CHAPTER 1

INTRODUCTION

1.1 HEALTH CARE SECTOR

Healthcare has turn into one of India’s major sectors both in terms of returns and employment. The industry covers hospitals, health devices, medical tourism, outsourcing, clinical trials, telemedicine, health insurance and medical equipments. Rise in population and increasing living expect, highlight the elevated domestic exact for healthcare services.

The author (Vidhi Maingi 2015) stated that, the domestic healthcare sector is expected to increase to $100 billion by 2015, according to the India Brand Equity Foundation and 71% of this development is expected to take place in hospitals. Presently, India stands at a cross-road of high-end multi-specialty private healthcare services on one end and lack of doctors, support staff, drug facilities at the other.

1.1.1 Problems in Healthcare Services

- The constant problem facing is still access to affordable hospitalization and clinical care.

- The WHO Report (2012) stated that the Doctor-Nurse density per 10,000 persons of the Indian population is an atrocious 19 (6 doctors and 14 nurses).
• Rustic India, which accounts for more than 70 per cent of the common people, is set to emerge as a future demand source. Only 3 per cent of expert physicians outfit to rural demand.

• The value of healthcare services has been rising and embarrassment severe challenges for healthcare providers, hospitals and the patients.

1.1.2 Existing Healthcare Environments

• Most medical information systems use manually recorded vital sign data for patient care and control.

• Nursing staff are responsible for the care of critically ill patients.

• Medical staff cannot automatically notice abnormalities and provide immediate health care services.

• The physician has to frequently visit the patient and asses his/her condition by measuring the parameters such as temperature, blood pressure, drip level etc. In case of emergencies, the nursing staff has to inform the doctor through some means of communication likes mobile phone.

• In most of the hospitals the continuous patient monitoring system is used only in Intensive Care Unit (ICU) not for all wards.

• From the problems identified, the existing health care systems are manual inspections, labor-intensive, prone to human errors, experience-based judgments from clinicians and nurses
finally ineffective. It introduces huge amount of pressure on clinicians and nurses as stated by Mengling Feng et al (2011).

Hence, here promptly we need an effective mechanism to address affordable and quickly available healthcare for all.

1.2 PATIENT MONITORING SYSTEM

1.2.1 Introduction to PMS

Patient Monitoring System (PMS) is a distributed platform to deliver healthcare services to both patients and practitioners.

The author (Hudson LD 2011) stated that, the patient monitoring system can be thoroughly defined as “repeated or continuous observations or measurements of the patient, his or her physiological function and the function of life support equipment for the purpose of guiding management decisions including when to make therapeutic interventions and assessment of those interventions”.

1.2.2 Type of Patients Need Continuous Monitoring

The patients who need continuous monitoring in hospital environment are listed below.

- Patient who has severe myocardial infarction (heart attack).
- Patient whose respiratory system is suppressed by a drug overdose or anesthesia.
- Patients immediately after open-heart surgery.
- Patients with multiple pain or tainted shock.
• Premature infant whose heart and lungs are not fully developed.

• Mother and baby during the labor and deliverance process.

1.2.3 Need for Computerized Monitoring

Close monitoring and timely treatment are extremely essential to prevent patients from critical situations. The continuous 24 hours patient monitoring is not possible by a human being. Hence the computers are used for the following purposes:

• To obtain physiological data normally or continuously, such as blood pressure, temperature, Heart rate readings.

• To supply clinical alert messages and advisories based on multiple sources of data.

• To converse information from data-producing systems to distant locations (e.g., laboratory and radiology departments).

• To integrate and associate data from multiple sources.

• To measure the severity of illness for patient classification purposes.

• To function as a decision-making tool that health care professionals may use in planning the care of critically ill patients.

• To analyse the outcomes of ICU care in terms of clinical effectiveness and cost effectiveness.
1.2.4 Renovation in Patient Monitoring

The development of new healthcare systems for nursing and critical care, necessitate automatic vital sign monitoring, alarm system, data integration and data communications across different sites such as hospitals, critical care facilities and outpatient clinics. Nowadays with advanced technologies more number of patient monitoring systems are developed and utilized in an effective manner. Some of them are listed here.

