Design and Implementation of Patient online Monitoring and Clinical Decision Support System

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Acknowledgement

My journey in the MS has not been very smooth, and it did not take a straight path. In fact, the road to success has been treacherous with many riddles in its way. But the hard work and relentless efforts that I had put into my academic career has now given its fruit and it makes me feel triumphant that I had been able to harvest all my efforts into a glorious resolve. Such success in my life would not have been possible without the shear support from all those who had helped, guided, mentored and encouraged me in all endeavors of life.

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List of Abbreviations

POMS	Patient Online Monitoring System
ML	Machine Learning
KPOMS	Knowledge Based Clinical Support System
SDSS	Standalone Decision Support System
HER	The Electronic Health Record
IC	Integrated Circuit
VMR	Virtual Medical Record
ANN	Artificial Neural Networks
CPOMS	Chronic Patient Online Monitoring System
ODPF	Optimal Decision Path Finder
SNR	Signal to Noise Ration
PCA	Principle Component Analysis
CDSS	Clinical Decision Support System

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Chapter 1

Introduction

1.1 Background and Motivation

For many years' physicians and paramedical staff had to face a fundamental problem in monitoring various vital signs of health in the human body such as blood pressure, body temperature and the number of heart beats per minute. There was none other than a single approach to this laborious task: a member of the health care staff had to be on the side of the examinee at all time to monitor the state of the variables in the human body. To provide a solution to this conundrum, various techniques were employed. Such techniques involved using an extended cable from the monitoring system to a centralized control room, but it too did not solve the dilemma, as constant human monitoring was still indispensable.

A breakthrough to this predicament came in the late twentieth century in the form of Patient online Monitoring and Clinical Decision Support Systems (CDSS). With the invent of such an articulate system, there is no more need for a member of medical staff to constantly monitor the health of the patient. The system not only has the ability to provide a sustained patient monitoring, but also alerted the examiner of the system whenever an anomaly in the health status of the examinee was detected. Hence, it terminated the need for constant human monitoring usually done by a paramedic staff [2].

Since then, many advances have been made Patient online Monitoring and Clinical Decision Support Systems (CDSS). Primitive versions of the system, although were able to achieve a quantum leap in the conundrum, still needed significant improvements in terms of their capabilities. Although, the system had the capability to detect anomalies in the health status of the patient, the pioneers of the system discerned that the system can be utilized to further curtail the burden on the healthcare staff [3]. Subsequent advancements followed in the refinement of the system. The later versions of the system were engineered, in additional to anomaly detection, to have the tendency to reach out a conclusion based on the monitoring of the health status of the examinee. Such a tendency came in the form of

Machine Learning (ML). ML stems out from principles of statistical analysis and computer algorithm. The algorithm, through arrangement of data sets, which are values of health conditions of the patient such blood pressure level, can be programmed to reach out a conclusion in terms medicine prescription, recommended course of action to be followed and also had the ability to provide a diagnosis for various ailments associated with the human health [4]. Hence, an algorithmic approach towards the development of such a system is the epicenter of research in this dissertation [5].

1.2 Statement of the Problem

As of today, 194 countries lie under the jurisdiction of World Health Organization (WHO). The WHO estimates that in the year 2017, total number of documented deaths across these countries was estimated to be 57 million. However, only 27 million such deaths were attributed to known causes. It implies that not even half of the deaths globally were due to a factor that was diagnosed. Likewise, WHO estimated that annually around 49 % of the people suffering from Tuberculosis were diagnosed with the disease, while 51 % people having Tuberculosis were not even aware of their medical condition [1]. These statistics give a glimpse of harsh reality in diagnosis for various health-associated ailments.

Research illustrates that most patients manifest symptoms of health decline couple of hours before any detrimental change takes place in the human body. Without a mechanism for continues monitoring, symptoms that depict decline in health can be potentially neglected. Estimates from World hospitals (Hospital protocols) have shown that Doctors, Physician, Nurses and other paramedical staff make several visits to the patient Ward or room in 24 hours. Window has the potential to severely exaggerate the medical condition of a patient, if not supervised with due attention. Hence, the imminent need is not for enhanced treatment facilities but for more monitoring facilities. Key vital signs in the human include blood pressure, blood glucose level, heart beat rate and the body temperature. All other grave medical conditions can be well forecasted by closely monitoring any aberrations in these four fundamental parameters in the human body. Therefore, through monitoring a patient, majority of the complications can be avoided before they develop into a serious physiological condition. Design and implementation of above-mentioned system with effective features selection and elevated rated techniques for clinical decision support systems are known as an important research concern. Therefore, it is proposed that a Patient online monitoring & clinical decision-making support system will be prepared to meet the following requirements.

