the file system, a SQLite database or any other storage location which an application can access. It defines and states the data format which it supports and also provides a set of methods to enable other applications to query or modify the data. An application calls these methods by an object called content resolver which communicates with every content provider. Content resolver manages the Inter Process Communication (IPC) while sharing the data between various content providers.

4.1.4. Broadcast Receivers

Broadcast receivers as the name suggests broadcasts the information in the system. There are a lot of broadcast messages that initiates from the system and are required to be transmitted for example broadcasting a message that battery is low, wifi has been detected and internet connection has been connected, screen turn off notification and many more. The applications developed in the android can also have this functionality of initiating broadcasts. An application, like activities can also have any number of broadcast receivers, where each broadcast receiver is a sub class of broadcast receiver. The broadcast receivers perform least amount of job and are only responsible to connect with other available components in an application [35]. The broadcast receivers do not uses any user interface but only prompts the messages on the status notification bar.

The activity, service and broadcast receivers are activated and initiated by a message which is called as intent. Intent binds different isolated components to each other at run time for an application. The intent objects are declared to send the message for activation of specific components or any specific type of component [38]. The intents are also used to define the actions in the activities and services which are to be performed in the application, sometimes it also specifies the URL of the information data on which the action is to be performed. Intent simply defines the announcement being broadcasted for the broadcast receivers. And the last component, content provider does not activate by intents but is initiated by content resolver when it is targeted by a request.

4.2. Architecture of the application

The application developed is an android application which is based upon an intelligent agent where intelligent agent performs various tasks which reduces the user effort and user does not have to perform useless work. The application consists of two kinds of intelligent agents namely Scheduler agent and Emailer agent. The scheduler agent has the goals to delete the older dated scheduled meeting details automatically just asking the user for the final approval for deletion. Also it has the responsibility to send the user the list of meetings scheduled for the day; which is prompted every morning showing the list of the meetings. The scheduler performs its function by communicating through central database of the application. Also the emailer agent has the task to automatically send the schedule meeting notification by mail to the user mail box at the time the user schedule his/her meetings in his/her android phone. Figure 4.5 shows the architecture of the application where shows various different interactions.

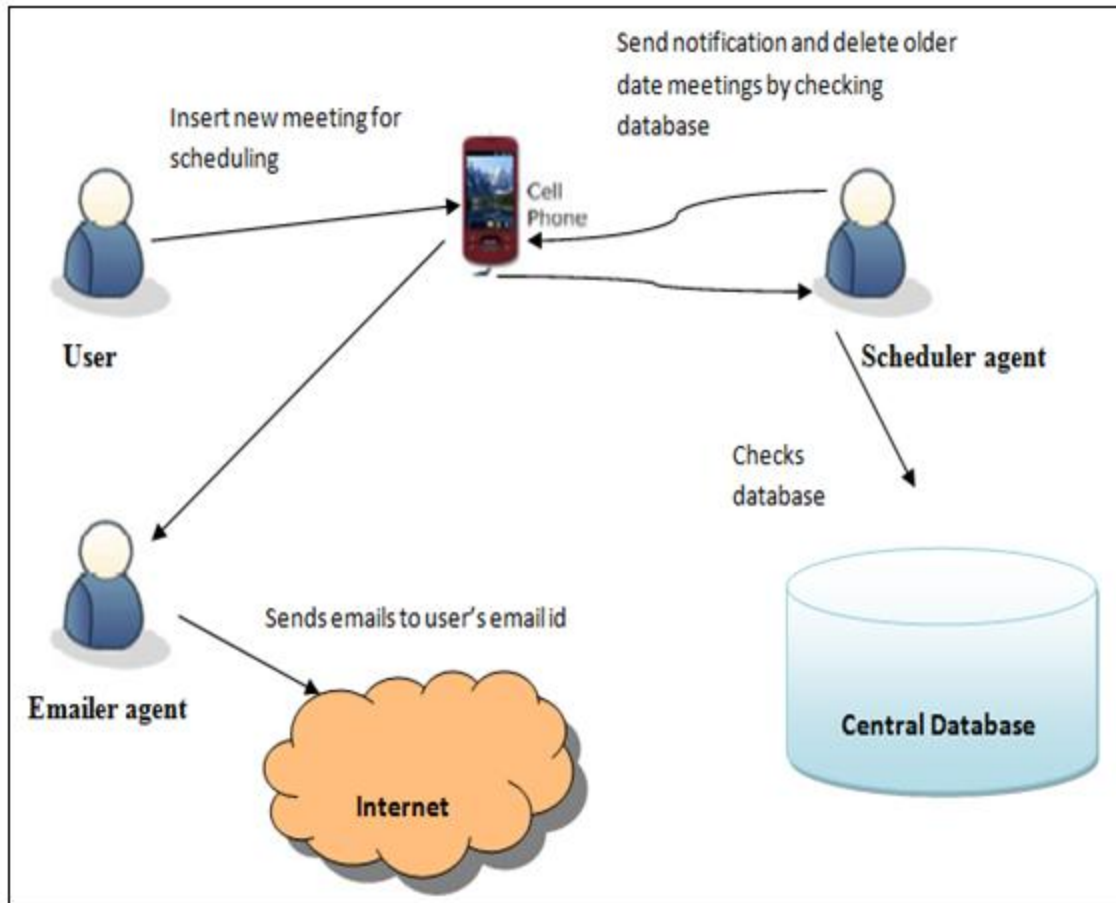


Fig.4.5. Architecture of the application

4.3. Algorithm and Salient features of the application

The application has been developed using the Integrated Development Environment (IDE) by eclipse with the help of Android Development Tools (ADT) plug in and Android Software Development Kit (SDK). The application testing was performed by the android emulator during the development while the finished application was tested on the real device. The application is based upon the intelligent agent who makes it different from the ordinary reminder application. The algorithm of the application has been discussed in the following section.

4.3.1 Algorithm

- The application starts with showing two categories whether scheduling for a formal meeting or for a new informal tasks.

- When the user open one of the list the application prompts the message “do you want to delete older date meetings?”
 - If you click on “yes” the scheduler agent deletes all the older dated meetings
 - If “no” the scheduler agent won’t delete any meeting and the user can delete the meeting one by one by long pressing the meeting which he/she wants to delete.
- User can then “Insert” new meeting by adding title, time, date and setting the priority for the scheduled meeting.
- Once meeting is scheduled, an automatic mail is send to the email account by the electronic mailer agent.
- The scheduler agent also takes care of the service, where if user wants can get the daily notification of all meetings scheduled for the day every morning.

4.3.2. Salient Features of application

The proposed application has various salient features which have been included to make it a unique application. User can schedule his meetings giving the title, date, time and a priority for the meeting. The meetings scheduled come in a sorted manner according to the dates and then the priority i.e. first the meetings are scheduled according to the dates then according to the priority given to each meeting scaled from 1 to 5, 5 being highest and 1 being lowest. Either user can set the notification instantly or can set the alarm for the notification. The alarm can be postponed, snoozed or dismissed whenever it is prompted. Automatic deletion of the older dated meetings from your meeting list, as whenever you open the list and older date reminders are already there, the application asks whether you want to delete the older reminders or not. Saying yes it will delete all the older reminders. Also the user can delete one particular scheduled meeting by long pressing it. This will delete one specific meeting selected by him.

The prompt of the notification for the daily scheduled meeting which is also automatic is done in the scheduler. This is the service which runs in background and makes the scheduler more intelligent by notifying the users for the meetings scheduled for the day automatically once the user starts its service. The application only prompts for the day

when the meeting list has the meetings scheduled for that particular day. Here the application do the filtering and completes the personal goals for notifying the user about the meeting. Along with the scheduling and setting of the reminders for the meetings, the user can simultaneously also send the emails to the other members of the meeting to inform them about the meeting time and date. When the user schedule the meeting for himself in his phone at the same time a mail also reaches his/her inbox about the meeting automatically which the user can see from anywhere if he/she lost his/her phone or forgets to carry along with him. The intelligent agent saves time and effort by deleting automatically the unwanted reminders which earlier has to be deleted manually. Also the agent takes full care of notifying the meetings timely so that user may not miss any of its meetings even if he has not set any reminder for it. This gives the user the internal satisfaction and releases one of his/her tensions. The application requires the internet connection which is used by the emailer agent to send the automatic emails and by the user to send emails to the other members of the meeting. If the internet connection is not there sometimes the application also terminates forcefully.

All the above discussed steps and features can also be explained through the given flow charts given in figure 4.6 and 4.7. Figure 4.7 is the continuation of the flow chart given in figure 4.6. The flow chart discussed gives the proper flow of tasks during the execution of the application by the user. Users perform various different steps in the proper order and flow. Various features of the application can also be performed in any order as no specific order them is not defined. Also there are operations which are performed simultaneously and in coordination. The intelligent agents also perform in coordination to complete their set of goals.