- Remote patient monitoring
- Home based patient monitoring
- Mobile based patient monitoring
- Internet based patient monitoring
- Intensive care patient monitoring
- Elderly patient monitoring
- Agent based patient monitoring

All the above mentioned systems are bring into play the wireless sensor network systems for effective monitoring. The Artificial Intelligence and data mining techniques are also the main areas used in monitoring systems.
Wireless sensors wearing by patients convey vital signs to personal server, which is operation on PDA devices such as, tablet, smartphones or laptop. In sequence, the data is transmitted to the room server (hospital server) of the healthcare system from personal server, such as medical database or emergency server over in Network. From the server the patients data are analysed by healthcare networks (like Doctors, Experts or Nurse). Figure 1.1 illustrates the Patient monitoring system in hospital environment.

1.3 WIRELESS SYSTEMS IN CLINICAL CARE

Wireless monitoring of vital signals of a huge number of patients is one of the present needs in order to organize a complete wireless sensor network in healthcare system. In recent times, interest in wireless systems for health applications has been rapidly increasing. Moreover, with all of these concealed wireless methods for medicinal application are now not only listening carefully by healthcare peoples and the government, also by researchers and business.
The advances in information and communication technologies enable technically, the continuous monitoring of health related parameters with wireless sensors.

1.3.1 Limitations of Wired Systems

Traditionally, the sensor devices are close to patient by wires and the patient uninterruptedly becomes bed-bound. In case, the patient needs to be moved, every monitoring appliance has to be detached and then reconnected afterward.

If a patient is admitted in ICU a regress monitoring of health parameters is done. But consider if a patient is admitted in a normal ward there advance measurement systems doesn’t exist. In such cases nurse goes to ward and measures patient’s body parameters for every certain interval of time. During this manual measurement there is chance of missing the accuracy due to inefficient nurses, the measurement records which are taken by nurses are analysed by doctors as reference of disease diagnosis. If the measurement goes wrong the diagnosis fails or misleads.

Compared with wireless networks, wired networks contain one of the biggest growing problem is wires. Complicated wires and power cords are difficult to manage and hugely degrade the flexibility. Wiring and rewiring are the bottleneck of development of wired networks.

So, aiming to solve the above mentioned problems by sensor technology, we ought to need an entirely wireless Clinical care system. Figure 1.2 illustrates the wireless network based Clinical care system.
In this system, the wireless Body Area Network (WBAN) used to collect physiological signals of patients. The acquired signals are fed into the personal server all the way through Wireless Personal Area Network (WPAN). The wireless communication among the sensor nodes and the personal server uses ZigBee standard. Later, arriving to the hospital server, the data is accessible to a clinician through hospital’s Wireless Local Area Network (WLAN) in PDA Devices. Finally clinicians can analyse the physiological data and give analysis advices accordingly.

1.3.2 Advantages of Wireless Clinical care Systems

- Continuous patients monitoring and data updation.
- Minimize workload and boost effectiveness of hospital staff.
- Improve the comfort of the patients and enhance mobility.
- Reduced risk of infection and risk of failure.
- Low cost of care delivery with higher efficiency.
- Guarantee patients health and keep life.

1.4  DESIGN OF WIRELESS PATIENT MONITORING SYSTEM

Prior to design a wireless patient monitoring system the following things need to study.

1.4.1  Wireless Sensor Network

Wireless Sensor Network (WSN) technologies are well planned one of the key research spot in computer science and the healthcare appliance industries for improving the worth of life.

Karlsson et al. (2005) stated that, a sensor network with intelligent behavior is a system that can get used to the situation, present information that is relevant for the moment and a system that has reasoning parts that are designed to function with low-level rules and work together to achieve a high-level goal.