- Propose genetic algorithm-based feature selection approaches and to compare the current and previously proposed feature selection algorithm on the medical database.
- To determine which feature selection method and which type of algorithm is most suitable for different patient's clinical database.
- Also, determine which feature extraction method or technique & which type of algorithm is most suitable for different patient's clinical database. (inform of physiological signal from human body)
- To determine, how to the system prescribed automatically medicine through machine learning & how can get rid to take medication through social networking websites messages from physicians [26].
- Determine how to get complete relevant signal without any irrelevant data from physiological signal through feature extraction, Gaussian & adaptive Gaussian filter.
- Design and implementation of patient online monitoring system to remove the distance between Patients and doctors. Provide 24x7online monitoring on Doctor mobile and PC.
- To propose a permanent system to find intensity of appetite for patients who are in constant illness.

1.3 Dissertation Organization

Embodied in this dissertation are seven chapters. The first chapter contains the introduction, gives the generic idea about the thesis, and states the fundamental questions whose answers will be explored in the subsequent chapters. The second chapter contains the work that has already been conducted by the scientific community in the field of POMS along with literature review, which states various academic sources that have been utilized in the formulation of this dissertation. This chapter also introduces ML, which has been the focal point in development of POMS of our choice.

Detailed exploration of the research question proposed begins from the third chapter, which revolves around the database that is given as an input to the inference engine. Both KPOMS and non-KPOMS will be explored, but as stated earlier, the emphasis will be placed on KPOMS, due to its relative advantage over non-KPOMS. The fourth chapter will be core research area of this dissertation. It will elaborate the ML framework, which will form the basis of implementing the POMS. In this chapter, emphasis will also be placed on the ANN, which in collaboration with ML, assist the POMS to reach a conclusion about the physical state of the patient. The fifth chapter will be dealing with the communication of inference made by the inference engine with its users. It will revolve around cord and cord-less communication and deals with electrical communication concepts both digital as well as analogue. The sixth chapter will be based upon the effectiveness of POMS with special emphasis on its effectiveness in Pakistani society. The reliability of the system will also be monitored and evaluated in this chapter. The dissertation will culminate with the conclusion, which will be last chapter. In conclusion, overall performance and feasibility of Patient online Monitoring & Clinical decision support system in Pakistan will be evaluated and recommendations, based on the research conducted in this thesis, will be put forward.

Chapter 2

Purpose of Research

2.1 Background Work

With the advancement in electrical Engineering & Technology and software engineering, the world turned out to be progressively motorized and one of the culminations to the mechanization was the improvement of CPOMS. The advancement and improvement of such frameworks can be classified into four principle times as:

1) Standalone choice emotionally supportive networks.
2) Integrated frameworks.
3) Standards based frameworks.
4) Service models

Each model is based in detailed about consequent sub segments, which will picture the rise in the advancement of CPOMS. It is of foremost essentialness to observe the development of such framework to completely appreciate the contemporary frameworks and their functionalities.

2.1.1 Standalone Decision Support System

The principal Period of advancement of CPOMS started in 1959 when a paper titled "Thinking establishments of restorative conclusion from long separation; emblematic rationale, likelihood, and esteem hypothesis help our comprehension of how doctors reason" by Ledley and Yearned was distributed. In 1959, a probabilistic model spread out for therapeutic conclusion, it was with grounds in set-hypothesis and Bayesian deduction. This model distributed in Science and was an instructional exercise and sort cards used for simple PC. This is a conclusion, and a progression of punches, which populate to side effects. By selecting the cards, matched the side effects as per situation. The quantity of cards having the specific conclusion indicates the probability of that analysis. The system/model can attend new patients conveniently.

From that point forward, SDSS has seen fast change in terms of precision and the work was conveyed encourage by numerous researcher and organization over the globe. In 1971, with quick development and exactness brought into the framework, the SDSS turned out to be precise up to 79.6% by examination of its aftereffects of conclusion from the master doctors. Such framework depended on the KCPOMS where the info in regards to a patient bolstered into the framework as clinical parameters and the yield would be as a conclusion of the restorative condition. SDSS must be physically worked, could not continually screen the condition of a patient without consistent supervision of a specialist client. They were known as independent choice emotionally supportive network since they worked independently from different frameworks and could not be coordinated into different frameworks for improved computerization essentially because of restriction of the innovation accessible around then.