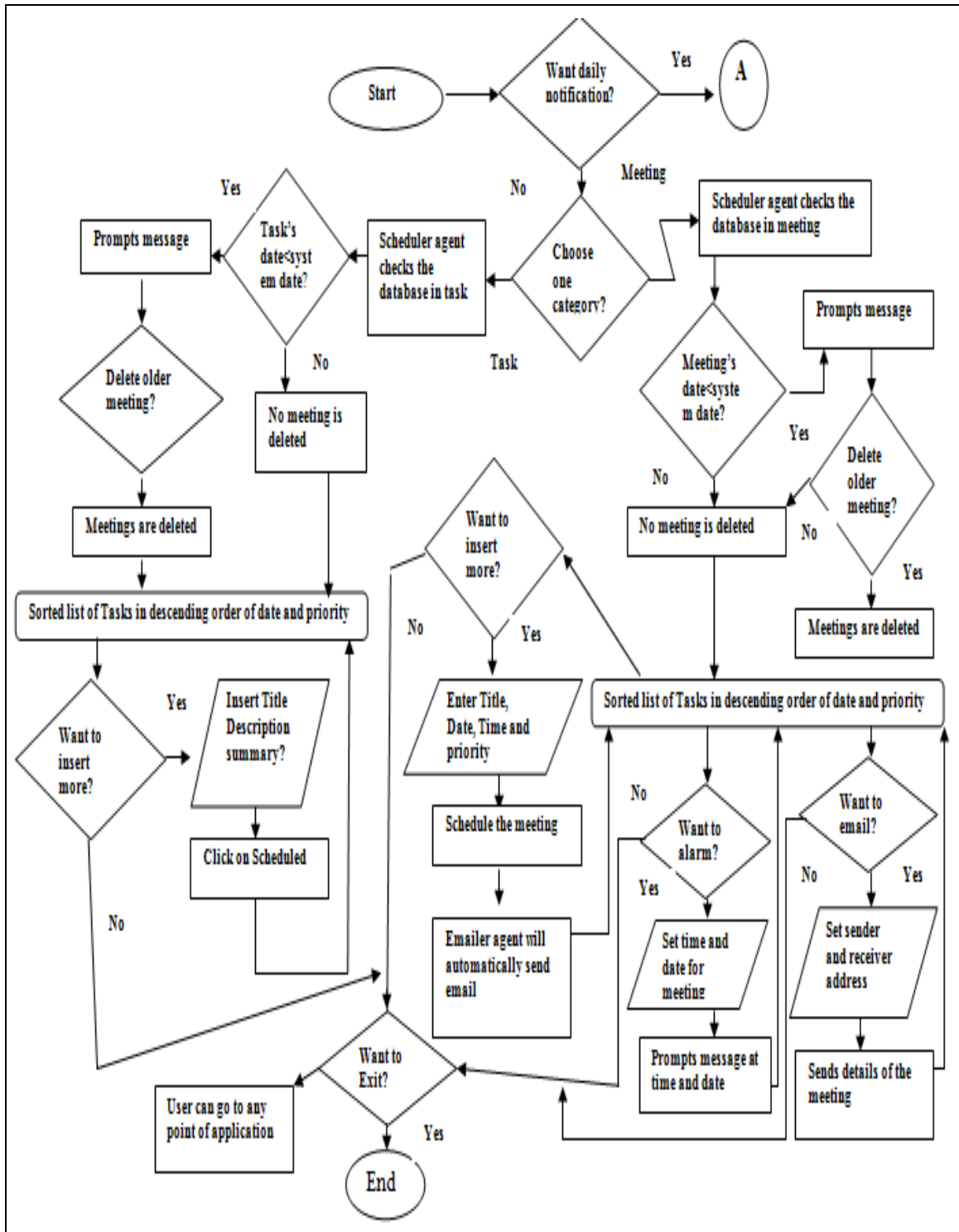


Fig.4.6. Flow Chart of Application

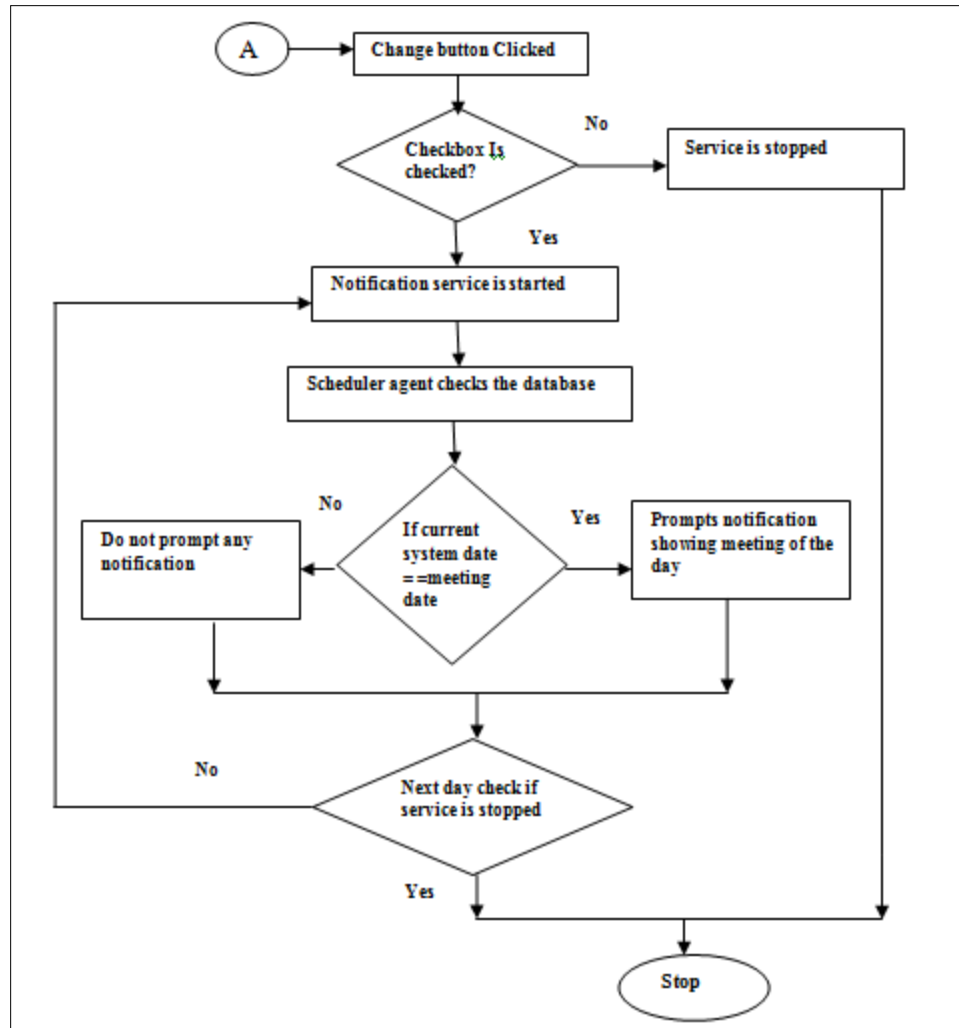


Fig.4.7. Flow chart of application (*Continuation*)

4.4. Flow of classes

Figure 4.8 shows the actual flow of java classes in the application during the execution of the application. The application is developed in the eclipse with the help of a number of java classes. Every java class depicts one of the functionality with one activity of the application. When the activity starts in the application of the scheduler cum emailer the particular java class corresponding the activity runs in background to provide the functionality to the user.