A WSN consists of spatially dispersed and dedicated sensors that can gather, monitor process and record the substantial or ecological conditions such as temperature, humidity, sound, pollution levels, pressure etc, and collaboratively pass their data through the network to a vital location. Currently, WSN can be found in different healthcare applications like Glucose level monitoring, monitoring insecure diseases and Infant monitoring etc., stated by (Mehmet Yuce 2010). WSN has its own features, such as low cost and low energy consumption, deployed in difficult-access areas and the ability of self-configuration.
1.4.2 Wireless Body Area Network

For healthcare sources, hospitals, policy makers, insurance companies and patients, the cost of healthcare services has increased and this has been posing severe challenges. A major problem to be tackled is taking care of the health care services of a great number of patients surrounded by simple reach in the circumstances.

A Wireless Body Area Network (WBAN) is a unique design sensor network that acts as a boundary between different sensors in and around the human being body and the computer. They consist of a number of physiological sensors attached to the human body or implanted in the body that will trace and process the physiological changes, sending these measurements to an outer processing part, which could be then transmitted to additional external servers. One of the targeted purpose of WBAN is in health environments, where conditions of a huge number of patients are constantly being monitored in real-time proposed by Mehmet R Yuce et al (2008). Figure 1.3 shows an illustration for Body Area Network.

![Figure 1.3 Body Area Network](image-url)
1.4.2.1 Advantages of WBAN

- Patients equipped with BSNs need not be physically present before the doctor for their diagnostic.
- Physicians can examine patient’s physiological records in time and then provide real-time analysis advices which are significant to patient’s progress.
- Modest wearable sensors permit physiological data to be collected routinely, reducing the carrying cost and usual visits to the physician.
- Physician can take care of a small amount of patients at the same time, thus reduces staff expenses.
- BSNs can sense minute changes in vital signals e.g. blood-oxygen or heart rate and levels that are not understandable in a one-off appointment to a doctor.

1.4.2.2 Wireless Body Sensors

Wireless based non-confining checking systems recover the quality of life for the patients while serving as a cost valuable solution to the difficulty of health care monitoring that is degeneration with the raise in the aging people. The Wearable Body Sensors are the sensors which are formed wearable or implantable in patient’s body in view of the fact that the name is Wearable Body Sensor Network. (Image courtesy: sunrom.com)
Figure 1.4 Some of the Wireless Body Sensor Devices

Figure 1.4 illustrates some of the wireless body sensor devices, by using this type of devices the patients are monitored from anywhere and movable to anyplace inside the hospital with limited location. Here the above mentioned sensors are explained clearly.

(a) **BP and Heart rate Sensor**

This product gives blood pressure reading along with heart rate for personal monitoring and reference.

(b) **Pulse Monitoring Sensor (SpO2 Sensor)**

This sensor is useful in making Pulse oximetry, which is a test that measures what proportion of the oxygen-carrying molecules in the blood (called hemoglobin) are actually carrying oxygen. This is known as oxygen saturation or SpO2. It is regularly attached to a health monitor so staff nurses can observe a patient’s oxygenation at all time.
(c) **ECG Sensor**

This sensor is used to monitor the ECG signals. It is easy to fix to chest to haul up ECG signals. The centre is filled with liquor electrode gel for fine contact and pickup. Eliminate plastic backing sheet to rendering the adhesive. Then attach to chest and fix to ECG module for signal pickup. It gives high-quality stabilization and speedy reading.

(d) **Heart Beat Sensor**

It can be attached to finger and get Analog output from the sensor based on heart beat pulse. We can read the analog output with microcontroller ADC and then plot it or calculate readings like heart beat per minute.

(e) **Temperature Sensor**

The temperature sensor used to monitor the temperature level of the patients.