2.1.2 Integrated Systems

Due to the inability of the Patient online monitoring & Clinical decision Support system to work in conjunction with other clinical apparatus, new system designed in 1967 at LDS hospital at Salt Lake City, Utah, USA. This new system had the comparative advantage that it could work simultaneously with other medical support systems such as the HER and the CPOE. The newly designed integrated system established on the principles of Bayesian concept of probability and so therefore had the Bayesian decision support capabilities and so was able to include modules for variety of functions. The input to such a system was a large set of rules, which acted as a knowledge base [6]. A network of IC has connected the Patient online Monitoring & Clinical decision support system to other medical care appliances. This significantly reduced the burden on the clinical staff as the new system was not only able to diagnose the treatment but also, based upon the input and the results from the diagnosis, it could suggest a course of action for a particular ailment. Over standalone systems, there were two key benefits:

First– Auto saving information option, it is already stored electronically.

Second – Systematically proactive, give alerts to user about dangerous drug interaction or a dosing fault without backing or human involvement. The major disadvantage is not simple way to describe them or reuse content. Standalone systems can be shared conveniently by mailing a tape. Inconsistency, integrated systems developed since directly into larger clinical systems cannot be directly shared to others who are not user of same clinical system. Further, integrating decision support system can create knowledge-management problems. If clinical hit is not fresh than it shall be not easy to extract the information from the code.

2.1.3 Standard Based Systems

Due to the limitations of the integrated system of not having a standardized or a common content that can be employed for multiple users, a need emerged for a new system that could be utilized by a larger set of community, while at the same time work in integration with other medical support equipment. The work started on the new system called as Arden Syntax which combined syntaxes used by major decision support systems and hence could be used by all CDSS [8].

The Arden Syntax has three main components: maintenance, library and the knowledge. Maintenance part of the Arden Syntax had recordings such as when and where the input was last fed into the system, when it was last looked at or when was the system last updated. The next major component of the new system was the ‘library’. Library stored data describing clinical rules, their purpose, their explanation, references of sources of information and rules regarding proactive measures that may be required. Embedded in the knowledge section was the computable section of rules. This section has the capability to read values such as lab tests and contained list of medication that may be prescribed to the potential patient. The system had capability to detect any anomaly in the normal physical state of the patient. The Arden Syntax could also assign priorities based upon the intensity of the abnormality.

However, the Arden Syntax too had its limitations. First of all, it was patient specific and was thus not a population-based decision support system. Secondly, it employed event driven approach i.e. it only detected certain abnormalities and so had little use from the point of care reference.

2.2 Existing Work

Due to the limitations of the above three existing decision support systems, it was eminent that a new system must be designed that could overcome the issues associated with the already existing systems. With onset of concepts in computer science and electrical embedded systems such as Artificial Intelligence and the Machine Learning, a new CDSS was proposed which became to be known as the 'service model'. The service model worked on the principle of Virtual Medical Record (VMR) and ML [9]. Using techniques such as the cloud computing and ML, the decision support system had links to all systems similar to it, operating all across the globe, hence, there is no need to feed the hasty knowledge base into the system [10].

In fact, the system could now gain access to every knowledge base present on all networks similar to it. The new system had the ability to diagnose, monitor and suggest a recommended course of action for its users both reactively and proactively [11]. Additionally, the added advantage for this system was that it could be used for nearly every user and had not to be limited to a specific patient. The service model for the decision support system acted like a smart computer that had its own brain and could utilize a wide array of information [12]. This resulted in a significant reduction in work that had to be performed by the user in terms of entering the information into the system. The added advantage of the new system was that it could generate diagnosis and give recommendations for a wider range of medical conditions: thanks to the numerous data base it could access. Such a system will be the emphasis of research in this dissertation and will be explored in depth in the subsequent chapters to follow.

2.3 Literature Review

A wide assortment of famous scholarly assets including diaries and books has counseled to draft this thesis. This thesis gives an intensive prologue to the Patient online monitoring & clinical decision support system and expounds the historical backdrop of the improvement of the framework. It is viewed as key that the advancement of the model must be precisely inspected with the goal that the contemporary patterns in the improvement can be framework can be very much appreciated and the requirement for such a detailed framework can followed back to its underlying advancement.

Detailed comprehensions of the concepts of ML have been studied before the official commencement of this dissertation since implementation of ML algorithm has been the main focus in this work. Techniques of ML such as the decision tree learning, Bayesian Learning and similarity and metric learning have been mastered as a pre-requisite to this work. Additionally, comprehension of ANN has been achieved which, in conjunction with ML, assists in formulation of algorithm for CDSS.