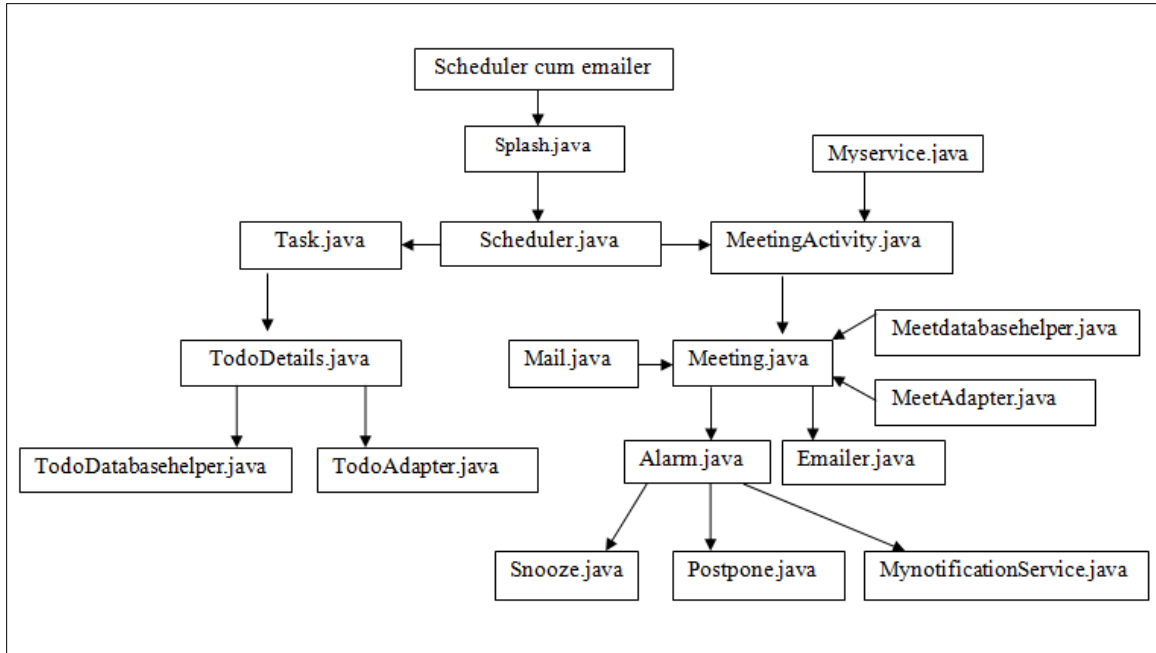


Fig.4.8. Flow of Classes

CHAPTER 5: IMPLEMENTATION RESULTS

The mobile application development is an excellent choice for a beginner software engineering project that aims to introduce developers to elementary development process activities such as design, implementation and testing. The reason is its low complexity, great opportunity for innovation, and huge market interest into new and innovative mobile applications. Due to its simplicity, the developers can easily, and in relatively short period, get acquainted with elementary development concepts, techniques and resources that can be combined to produce mobile applications [39].

Proposed application has been developed using the Integrated Development Environment provided by Eclipse [40]. It includes Android Development Tools as plug in and Software Development Kit by Android. The testing of application was performed by the android emulator during the development of the project. The completed application was tested on the real device i.e. the Android phone. The application has been developed in Java programming language. The editor environment for the project is Eclipse along with SDK android with version 2.2.3. The database used is a SQLite database, which is lightweight database engine that provides a small storage size. Notification manager service available in the Android SDK is used to get the reminders at the particular date and time.

Following are the results and the snapshots of the application developed, every snapshot is accompanied by its description and is sorted in the execution order of the running application by the user.

Every application developed on an android platform is started by clicking on the application icon. Figure 5.1 shows the icon of the developed scheduler cum emailer application and figure 5.2 shows how the application starts with a sound in background.

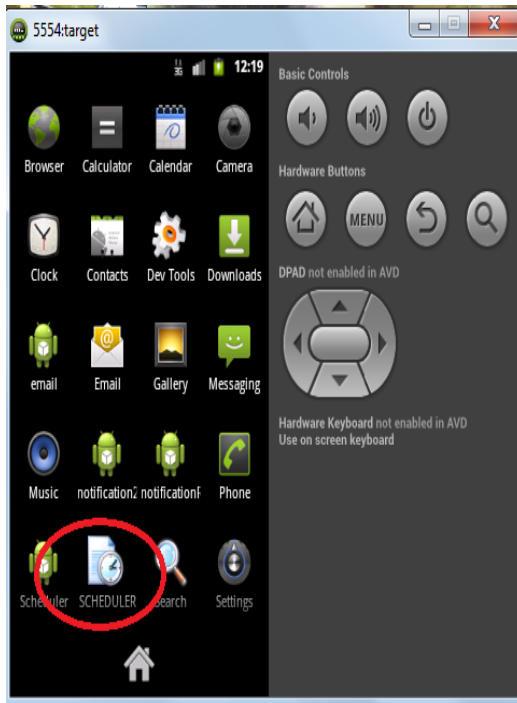


Fig.5.1.Application Icon



Fig.5.2.Application Starts

The application starts and shows its first screen having two categories one is meeting and other is the task. The figure 5.3 shows the snapshot of two broad categories.

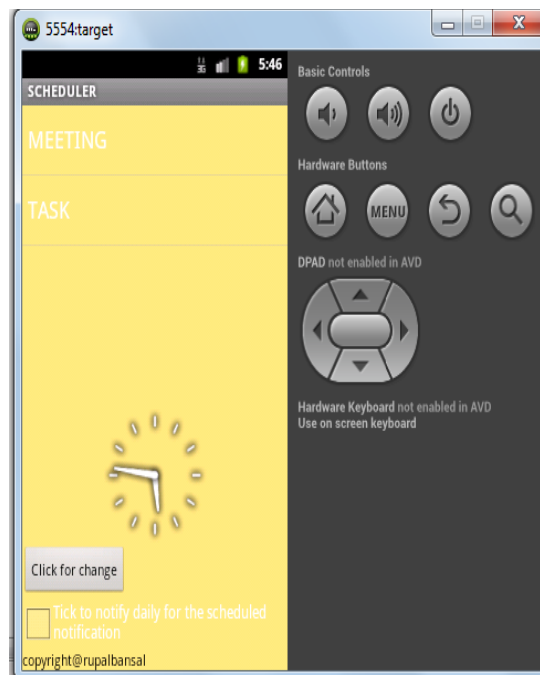


Fig.5.3. Showing two broad categories

Choosing the meeting category the list of already scheduled meetings are shown; but scheduler agent prompts the message to delete the older date scheduled meetings which is shown by the figure 5.4. If user says no then no meeting will be deleted else saying yes all older date meetings are deleted. These are shown by figure 5.5 and 5.6.

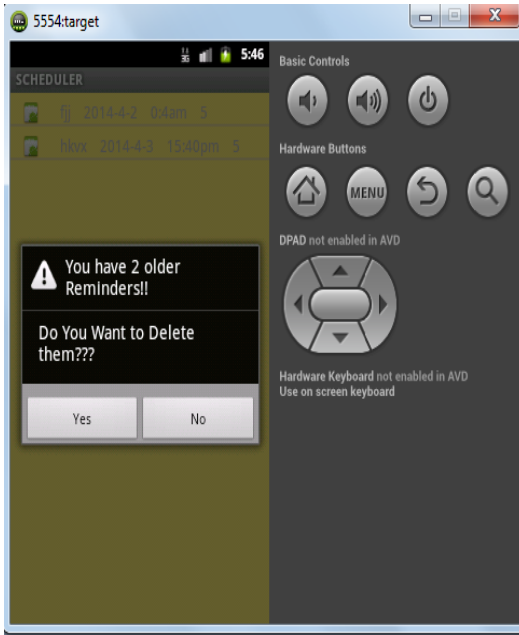


Fig.5.4.Prompt by scheduler

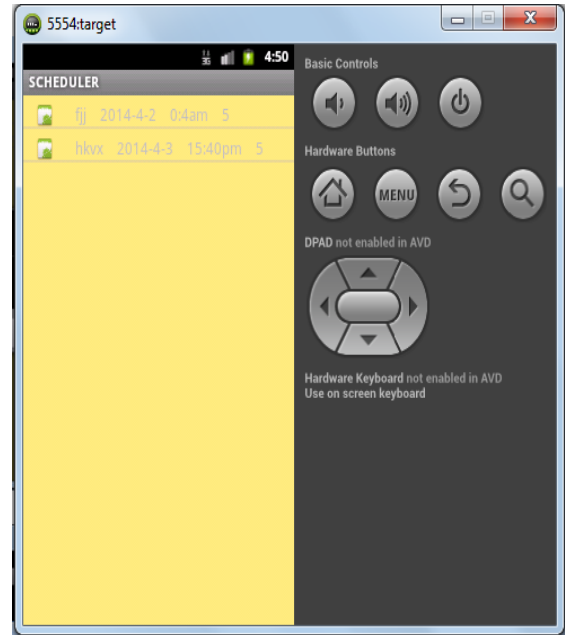


Fig.5.5. "No" delete meetings

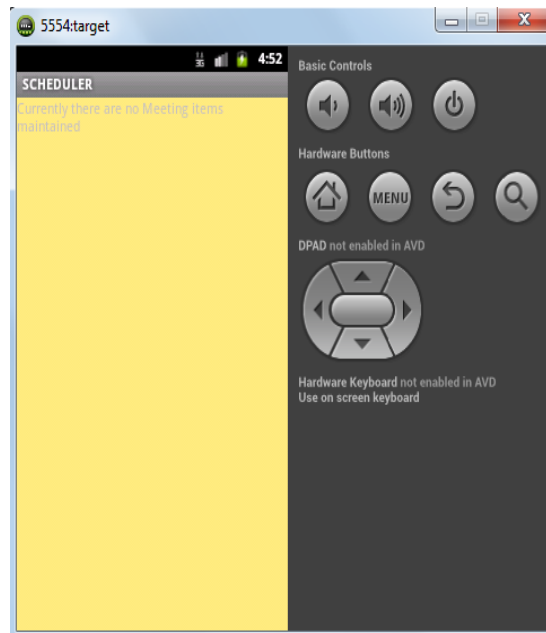


Fig.5.6. "Yes" delete meetings

The snapshot figures 5.7 and 5.8 depict that there is also an option where the user can check for about the developer of the application selecting the option from the menu palette.