<table>
<thead>
<tr>
<th>S.NO.</th>
<th>SENSORS</th>
<th>PURPOSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Electrocardiogram sensor (ECG)</td>
<td>Monitoring heart activity</td>
</tr>
<tr>
<td>2</td>
<td>ElectroMyogram sensor (EMG)</td>
<td>Monitoring muscle activity</td>
</tr>
<tr>
<td>3</td>
<td>Electroencephalogram sensor (EEG)</td>
<td>Monitoring brain activity</td>
</tr>
<tr>
<td>4</td>
<td>Blood pressure sensor</td>
<td>Monitoring BP level</td>
</tr>
<tr>
<td>5</td>
<td>Tilt sensor</td>
<td>Monitoring trunk position</td>
</tr>
<tr>
<td>6</td>
<td>Breathing sensor</td>
<td>Monitoring respiration</td>
</tr>
<tr>
<td>7</td>
<td>Motion sensors</td>
<td>discriminate the user’s status and stages of activity</td>
</tr>
<tr>
<td>8</td>
<td>Temperature sensor</td>
<td>Monitoring the temperature level</td>
</tr>
<tr>
<td>9</td>
<td>Drip Sensor</td>
<td>Monitoring the saline level</td>
</tr>
<tr>
<td>10</td>
<td>Skin sensor</td>
<td>Monitoring the blood flow</td>
</tr>
</tbody>
</table>
Table.1.1 List out the various types of body sensor with their use.

1.4.3 **Wireless Private Area Network**

WPAN using Bluetooth or ZigBee standards are ahead in popularity with wireless motes existing from industry. A number of vital sign monitoring systems have been proposed and deployed in existent medical settings. In count to patient observing these systems can be used for patient tracking in conditions where locality information is essential. The rising cost of in-bed hospitalization and the current technological advances in low-power incorporated circuit sensors coupled with the opening of power proficient protocols such as Bluetooth or ZigBee has tempted researchers to study the establishment and practice of wireless networks as a medium for transmitting patients’ related information with no need to confine them to a premise.

Latest advances in low-power wireless communication technologies like ZigBee (IEEE 802.15.4), Bluetooth etc. have enabled the progress of small, body-wearable, wireless sensors system for patient monitoring. One such design is shown in Figure 1.5 in which the body sensors are the Bio Front End Devices (BFEDs) and they permit monitoring of different bio-parameters (such as Heart beat, ECG, Blood Pressure, etc.) of a number of patients at a central place.
1.4.4 Wireless Data Transmission System

The fast development of the technologies extends the prospective for exploitation of wireless health relevance market. At this time, credit to the major wireless network approach, such as cellular 3G and beyond, Wi-Fi mesh caregivers can contact into vital information wherever and at whichever within the healthcare network. The current pervasive computing, consisting of RFID, ZigBee, Bluetooth and Wi-Fi. BAN with sensors consuming very low power is used to supervise patients in serious conditions inside the hospital.
Figure 1.6 Data Rate vs. Power of Wireless Transmission Techniques

Figure 1.6 represents the various Wireless transmission medium with their data rate and power utilization.

Figure 1.7 Types of Wireless Transmission Medium
The Figure 1.6 shows some of the wireless transmission medium, the details are given below.

(a) ZigBee Module

(b) Bluetooth Module

(c) External Antenna Wi-Fi Module

(d) GSM Modem

The Table 1.2 represents the comparison of wireless data transmission technologies. Compared to Bluetooth and Wi-Fi, ZigBee provides advanced network flexibility, bigger number of nodes and a better transmission series with low power utilization.

**Table 1.2 Comparisons of Wireless Data Transmission Technologies**

<table>
<thead>
<tr>
<th>Name</th>
<th>Bluetooth</th>
<th>ZigBee</th>
<th>Wi-Fi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical layer standard</td>
<td>802.15.1</td>
<td>802.15.4</td>
<td>802.11</td>
</tr>
<tr>
<td>Application</td>
<td>Cable Replacement</td>
<td>Monitoring &amp; Control</td>
<td>Web,e-mail ,voice data</td>
</tr>
<tr>
<td>Network Size</td>
<td>7</td>
<td>100s -1000s (unlimited)</td>
<td>32</td>
</tr>
<tr>
<td>Transmission Range meters</td>
<td>1-10+</td>
<td>1-100+</td>
<td>1-300+</td>
</tr>
<tr>
<td>Battery Life (days)</td>
<td>1-7</td>
<td>10-100</td>
<td>0.5-5</td>
</tr>
<tr>
<td>System Resource(Data)</td>
<td>250 KB+</td>
<td>4-32KB</td>
<td>1MB+</td>
</tr>
<tr>
<td>Maximum Data Rate (KB)</td>
<td>720</td>
<td>20-250</td>
<td>11,000+</td>
</tr>
<tr>
<td>Security</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Network Architecture</td>
<td>Star</td>
<td>Mesh</td>
<td>Star</td>
</tr>
<tr>
<td>Success Metrics</td>
<td>Low Cost</td>
<td>Reliability, low Power, low Cost, Scalability</td>
<td>Speed, Flexibility</td>
</tr>
</tbody>
</table>
1.4.5 GSM Modem