This dissertation looks into the detailed development of CDSS from its design to implementation. Special emphasis has been placed on the use of Artificial Intelligence and Deep Learning to implement this work in a smarter manner. The use of electrical embedded systems and the principles of electrical communication techniques have been employed in this work so that this dissertation is an embodiment of most, if not all, of the concept that are the foundation of electrical engineering.

2.3.1 Patient Online Monitoring & Clinical Decision Support System

This model also defined as computerized clinical system. Above-mentioned system operates through Machine Learning (Artificial intelligence). A patient online monitoring and clinical decision support system further categories in three components. That is Machine Learning (Supervised clinical data) or knowledge base, interference Engine and mechanisms to communicate with paramedical staff, consultant and physicians through networking [27].

Knowledge base portion contain medical data like physiological signal, clinical sign & symptoms and vital sign parameters then human interface engine gathered medical data with patient data and calculate individual patient results. After calculation of results, that system generates alerts (drug interaction), recommendation (possible diagnosis) for relevant physician, paramedical staff and consultant if the any abnormality detected from clinical signal [4].

2.4 Machine Learning (ML)

Before ML is formally implemented into the development of CDSS (Clinical decision support System), it is fundamental to give a brief about the core concepts behind this approach. ML stems out from a branch of computer science referred to as Artificial Intelligence [13]. It is built upon the fundamental mathematical concepts of statistics, where by the machine gets the cognitive ability to learn and based on its learning give a decision without being explicitly programmed.

Machine Learning is further separated into two main types:

1. Supervised machine learning
2. Unsupervised machine learning.

Supervised ML has been implemented in this work where a set of data has already been fed into the system. The ML algorithm is than applied to the data, which sorts the data into a model. Once a new variable has to be tested by the user, the variable has to pass the test of the model i.e. based on the model, the variable being tested is assigned either as positive and negative. The other type is the unsupervised ML where the system is left on its own to find its data set and correspondingly develop the data set. Due to high error rate in the accuracy of outputs from the unsupervised ML and the fact that the system is in its preliminary stage of development yet, the emphasis of this dissertation has been placed on supervised ML.

In developing the statistical model, the ML algorithm arranges the data set into a probability distribution graph and develops a probability density function. Based on the probability density distribution, a reference line is set above or below which the input is classified as 'positive' or 'negative' [14]. If the input is above the reference line than it confirms the hypothesis and affirms the presence of the particular, physical condition the user is looking too sought after and vice versa. ANN, a branch of ML, is also of vital interest in this work in the development of CDSS. ANN is characterizing calculation that is indistinctly invigorated by organic neural systems. Calculations are organized regarding an interconnected gathering of fake neurons, handling data utilizing a connectionist way to deal with calculation. Current neural systems are non-straight factual information demonstrating apparatuses. They are normally used to display complex connections among information sources and yields, to discover designs in information, or to catch the measurable structure in obscure joint likelihood dispersion between watched factors.

Therefore, based upon the fundamentals of statistics and probability, ML has been invoked into this project for the development of CDSS.

2.4.1 Mass Spectrometry

To initiate the process, a sample of blood, which is a source of various biomarkers present in the human body, is taken from the patient. Since, the entire blood sample contains too much unwanted information so; proteins are extracted from the blood through a technique called centrifugation. The centrifugation of blood spins the blood samples at high speed inside a tube, which separates the liquid portion of the blood from the proteins, present in it, based upon the $\frac{mass}{charge}$ ratio. Due to higher $\frac{mass}{charge}$ ration of proteins as compared to the liquid portion of the blood called plasma, proteins get settled at the bottom of the tube while plasma occupies space at the top of the tube, through which, the proteins can be extracted [15].

The capabilities of the mass spectrometer are gauged fundamentally through its ion source, mass analyzer and the detector. In CDSS, protein sampling takes place with Matrix Assisted Laser Desorption Ionization (MALDI), which provides a vast source of ions. To setup the protein sample for MALDI analysis, an aqueous solution of proteins is mixed with an aqueous solution of matrix such as the Sinapinic acid. The resulting mixture contains a vast abundance of matrix particles are compared to the proteins (10,000: 1). The prepared solution is deposited onto a MALDI plate and left to dry at atmospheric conditions [16]. After the sample has been dried, the plate is introduced into an electron chamber where an accelerating beam of electrons is bombarded with the sample of proteins and Sinapinic acid. The vibration and translation energy of the electrons is used to ionize the protein molecules into ions. The resulting ionized protein molecules are extracted and accelerated into a Time-of-Flight (TOF) chamber. The chamber contains a high electric field, which separates the ionized proteins based upon their TOF, which depends upon $\frac{mass}{charge}$ of the ionized proteins. The principle behind separation is as follows:

Potential energy of ionized protein molecules = $E_p = qV$ (1)

Kinetic energy of electrons in TOF analyzer = $E_k = \frac{1}{2}mv^2$ (2)

Equating equation (1) and (2) will result in $qV = \frac{1}{2}mv^2$ (3)

putting $v = l/t$ into equation (3) will result in $\frac{m}{q} = \frac{2Vt^2}{l^2}$ (4)

Ions with the same $\frac{m}{q}$ will have same TOF and will strike the detector plate at the same locations. When an ion strikes the detector, it releases a current into the detector plate which is then converted into voltage by the amplifier. Each peak of the amplified voltage signal corresponds to number and identity of each protein present in the sample of blood that was examined. The data is recorded in the form of a plot between $\frac{m}{q}$ and intensity of protein molecules. The diagram below depicts a mass spectrum

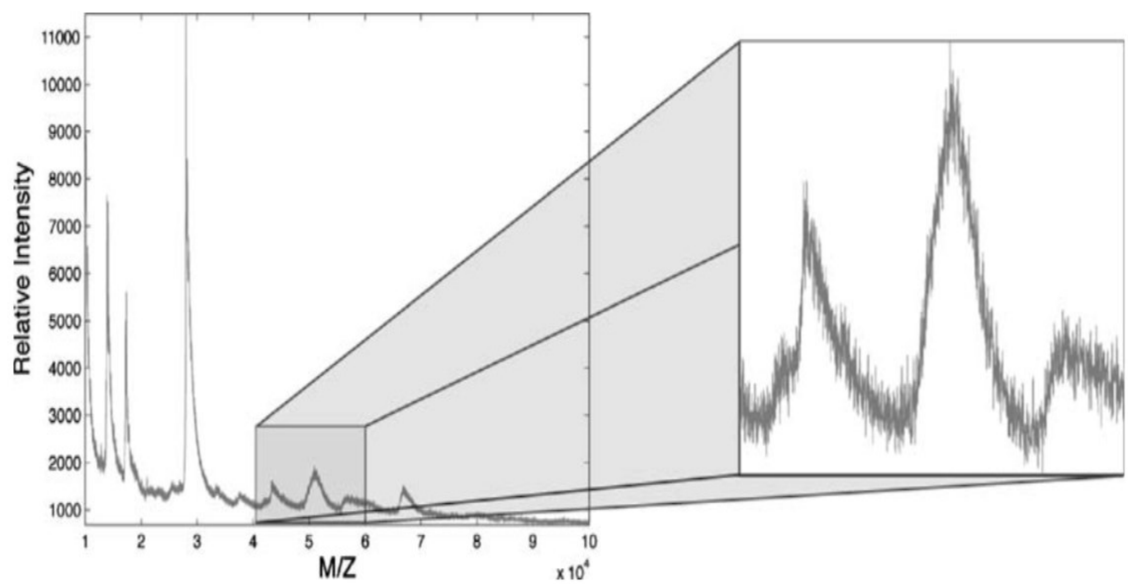


Figure: 2.1: Mass Spectrum diagram [17]

2.4.2 Feature Extraction

Features represent various measurable extracted from the previous section to provide a compendium of attributes of pathological features from the blood sample. The commonly used perspective to feature extraction resides on the principle of measuring intensities corresponding to particular $\frac{mass}{charge}$ values. However, this commonly used approach lays an extra burden on the ML algorithms since much of the redundant variables is crept into the data

Hence, to overcome the ailments associated with the commonly used approach, a new technique in feature extraction has been used, commonly referred to as Binning. In this approach, data-points are clustered to form a number of bins on the $\frac{mass}{charge}$ axis or the x-axis of the spectrometer. Such an approach extracts features from bins through calculation of mean of the peaks and the highest peak intensities [18]. Within a particular defined mass-error rate ([(exact mass) – (accurate mass)/ sample width of spectrum] the relative intensities of data points on the mass spectrum correspond to the same protein. Thus, the features are obtained from the spectrum based on attributes of the peaks containing a range of $\frac{mass}{charge}$ values.