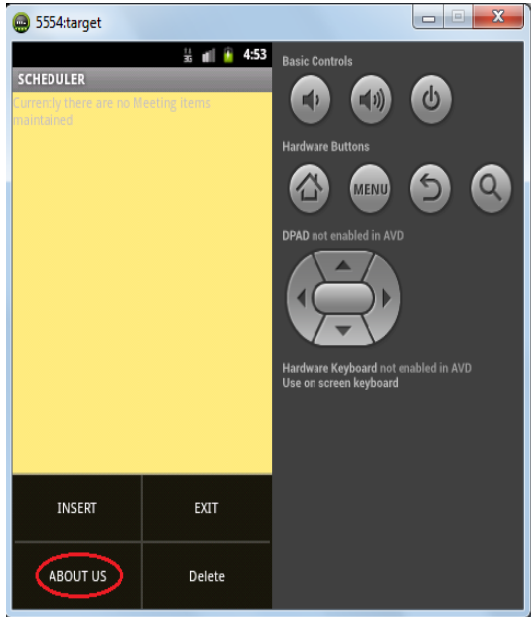


Fig.5.7. “About US” option in menu

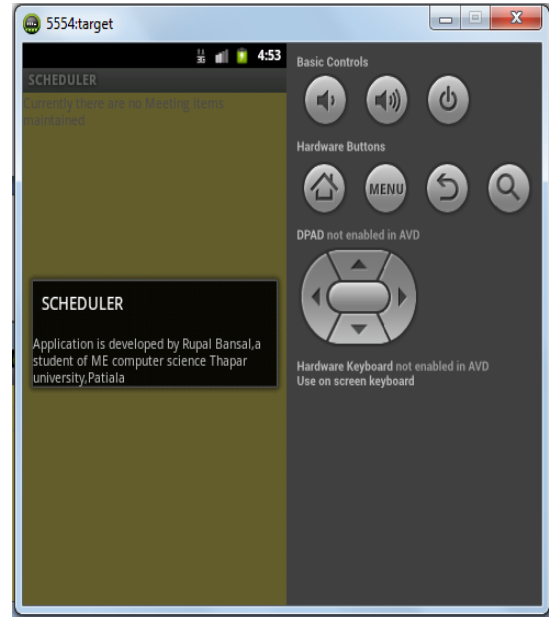


Fig.5.8. Prompting about the developer

The user can also insert new meeting to add into its scheduled meetings list by clicking on its insert option in the menu palette which is depicted by figure 5.9.

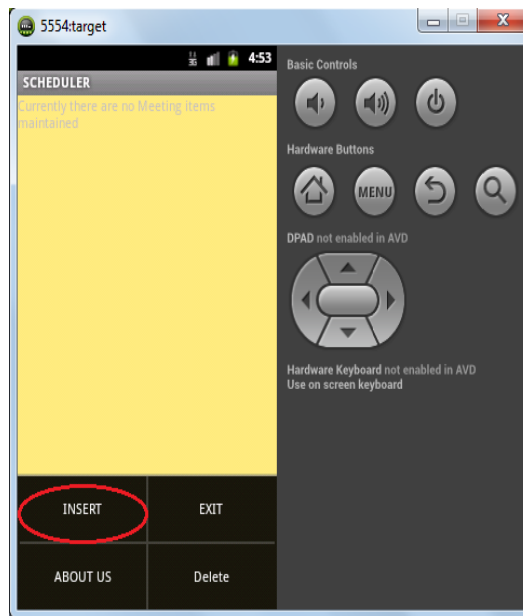


Fig.5.9. Insert option

Figure 5.10 shows the screen shots for inserting the new meeting for scheduling meetings by entering its title, date and time. The screenshot shows various option buttons which the user can use for utilizing various application functionalities. Figure 5.11 and 5.12 show the screenshots for the date and time dialog boxes used to select the date and time for a meeting.

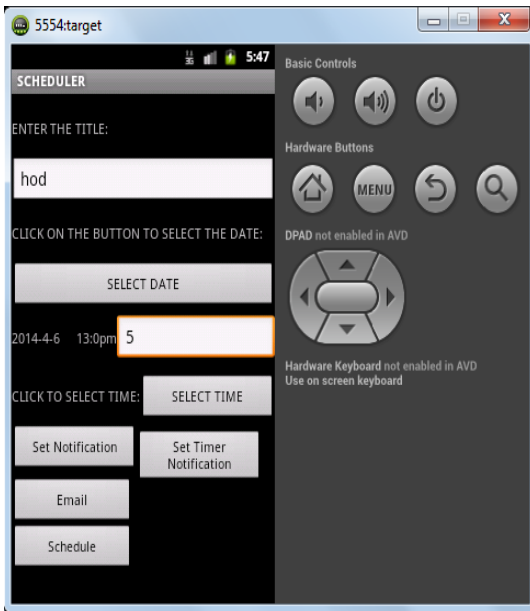


Fig.5.10. Insertion screen

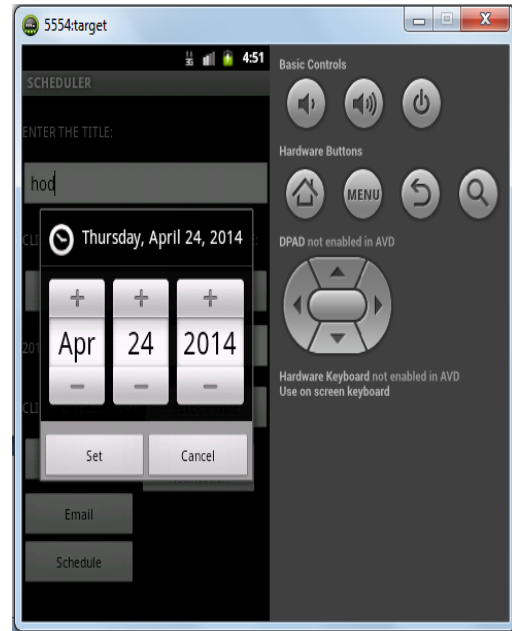


Fig.5.11. Date dialog box

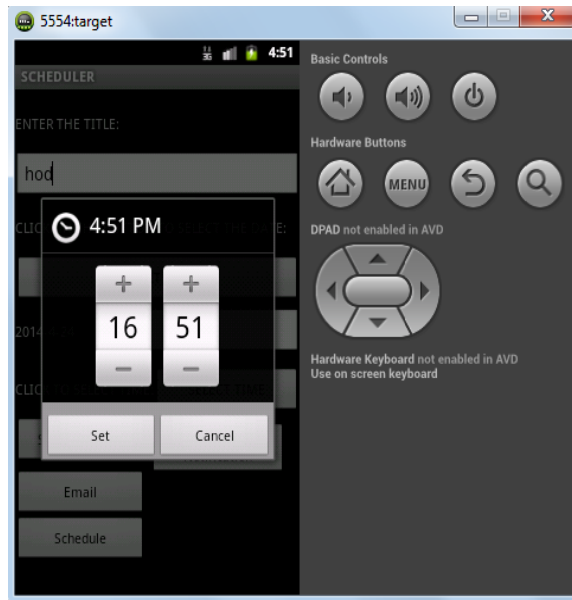


Fig.5.12. Time dialog box

After adding title, date and time of the meeting the user can click on schedule button to schedule the meeting selected from a number of buttons shown by figure 5.13. Figure 5.14 shows the screenshot of the scheduled meetings list.