A Global System for Mobile communications (GSM) modem is a wireless modem that functions with available 2G networks. A wireless modem is a device which establishes the communication between a PC and wireless network by generating, transmitting and decoding data from a cellular network. A wireless modem behaves like a dial-up modem. The main difference is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves. A GSM modem requires a subscriber identity module (SIM) card to operate, but the modem is controlled by computers through AT-commands. Some standard AT (ATtention) commands are supported by both GSM modems and dial-up modems. GSM modem also supports few extended sets of AT-commands.

1.5 INTELLIGENT AGENTS IN CLINICAL CARE

1.5.1 Introduction

Information systems were previously only able to perform statistical analysis and epidemiology. With the technology advancement and performance increased allowing more complete and complex software in hospitals. Classical computation paradigms fall short when trying to model an environment with such a variety of users and complex processes with interactions.

There is a requirement for dependable and reliable information flow between all participating subjects with intends to satisfy the universal goal improved health of a patient, i.e., "the capability of two or more systems or components to exchange information and use the information that has been exchanged". To assure these requirements and offer adequate decision
support, the use of flexible intelligent software support is becoming gradually more enviable.

Nowadays agents have an imperative and basic role in many sensible programs of E-health in which the illness analysis system, the patience and accelerate in healing and anticipation of dynamic data delivery are noticeable. Hence the E-health features, particularly the message and communication have increased the demand of agent.

Agent technology has emerged in the last years as a new and promising paradigm focused on the modeling, design and development of complex systems. It has become a leading area of research in Artificial Intelligence (AI). Agent knowledge offer well-organized and normal solutions, because they go with to the main properties of the medical field, namely problem-solving capabilities, distribution of information, resources, and responsibilities, decision-making with imperfect information, iterative modification of plans.

1.5.2 **Intelligent Agent**

An Agent is a computer program that is able to perform automatic and independent functions. The most common definition for agent is that “an agent is anything that can autonomously interact with its environment”.

Zeinab Abbasi Khalifehlou et al (2014) discussed some of the classification of attributes. The attributes are reactivity, autonomy, learning, cooperation, reasoning, communication, and mobility. An intelligent agent perceives its environment and makes informed decisions based on its perceptions and acts accordingly. They can interact with other kinds of entities including humans, machines and other software agents in various environments and platforms. Figure 1.8 illustrates Intelligent Agent concept.
1.5.3 Common Properties of Intelligent Agents

- **Autonomous** - Intelligent acting without straight external intrusion.

- **Adaptive** - proficient of responding to further agents and/or its location

- **Coordinative** - able to carry out some actions in a shared setting with other agents, via an arrangement, workflows, or some other route mechanism.

- **Cooperative** - able to synchronize with other agents to complete a common purpose.

- **Competitive** - able to direct with other agents where the success of one agent implies the crash of others.

- **Interactive** - communicates with the background and additional agents.
• **Intelligent** - state is formalized by information (i.e., beliefs, goals, plans, and assumptions) and interacts with other agents using symbolic idiom.

• **Mobile** - able to move itself from one location to another.

• **Proxy** – Agent may do a bit on behalf of somebody or something.

• **Proactive** - goal-oriented, persistent and does not just react.

• **Rational** - able to act based on inner goals and knowledge.

• **Transparent and accountable** - must be transparent when required, yet must give a log of its activities ahead demand.

• **Trustworthy** - adheres to Laws of Robotics and is truthful.