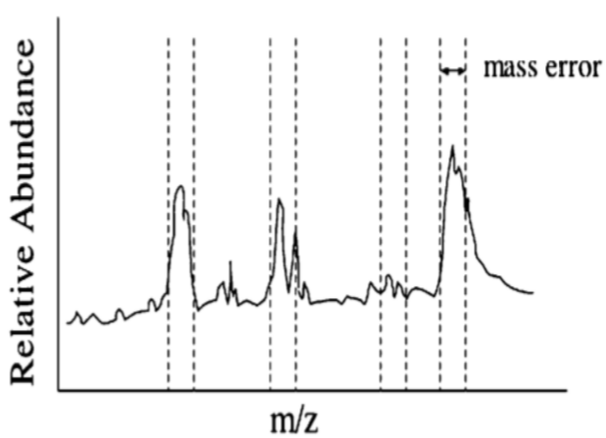
The process of feature extraction is divided formally into two steps: peak-detection and peak-alignment. The motif behind peak detection is to figure out the peaks corresponding to pathological features from the noise signal which at times is embedded into the signal of interest and so, such a noise cannot be extracted out through the process of adaptive Gaussian filtering. In peak detection, SNR (signal to noise ration) of the peaks in the same mass error rate are measured. A threshold is set for, usually SNR> 5, so that beyond this point a signal can be considered for further processing. Below this threshold value, the signal is considered noise and so not included to for further calculations.

The process of peak detection identifies peaks of our interest within one mass spectrum, but to form a coherent decision, multiple peaks from various spectra are required. Procedure of correlating peaks from more than one spectrum is referred to as peak alignment. The peaks from the multiple spectra with the same mass-error rate are united into one group and represent one particular pathological feature. The figure below represents how mass-error rates are associated on the mass spectrum.

2.5 Self-Decision Maker System

Before self-decision maker systemic formally implemented into the development of CPOMS, it is fundamental to give a brief about the core concepts behind this approach self-decision maker system stems out from a branch of computer science referred to as Artificial Intelligence. It is built upon the fundamental mathematical concepts of statistics, where by the machine gets the cognitive ability to learn and on the basis of its learning give a decision without being explicitly programmed.

Self-decision maker system is further divided into two main category i.e. supervised machine learning and unsupervised machine learning. Supervised self-decision maker system has been implemented in this work where a set of data has already been fed into the system. The self-decision maker system algorithm is than applied to the data, which sorts the data into a model. Once a new variable has to be tested by the user, the variable has to pass the test of the model i.e. based on the model, the variable being tested is assigned either as positive and negative. The other type is the unsupervised self-decision maker system where the system is left on its own to find its data set and correspondingly develop the data set. Due to high error rate in the accuracy of outputs from the unsupervised ML and the fact that the system is in its preliminary stage of development yet, the emphasis of this dissertation has been placed on supervised ML.



In developing the statistical model, the self-decision maker system algorithm arranges the data set into a probability distribution graph and develops a probability density function. Based on the probability density distribution, a reference line is set above or below which the inputs classified as 'Positive' or 'Negative'. If the input is above the reference line than it confirms the hypothesis and affirms the presence of the particular, physical condition the user is looking too sought after and vice versa. ANN, a branch of ML, is also of vital interest in this work in the development of CPOMS ANN is a learning calculation that is loosely enthused by natural neural systems. Calculations are requested regarding an interconnected gathering of fake neurons, preparing data utilizing a connectionist linger. Present day systems are non-direct measurable information demonstrating instruments, normally used to show the unpredictable connections among sources of info and yields for finding the examples in information, or catch the factual form in an obscure joint likelihood circulation between watched factors.

Therefore, based upon the fundamentals of statistics and probability, ML has been invoked into this project for the development of patient online monitoring and clinical decision support system.

The self-decision maker system uses for that when Physician and paramedical staff not available with the patient. When the patient's illness suddenly gets worse and then there is no Physician or consultant available for this patient, this system will automatically generate the slip and tell you which pharmacology should be given to this patient.

2.5.1 The Electronic & System Self-Generated Prescription

Electronic medicine is a reality a long way past the essentially utilizing PCs to compose and spare solutions. Fact to told, electronic & digital remedy (e-medicine) is an extensive term that suggests applying the computer gadgets to enter, alteration, audit and develop or send drug solutions that’s plan two-route transmissions amid the drive of consideration and the supplier. This type’s invention would firmly transmit or send medicine & solutions linked data between partners (prescription generator, distributors, pharma stores, health model designs, and medical safety net providers) either exactly or by a concern person (including an Electronic remedy arrangements) using the electronic media. E-remedy exchanges medicines from prescribers to drug stores, refills and recharges demands from drug stores to suppliers, solution advantage and model data and fills status notice for prescribers. In this manner, the use of electronic frameworks in solution can encourage the correspondence of a medicine, help the decision, and supply the pharmaceutical by choice help lastly gives a hearty review trail to the whole prescription process.