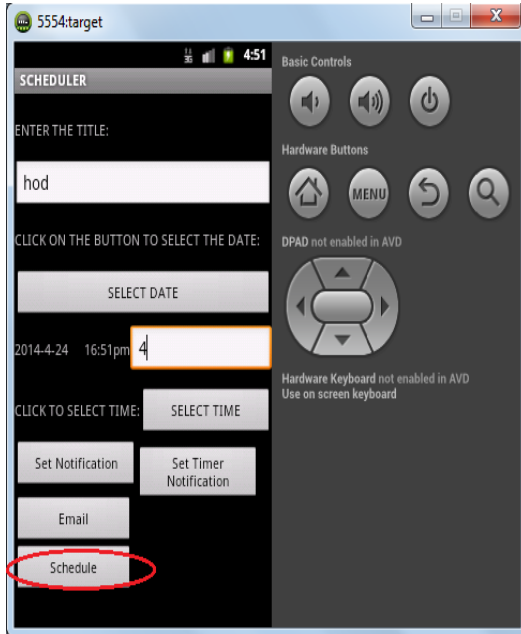


Fig.5.13. Schedule button

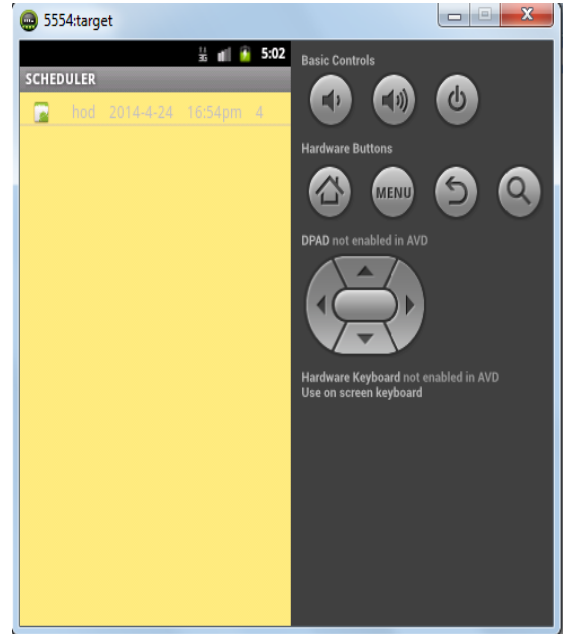


Fig.5.14. Scheduled meeting list

The scheduler agent automatically also sends the mail in the inbox of the mail box at the time the user schedule his meetings. Figure 5.15 shows the mail in the mail box.

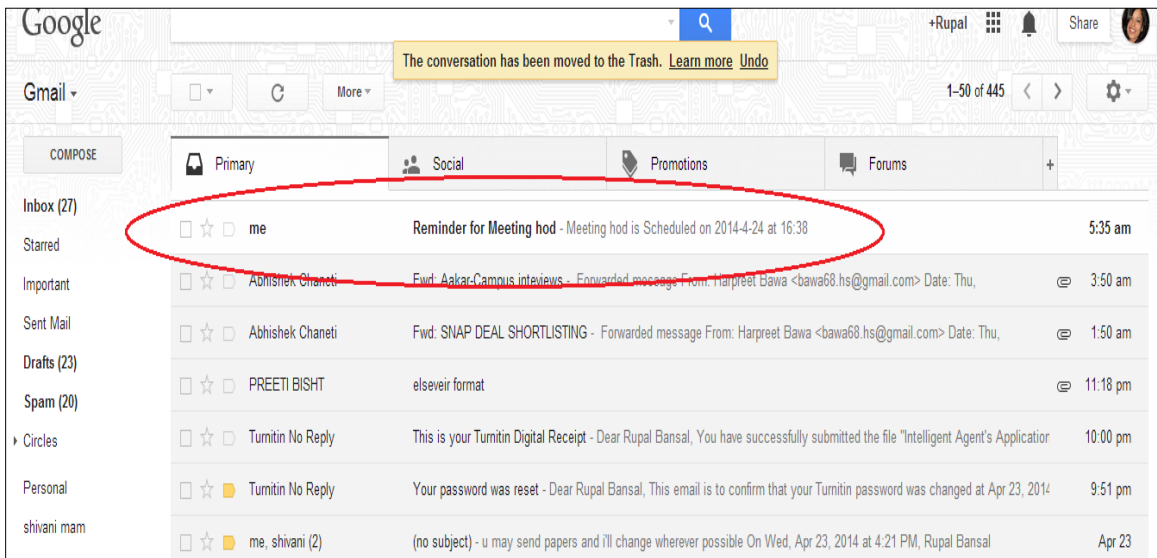


Fig.5.15 Mail in the mailbox of the user

The notification for the scheduled meeting can be instant or can also be a timer notification where the notification prompts at the set time and date. Figure 5.16, 5.17 and 5.18 depict the scenarios where the user can select within the two options and gets notifications accordingly.

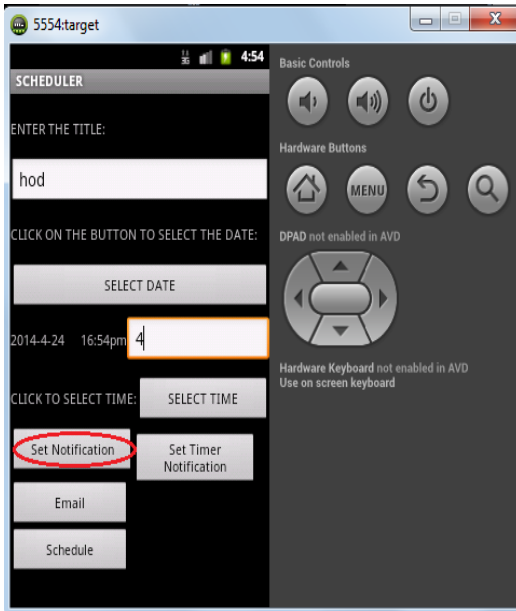


Fig.5.16. Set notification button

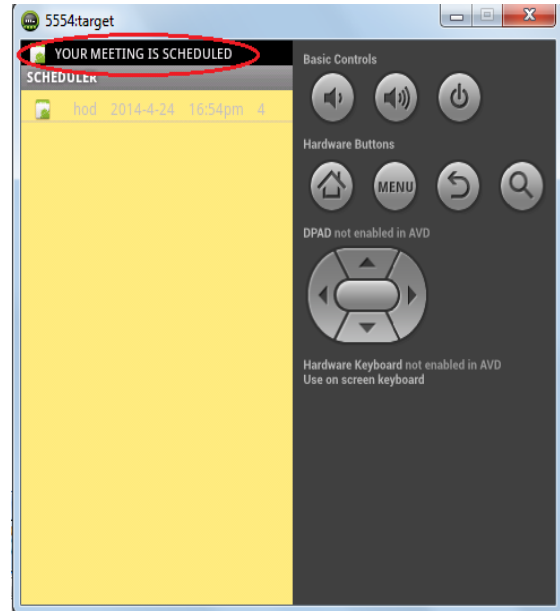


Fig.5.17. Prompts the notification

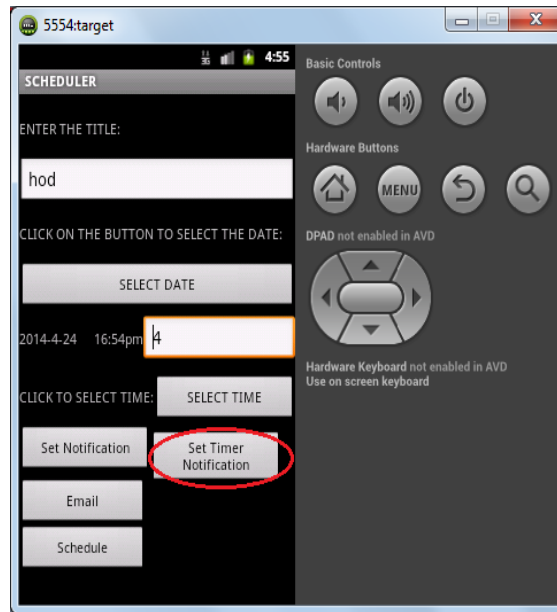


Fig.5.18. Set timer notification

After clicking on the set timer notification new screen asks for the time and date for the reminder of the scheduled meetings. A toast or a small message is given when the meeting is alarmed giving the confirmation for the meeting. Date and time dialog boxes are used for setting the time and date for the alarm. Whenever the system reached the same date and time the notification prompts showing the meeting. Figures 5.19, 5.20 and 5.21 depict the steps where the user can delay, postpone or can snooze the prompted notification.