## 1.5.4 Multi Agent System

A Multi-Agent System (MAS) is an illustration of distributed systems collected by agents. Multi-agent systems can be considered a fitting technology for the improvement of healthcare applications where the use of loosely coupled and mixed components, the active and distributed supervision of data and the remote association among users are often considered the most significant requirements. MASs are innovative methods for solving and implementation of computerized software systems in which the agents is collection of software classes factually.

Mohammad Kalmarzi Moghaddam et al (2013) suggested the most important objective of multi-agent systems is to present structure principles of compound systems involving a number of agents and mechanisms to organize the behavior of these agents. Agents are working together to attain entire goals in the system. Agent collaboration can enlarge processing pace and by
its unique characteristics such as intelligence and acquaintance raise the quality and efficiency.

**Major motivations for using MAS:**

- Need of some domain to multi-agent systems.
- To increase the speed with parallelism.
- Reliability.
- Extensibility.
- Programmer easier.

**1.5.5 Uses of Intelligent Agents**

- To improve the performance of a computerized system in terms of interoperability, scalability and reconfigurability.
- Offer added values over classical software approaches (e.g., reusability, reliability, flexibility, robustness, maintainability and adaptability).
- To supports the integration of legacy systems, tackling the shortcomings of centralized systems, such as performance bottlenecks, resource limitations.

Table 1.3 represents some of the Applications of Agents in Medical Field
Table 1.3 Agent Applications in Medical Field

<table>
<thead>
<tr>
<th>FIELD</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical Data Management Systems</td>
<td>Focused on the retrieval and processing of medical data (e.g., electronic health record)</td>
</tr>
<tr>
<td>Remote care Approaches</td>
<td>Aimed to remotely monitor the status of patients allowing pervasive care.</td>
</tr>
<tr>
<td>Decision Support Systems</td>
<td>Approaches aimed to assist the professional in the execution of healthcare processes such as treatments or diagnostics.</td>
</tr>
<tr>
<td>Planning and Resource Allocation</td>
<td>Systems centered on the coordination and scheduling of human and material resources.</td>
</tr>
<tr>
<td>Composite Systems</td>
<td>Systems which offer complete and integrated solutions for healthcare management for a concrete organization.</td>
</tr>
</tbody>
</table>

1.5.6 The Boundaries of Agents

Although agent technology has an important role to play in the development of leading-edge computing applications, it has some boundaries. It should be noted that the very nature of the agent paradigm leads to a number of limitations, common to all agent-based applications which are:

- No overall system controller.
- No global perspective.
- Trust and delegation.
1.6 AGENT DEVELOPMENT

1.6.1 Agent Oriented Programming

Agent-Oriented Programming (AOP) is a comparatively new software model that takes conception from the premise of artificial intelligence into conventional area of distributed systems. AOP effectively models an appliance as a set of components named agents that are characterized by amongst other things, autonomy, proactivity and capability to communicate.

Agent-oriented software engineering is support on Agent techniques. The key point of agent-oriented software engineering is to make methodology, tools and amenities for easy preparation and preservation of agent based software.

1.6.2 Agents versus Objects Programming

Agent Oriented Programming (AOP) brings about a number of innovative thoughts that are unknown to object oriented programming (OOP).

Object Oriented Approach

- OOP views the computational system as made up of modules (classes and objects).
- Each module carries out a particular task.
- Modules can communicate with each other and have individual ways of handling messages.
Agent Oriented Approach

- AOP specialize the framework by fixing the state of the agents consists of components such as beliefs, capabilities, and decisions.
- Various constraints are placed on the state of the agent.
- A computation consists of these agents informing, requesting, offering, accepting, rejecting, completing and assisting one another.

1.6.3 JADE Tool for Agent Development

Building and implement multi-agent environments, more tools and applications are existing. This proposed agent patient monitoring system exploits this JADE Tool for Intelligent Agents creation. Following illustrates the Jade Technology for Agent oriented Programming.

JADE is probably the most widespread agent-oriented framework in use today. It has been applying in a platform of projects and applications, both from the academic and the industrial communities.