There are a few primary strides in making and overseeing medicines electronically, as portrayed in Figure 3. Right off the bat, a client of the framework signs in by a type of validation to demonstrate his or her distinguishing proof. In the following stage, a clinician

distinguishes a patient inside the electronic medicine framework and the electronic solution process starts. This information ought to be promptly accessible to the clinician preceding entering new solutions. Diverse gadgets in different situations are utilized in three exercises of the electronic remedy process, for example, choosing a solution, entering parameters and marking the medicine. Likewise, clinical choice help is used through checking on cautions and updates in these exercises. At that point, the confirmed medicine was straight forwardly or in a roundabout way exchanged to drug store for administering. Remedy Refill and recharging demands are likewise
Robotized in e-medicine cycle, outlined in Figure. Besides, remedy claims are transmitted electronically from drug store to payers.

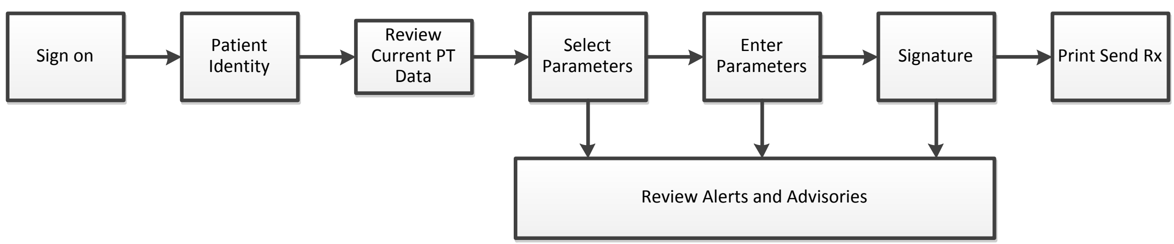


Figure 2.2: Electronic prescription generating system

2.5.2 Benefits of Electronic Prescription

Electronic & online digital technology indorsing that include information and medication data of relevant patient an offer the associated advantages:

- "PCs can keep up particular, neutral and up and coming medication databases, which establish fundamental instruments as the numbers of affirmed meds with expanding.
- Recommender can prompt for medication exact measurement data, with suggestions to guarantee that twins and sound comparable is not baffled.

- Essential particular data of patient i.e. overdose admonitions, medicate collaborations, and compassion alarms, can be introduced throughout approving, thus budding ADEs that would be somehow or additional undefined can without expanse be maintained a strategic distance.

- PCs decrease or even kill, the advantage for blunder by greeting previous therapeutic conditions or medicines of simultaneous, would stop using of prescribed medications in patients.
- It can boost up replenishment requires, as once patients are gone into the designed model.
- PCs can console data exchange to enhance help among clinicians and specialists who works together inside various parts of the arrangement organization i.e. sedate authorities in retail, office of specialist, and online circumstances medicate store advantage executives and prosperity plans and so on.
- The PCs can decrease social protection costs through time and reserves and by asking prescribers to consider cut down cost put out options.

Chapter 3

Methodology

3.1 Introduction

This is consisted core of the work, this chapter will thoroughly elaborate and progress an unconventional approach towards ML in the formulation of CPOMS. Hence, it important to describe a compendium of the chapter before we formally bar into the detailed framework for the implementation of our task.

3.2 Methodology of Patient online Monitoring System

The Patient online monitoring system (POMS) depends on the extraction of physiology-based heartbeat wave examination (PWA) highlights from crude transmission photo plethysmo graphic signals. These physiological highlights are anti cipatedlater into pulse esteems by methods for discontinuous oscillo metric estimations given by a brachial sleeve.