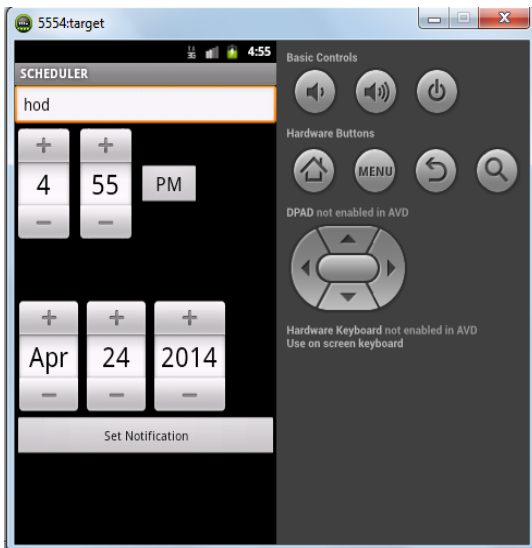


Fig.5.19.Select date and time for reminder

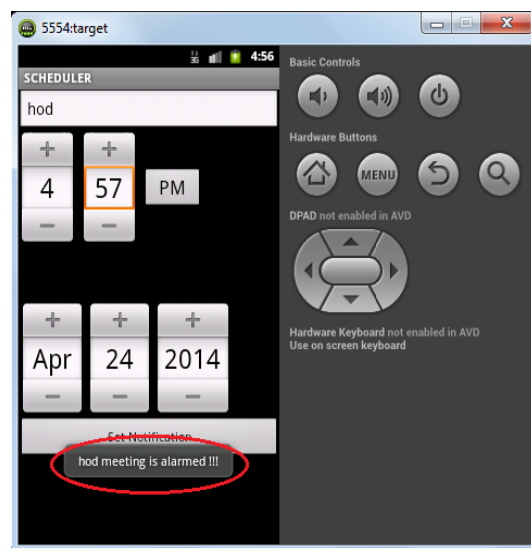


Fig.5.20 Reminder confirmation

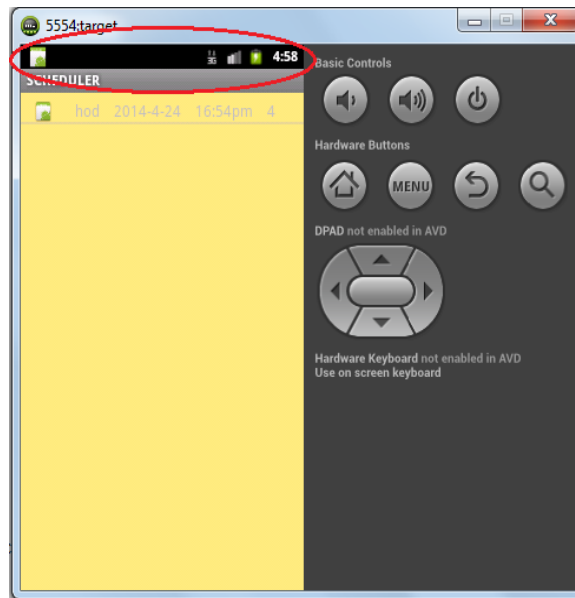


Fig.5.21. Reminder prompts at the specified time

Another email option is there where user can send emails to the other members notifying them about the meeting's time and date. Figure 5.22 and 5.23 show screenshots for sending email where the date, time and title of the meeting is automatically added in the body of the mail, the user only has to enter the email address of the recipients.

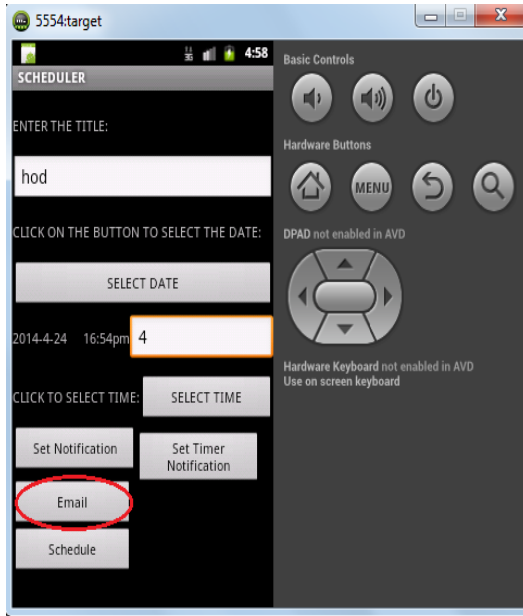


Fig.5.22.Email button

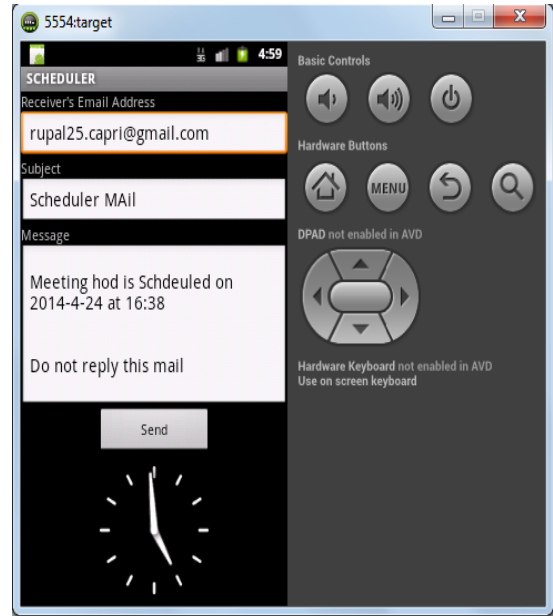


Fig.5.23.Email palette

Figure 5.24 shows the user's mail box as in example user sends mail to himself regarding meeting's time and date.

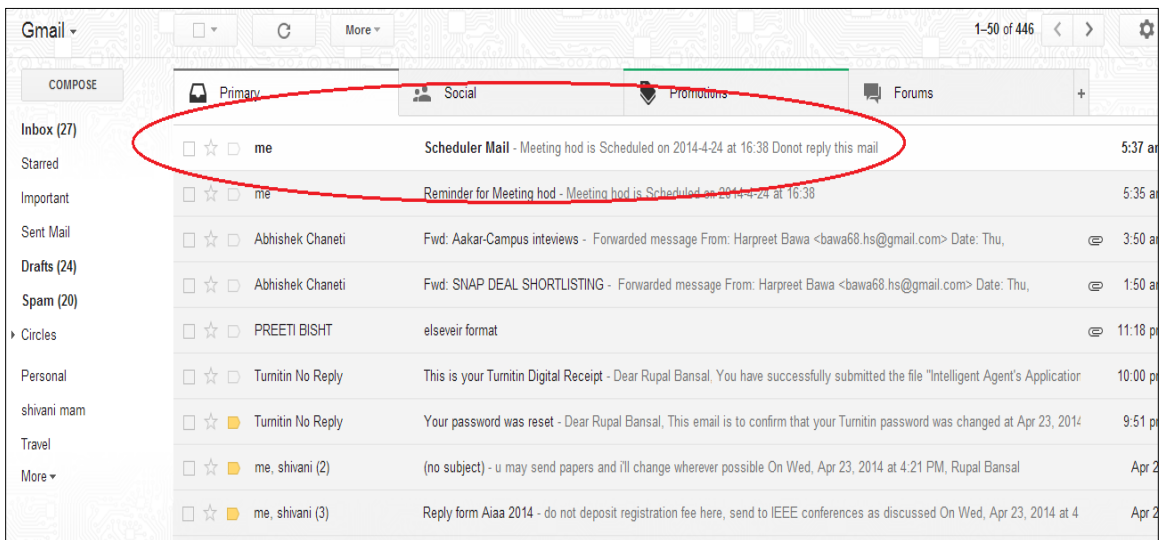


Fig.5.24. User's mail box

Figures 5.25 and 5.26 give the screenshots for starting the background service for the daily notification where user has to check the checkbox and then click the button and service starts.

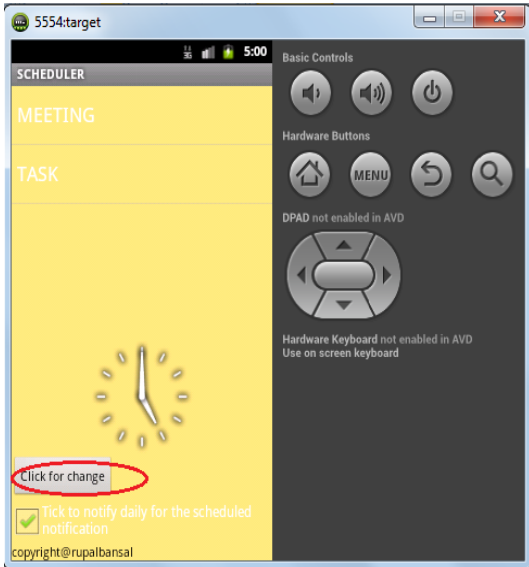


Fig.5.25.Click for daily notification service

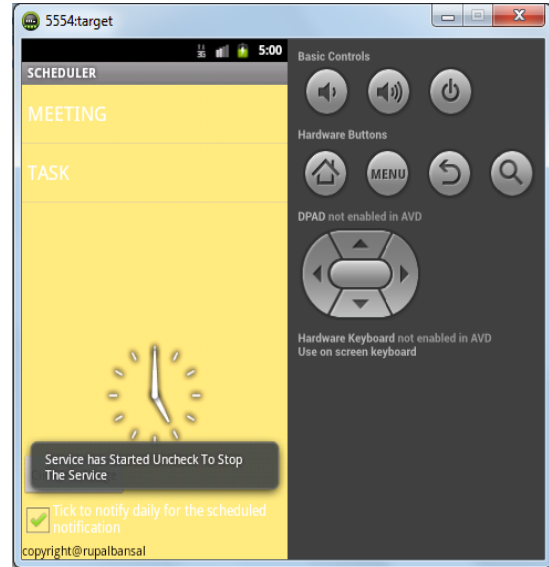


Fig.5.26.Service starts

Figure 5.27 shows the prompts for daily notification meeting which consist of all the meetings scheduled for the day by the users for reminder. This is the message which prompts daily on the basis whether the database consists of the meetings matching the current system date.