JADE is a software framework to aid the development of agent applications in compliance with the FIPA specifications for inter-operable intelligent multi-agent systems. JADE is an Open Source and the complete system can be downloaded from the JADE Home Page. The JADE agent platform tries to keep the high performance of a distributed agent system implemented with the Java language. The JADE platform provides an asynchronous messaging mechanism: each agent has a queue of messages (inbox), where the agent decides the time to read these messages. At the time
desired by the agent, it can only read the first message or read the messages that meet some criteria.

1.6.3.1 Advantages of JADE

**Autonomous:** The JADE agent can carry out autonomously. Every agent have own executable.

**Peer-to-Peer:** Each agent recognize by own inclusive name, so as to they can link and go away the system at any time of the process of the scheme by requesting the organizer. They in count classify additional performing agent with the assist of yellow-page and white-page services.

**Distributed System:** All agents have a part thread for implementation, so as to they can sprint in different machines, dissimilar surroundings and also can communicate among them by internet.

**Interaction Protocols:** A number of protocol options already are real in the JADE library, when require just using the utility, so execution is very easy.

**J2ME platform:** Maintain for J2ME platform and wireless environment. So it supports wide area of distributed calculation.

**Time requirement:** Using the agent model the whole system makes very fast, way it becomes a smaller amount of time consuming.

1.7 DECISION SUPPORT SYSTEM IN CLINICAL CARE

1.7.1 Introduction

Hospitals and health care organization are finding difficult to extract useful information for decision support due to the increase of medical data. Medical diagnosis is regarded as an important yet complicated task that
needs to be executed accurately and efficiently. Regrettably all doctors do not possess expertise in every sub specialty and moreover there is a shortage of resource persons at certain places. So the methods for efficient computer based analysis are essential.

The automation of this system would be extremely advantageous. It has been proven that the benefits of introducing machine learning into medical analysis are to increase diagnostic accuracy and to reduce human resources. Therefore, an automatic medical diagnosis system would probably be exceedingly beneficial by bringing all of them together. Appropriate computer-based information and/or decision support systems can aid in achieving clinical tests at a reduced cost as stated by Jyoti Soni et al (2011).

A Decision Support System (DSS) is a computer program application that analyses clinical data and presents it so that users can make better decisions more easily. Decision Support Systems provide clinicians, staff, patients and additional individuals with information and person-specific information, smartly filtered and presented at appropriate times to enhance health care.

The most common use of DSS is for addressing clinical needs, such as ensuring correct diagnoses, screening in a suitable manner for unnecessary diseases or averting bad drug events. However DSS can also potentially lower costs, improve efficiency and reduce patient inconvenience. The DSS may offer suggestions, but the clinician must clean the information, evaluate the suggestions and choose whether to take action or what act to take.
1.7.2 Classification of DSS

Decision support systems are generally classified into two major groups.

- Knowledge based DSS
- Non-Knowledge based DSS

Knowledge Based DSS:

The knowledge based decision support systems have rules normally in the form of IF-Then statements. The patient data is usually associated with these rules. For instance if the pain force is up to a certain level then cause warning etc., The knowledge base system in general consists of three major parts. Knowledge Base, Inference Rules and mechanism used to communicate. Knowledge base contains the rules, inference engine approach together policy with the patient data and the communication method is used to confirm the effect to the users as well as to present input to the scheme. (Example: Fuzzy set, Rule based, Evidence based).

Non Knowledge Based DSS:

DSS not including a knowledge base are called as non-knowledge based DSS. These systems instead used a form of artificial intelligence called as machine learning. (Example: Neural Networks, K-NN, Genetic Algorithms).

1.7.3 Machine Learning Algorithms in DSS

Data mining uses mathematical analysis to derive patterns and trends that exist in data. It is an interdisciplinary research field of data base
systems, Statistics, Machine learning, Information Retrieval and gradual process. Data mining can allow healthcare organizations to forecast trends in the patient conditions and their behaviors.