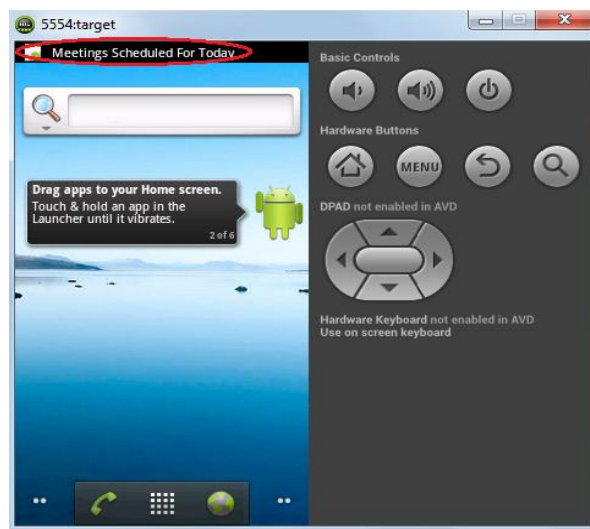


Fig.5.27 Daily notification prompts

Figure 5.28 shows the prompt message when service is stopped by the user which notifies that application no more serves any background service. Figure 5.29 and 5.30 show the second category of the task meeting and how to add the task of the user. This is the category defined to separate the formal and informal reminders; where the task category includes the informal birthdays, anniversaries reminders for the users.

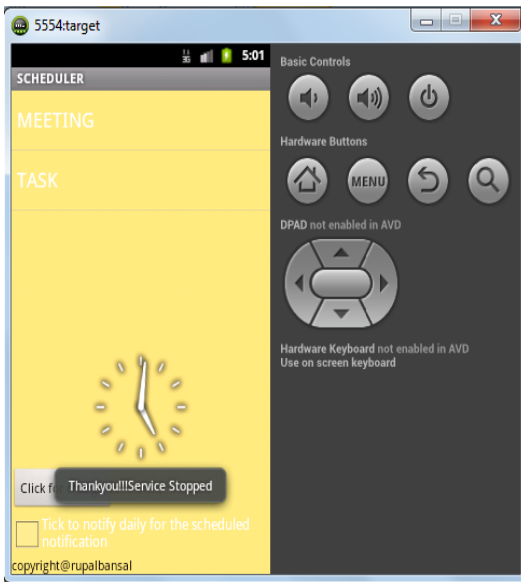


Fig.5.28. Service stopped

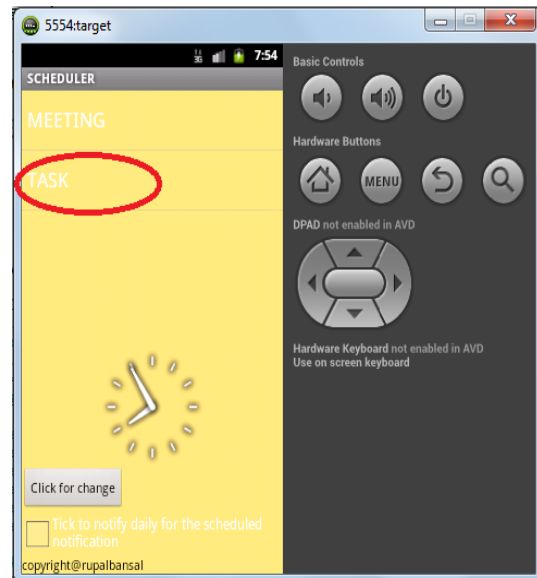


Fig.5.29. Second category

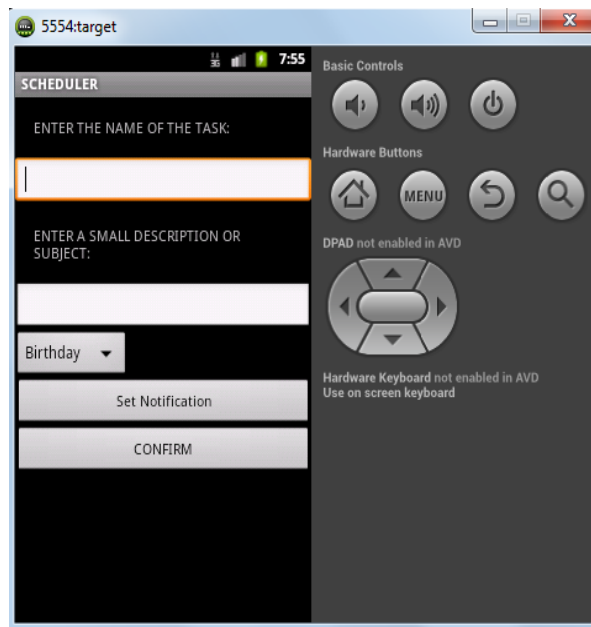


Fig.5.30. Task entry palette

CHAPTER 6: CONCLUSION AND FUTURE SCOPE

After a lot of survey about intelligent agents, various types of classification of intelligent agents are given and discussed with different other types of applications. Intelligent agent is an ever green topic which has been studied and growing from years and still is on full pace to grow and give surprising results for improving the applications and services further. The main aim of the thesis was to improve the efficiency and reliability of a service by automating it, where the intelligent agents came as a solution to automate the services and applications. Thereby, intelligent agents have been developed and used in the application called scheduler cum emailer to make it an intelligent automatic application with the help of android tools. It is called intelligent as now the application will perform some of the tasks automatically without the supervision of the human agent and will reduce the effort and time of user.

The application provides a very useful functionality where the user automatically gets the notification for meetings scheduled for the day; so that it can have a prior reminder of all his/her scheduled meetings of the day in the morning whenever he first as soon as he/she switches on his/her android mobile. Also the application gives the basic functionality where user can set the simple meeting notification either at that time only or can set a timer notification where the notification prompts only at that specified time and date. When the meeting is scheduled, at the same time user also gets the email for his/her scheduled meeting in his/her email account. This gives the facility that if the user lost his/her phone or forgets to bring then also he/she has all his/her meetings scheduled in inbox. This automatic emailing is also done by an emailer agent. The scheduler agent in the application has the main responsibility of reminding the user of all his/her scheduled meetings for the day which is the service that it performs everyday for the user without any mistake. Also it is the task of the intelligent scheduler agent to delete all older unwanted meetings in the scheduled list. Another new feature that has been added in present application is that the user can set a reminder for him/her and simultaneously he/she can also send the e-mail notification to other members. Thus, any event once scheduled in Android phone can be simultaneously communicated to all concerned

persons through e-mail. This saves the time and efforts for extra communication efforts required as well as reduce the chances of failure to communicate to anybody.

The intelligent agent who is also called as the software agent designed matches various characteristics which justifies that the agents in the application are intelligent agent. The distinct characteristics posed by the application's agent are autonomy, set and forget, Proactiveness, goal driven, benevolent, rationality, reactivity and veracity which were the characteristics possessed by any agent who called itself as intelligent. The application works in the environment which is fully observable, dynamic, stochastic and continuous. It senses its environment which is the system on which application is installed on the basis on the system date change and triggers event accordingly. The intelligent agent proposed is a multi agent system of the hybrid type which is the combination of the task agent as it completes all its tasks defined for it daily without any mistake, triggering agent which triggers whenever the condition is satisfied and the goal based agent as the agent always works towards achieving the defined goals. Thereby, the scheduler application has been automated using the intelligent agents and achieves all its features of time saving, effort saving, reliability, efficiency and usability [3].

The application proposed and created is tested on the real android phones of version 2.2 and above and got tremendous response and appreciations from various users and has stated that application reduces their tensions and worry of reminding the tasks and meetings. The application have the factor of providing the convince to the users where the users gets the reminders and emails about the meeting time and date which make sure user never forgets his/her meeting. The future scope of the thesis work is that the application can have group mailing facility for its users. Also there can be the functionality of sorting the scheduled meetings according to either the date or by priority. At present only the sorting is done through the date and then according to the priority.

REFERENCES

- [1] L. Xian, “Artificial Intelligence and Modern Sports Education Technology”, *International Conference on Artificial Intelligence and Education (ICAIE)*, pp. 772-776, Oct 2010.
- [2] E. Charniak and D. McDermott, “*Introduction to Artificial Intelligence*”, Pearson, fourth edition, 2009.
- [3] J. M. Haight and V. Kecojevic, “Automation vs. Human Intervention: What is Best fit for the best performance?”, *Published online in Wiley InterScience*, pp. 45-51, 2005.
- [4] S. Murugesan, “Intelligent software agents on the internet and web”, *TENCON’ 1997 IEEE region 10 annual conference*, 1997.
- [5] G. Li, “Research on several strategy based on agent of intelligent function in the application”, *2nd IEEE International Conference on Computer Science and Information Technology*, held August 8-11 2009 at Beijing Convention Center, Beijing, China, pp. 542-545, 2009.
- [6] A. Nareyek, “Intelligent agent for computer games”, *In Proceedings of the 16th National Conference on Artificial Intelligence*, held July 18–22, 1999, at the conference center in Orlando, Florida, 1999.
- [7] S. Kaushik, “*Artificial intelligence*”, Cengage Learning India Pvt. Ltd., pp. 517-520, 2011.
- [8] S. Sharma, “Intelligent agents in a goal finding application for homeland security”, *Proceedings of IEEE southeastcon*, pp. 1-5, 2012.
- [9] W. Huang, J. Jin, N. Wang and F. Wang, “Technology and Application of Intelligent Agent in Electronic Commerce”, *International Conference Measuring Technology and Mechatronics Automation (ICMTMA)*, vol.3, pp. 730-733, 2010.
- [10] C. Huang, D. Chen and H. Hu, “Intelligent agent-based scheduling mechanism for grid service”, *Proceedings of 2004 International Conference on Machine Learning and Cybernetics*, vol.1, pp. 16-21, 2004.

- [11] S. Bhat, N.S. Sidnal, R.S. Malashetty and S.S. Manvi, “Intelligent Scheduling in Health Care Domain”, *IJCSI International Journal of Computer Science Issues*, vol. 8, no. 3, pp. 214-224, 2011.
- [12] Technical appendix on software agents [online]. Available: http://wps.prenhall.com/wps/media/objects/5073/5195381/pdf/Turban_Online_TechAppC.pdf.
- [13] J. Russell and P. Norvig, “*Artificial Intelligence: A Modern Approach*”, Upper Saddle River, NJ: Prentice Hall, 1995, pp. 33.
- [14] P. Maes, “Artificial Intelligence Meets Entertainment: Life-Like Autonomous Agents,” *Communications of the ACM*, 1995, pp. 108.
- [15] D. Gilbert, Intelligent Agents: The Right Information at the Right Time [online]. <https://fmfiuk.hq.sk/Informatika/Uvod%20Do%20Umelej%20Inteligencie/clanky/ibm-iagt.pdf>.
- [16] B. Hermans. Intelligent Software Agents on the Internet [online]. Available: <http://www.agent.ai/doc/upload/200302/herm97.pdf>.
- [17] S. Franklin and A. Graesser. A Taxonomy for Autonomous Agents [Online]. Available: <http://www.msci.memphis.edu/~franklin/AgentProg.html>.
- [18] E. Homayounvala, A.H. Aghvami and I.S. Groves, “On migration policies for personal assistant agents embedded in future intelligent mobile terminals”, *Sixth IEEE International conference on 3G and Beyond*, pp.1-5, 2005
- [19] I.F. Imam, “Adaptive Applications of Intelligent Agents”, *Ninth International Symposium on Computers and Communications ISCC*, vol.1, pp. 7 – 12, 2004.
- [20] Z. Shen, R. Gay and X. Tao, “Goal-based intelligent agents”, *International Journal of Information Technology*, vol. 9, no. 1, 2003.
- [21] U. Rafique, Y. S. Huang and Y. C. Miao, “Motivation Based Goal Adoption for Autonomous Intelligent Agents”, *IEEE/WIC/ACM International Conferences on Web Intelligence and Intelligent Agent Technology*, vol. 2, pp. 54-57, 2011.
- [22] M. Wooldridge, “*An Introduction Multi Agent System*”, John Wiley & Sons Inc, pp. 172-187, 2003.
- [23] R. Yamada, H. Nakajima, S. B. Brave et.al., “An Implementation of Socially-Intelligent Agents providing Emotional Support and its Application”, *IEEE*

- International Conference on Systems, Man, and Cybernetics*, vol.1, pp 322-326,2006.
- [24] N. F. Matsatsinis, P. Moratis, V. Psomatakis and N. Spanoudakis, “An Intelligent Software Agent Framework for Decision Support Systems Development”, *Compositional formal specification of multi-agent systems*, 2000.
- [25] A. Hylton III and S. Sankaranarayanan, “Application of Intelligent Agents in Hospital Appointment Scheduling System”, *International Journal of Computer Theory and Engineering*, vol. 4, no. 4, 2012.
- [26] S. Sankaranarayanan and K. Cuffe, “Intelligent agent based scheduling of student appointment-android environment”, *5th International Conference on Computer Sciences and Convergence Information Technology (ICCIT)*, pp. 46 – 51, 2010.
- [27] R.A. Brown and S. Sankaranarayanan, “Intelligent Agent based Mobile Shopper”, *IFIP International Conference on Wireless and Optical Communications Networks*, pp. 1-7, 2009.
- [28] W. Liu and N. Liu, “An Intelligent Sales-agent Interface Prototype for B2C Online Shop”, *International Conference on Computer Science and Service System (CSSS)*, pp. 196 – 199, 2011.
- [29] A.Sánchez-Guzmán, C. Mora and R. García-Salced, “Intelligent Agents: A Physics Education Opportunity in Latin-America”, *Lat. Am. J. Phys. Educ.*, vol. 3, no. 2, 2009.
- [30] N. Karacapilidis and P. Moratis, “Intelligent Agents for an Artificial Market System”, *Fifth International Conference on Autonomous Agents ACM*, pp. 592-299, 2001.
- [31] R. Khosla, M.-T. Chu, K. Tohi, K.G. Yamada, K. Kuneida and S. Oga, “Emotionally Intelligent Agents for Human Resource Management”, *IEEE/WIC/ACM International Joint Conferences on Web Intelligence and Intelligent Agent Technologies*, vol. 3 , pp. 349 – 352, 2009.
- [32] P. Maes, “Agents that Reduce Work and Information Overload”, *Magazine Communications of the ACM* , vol. 37, no.7, pp. 30-40, 1994.

- [33] S. Ho, "A grand challenge for computational intelligence a micro-environment benchmark for adaptive autonomous intelligent agents", *IEEE Symposium on Intelligent Agent (IA)*, pp.44-53, 2013.
- [34] Android developers [online].Available: <http://developer.android.com/>.
- [35] Expert Android and Eclipse development knowledge [online].Available: <http://vogella.com/>.
- [36] R. Meir, "*Professional Android Application Development*", Wiley Publishing, Inc., pp. 10-15, 2009.
- [37] P. Yong-Cai, L.Wen-chao and L. Xiao, "Development and Research of Music Player Application Based on Android", *International Conference on Communications and Intelligence Information Security*, pp. 23-25, 2010.
- [38] J. Liu and J. Yu, "Research on Development of Android Applications", *IEEE 4th International Conference of Intelligent Networks and Intelligent Systems (ICINIS)*, pp. 69-72, 2011.
- [39] R. Grgurina, Brestovae G. and Grbac T.G., "Development Environment for Android Development: an Experience Report", *IEEE 34th International Convention on MICRO*, pp. 1693-1698, 2011.
- [40] Eclipse Project [online].Available: <http://www.eclipse.org/eclipse/>.

LIST OF PUBLICATIONS

- [1] R. Bansal, S. Goel, “Intelligent agent in scheduler cum emailer application”, accepted for publication in *2nd International Conference on Emerging Research in Computing, Information, Communication and Application-ERCICA2014*, Bangalore, August 2-3, 2014 (Sponsored by Elsevier).
- [2] R. Bansal, S. Goel, “Developing A Scheduler cum e-mailer Application for Android”, Communicated in March 2014 in *Information Resource Management Journal (IGI Global)*, USA, 2014