Data classification is an important problem in engineering and scientific disciplines such as biology, psychology, medicines, marketing, computer vision and artificial intelligence. The goal of the data classification is to classify objects into a number of categories or classes.

Data mining provides the link between knowledge of continuous data, such as biomedical signals collected from patients in intensive care units and it develops an intelligent monitoring system that sends reminders, warnings and alarms for the pre-selected critical conditions. The way of gathering the input data and to present output information’s is different in different methodologies. Vapnik (2000) discussed two approaches of Data mining. The two approaches of machine learning algorithm are Supervised and unsupervised learning.

1.7.3.1 Supervised Learning

**Supervised Learning**: Discover patterns in the data that relate data attributes with a target (class) attribute. These patterns are then utilized to predict the values of the target attribute in future data instances.

Some of the supervised learning algorithms are

- Artificial neural network (ANN)
- Back propagation
- Decision trees
- K-Nearest Neighbor (KNN)
- Naive Bayes
- Support vector machine (SVM)

1.7.3.2 Unsupervised Learning

**Unsupervised Learning**: The data have no target attribute. We want to explore the data to find some intrinsic structures in them.

**Some of the unsupervised learning algorithms are**

- Clustering (e.g., k-means, mixture models)
- Expectation–Maximization algorithm (EM)
- Method of moments
- Blind signal separation techniques.
- Principal Component Analysis

1.7.4 The Problem of Predictions

Predictive models provide the best knowledge support and experience to healthcare workers. This requires a review of medical documentation of a healthcare institution and prescription drugs to determine which problems are the most common amongst patients.

The goal of predictive data mining in medication is to develop a predictive model that is clear, makes reliable predictions and helps doctors to improve their prognosis, diagnosis and treatment planning procedures.

The problem of prediction in medicine can be divided into two phases: learning phase and the phase of decision making. In the learning phase, a large data set is transformed into a reduced (simplified) data set.
Number of features and objects in this new set is much smaller than the original set in several different ways. The rules generated in this phase are used later to make accurate decisions. Newly formed data set is used to make predictions when the new instances with unknown outcomes occur with the predictive algorithm. This algorithm compares the characteristics of a new object with the characteristics of objects represented in the selected data set. If the match is found, the new object gets the outcome which is equal to the corresponding object in the set.

1.7.4.1 Types of Prediction Methods

Two types of prediction methods are available. One is statistical method and the another is hybrid method.

(i) Statistical Method

It is one of most simple and useful method used for data collection. It can be in the form of a survey, experiment result or questionnaire. Development of clinical decision support systems using statistical method as an integral part is very common. Data can be collected as a questionnaire mentioning the condition of patient how he looks similar to, its way of talking, what he feels and many more. It can be a better way of quantitative and qualitative assessment of postoperative pain.

(ii) Hybrid Methods

Hybrid Intelligent Algorithm improves the accuracy of the disease prediction system. A combination of two or more methodologies within a design of single system results into a hybrid system. Hybrid systems extract the best from all methodologies and provide an optimal solution for clinical decision support systems. For example to identify the clinically relevant
aspects automatically, the combination of knowledge-based and statically techniques can be good approach. The extracted elements then served as an input to the algorithm to score a relevance of citations with respect to structured representation of information needed, based on the principles of evidence based medicine. The principles of evidence based medicine can be captured computationally and implemented in a system. It has the potential of improving the quality of health care. Meta reasoning method such as hybrid systems consists of different reasoning methodologies. It consist of a rule based, case based and model based reasoning. That finally results into an overall improvement of the system performance.

1.8 PROPOSED CONTENT OF THE THESIS

The rest of the thesis work is organized as follows: The second chapter describes the detailed literature review of various patient monitoring systems, intelligent agents PMS and discussed various data mining algorithms used for decision making in healthcare. The third chapter gives the scope and objectives of this research. The fourth chapter gives the detailed design of a new intelligent agent based patient monitoring system. The fifth chapter describes the machine learning algorithms taken for the design of a new decision support and comparison. The experimental setup and performance evaluation of PMS and DSS are discussed in sixth chapter. Followed by conclusion of this research work and future direction are discussed.