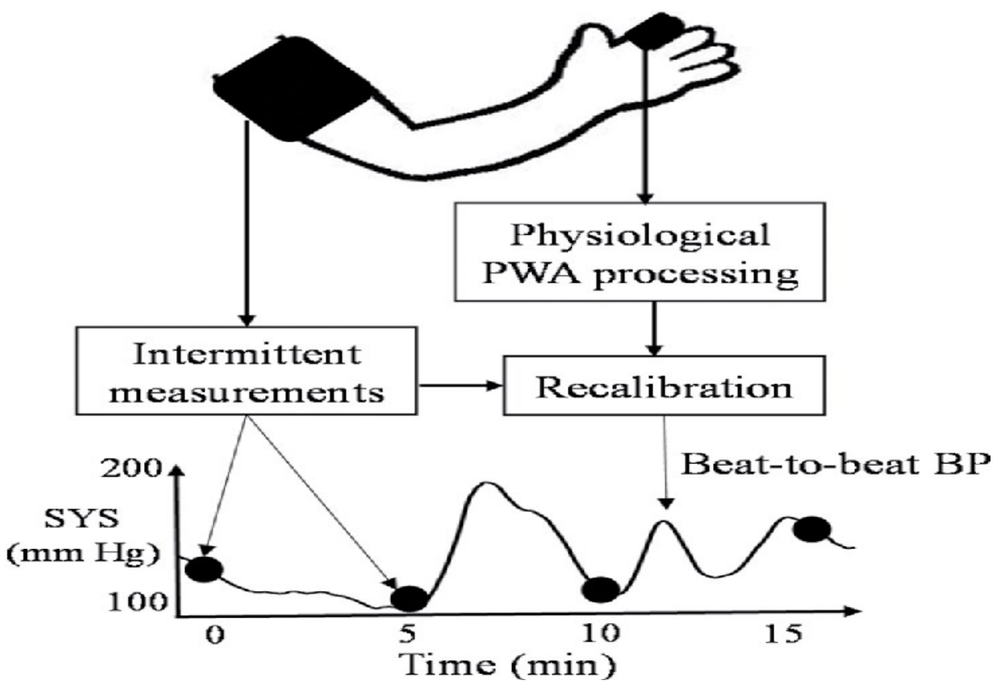


Figure 3.1: Methodology of Patient online Monitoring System

Crude photograph plethysmographic signals are gained by a fingertip beat oximetry test. While for the present examination a business transmission test is utilized, few other ways to gain a surrogate measure for fringe blood vessel pulsatility is adjusted for this procedure.

After a pre-preparing and denoising strategy, a PWA procedure connects to each blood vessel beat. The actualized PWA calculation removes highlights from each heartbeat in light of the wave reflection hypothesis of the blood vessel framework. The calculation expects that blood vessel beats engender along the blood vessel tree being reflected at each blood vessel stretching. The subsequent blood vessel beats are in this way the superposition of forward and in reverse waves meddling at different areas of the blood vessel tree.

Given the blood vessel topology of a patient, changes in circulatory strain change the speed at which blood vessel beats engender, reforming the individual blend of episode and reflected waves. These morphological changes are measured by means of the actualized PWA calculation as modifications of the patients' blood vessel pulsatility designs.

Pulsatility design changes are roundabout pointers of the elementary changes in proliferation qualities, and hidden changes of focal circulatory strain. Therefore, the result of the executed PWA calculation is a vector of physiologically noteworthy highlights containing data on the patient's focal pulse condition.

3.3 System Requirements

There are two types of requirements for operation.

A. Hardware Requirements

- Header data transmitter with RS-232 connecting port.
- 32-inch Graphical LCD or LED for monitoring of patient vital sign through above-mentioned System.
- Vital sign sensor or probes like Temperature sensor, blood pressure sensor, ECG probes, SPO2 probe and etc.

- GSM Module. SIM300, and alerts to relevant physician or doctor for in case of Emergency.
- J-Tag Debugger. This is a Colink program of system.
- Ethernet Cable. To connect data transmitter with machine. (LAN Connections)
- USB Power supply adopters - Power supply to routers.
- D-Link Wi-Fi router - wireless connections of system

B- Software Requirements.

Programming necessities for activities are recorded as pursues:

- Keil IDE -Keil advancement condition to alter, aggregate and investigate code. It can even consume the code to the processor utilizing modules required for J-Label code burner.
- Flashes Enchantment - consume the Hex document into the microcontroller.
- CoocoxCoLinkEX J-Label Debugger - troubleshoot code live on the equipment with well-ordered element. We can likewise utilize programming breakpoints.
- Web Converter V1.0 - change over the website page from HTML organize into cluster of strings.

3.4 System architecture

3.4.1 Overview and Framework

The analysis and few checks that purpose of client communication with the scenario, for the development of the setting watchful web page & coordinated structure of these things. There are different settings that are varying as populated by their application in software engineering and scenario from the designers.

Reference to21: the setting can be distinguished into three types:

1. Context PC (structure accessibility, information exchange or data transfer data and capacity and adjacent assets i.e. printers, displays, stations).
2. Background (user profile, region, very-near individuals, and current social status).
3. Physical & Objective situation (control, clamor levels, activity conditions, fever).

This also manages the time, since it is critical time of day, the week, the season, and so on. Furthermore,

Therefore, a setting for some undefined period; say an extra component, the historical backdrop of setting.

Symbolizes the setting, as the data can be used for portraying the circumstance of an element. An element is a person, region, or question that is understand relevant to the communication amid a customer &applications, including the user and all these applications.

To populate learning in consideration of perfect structure proposed by in above, there are distinctive choices, for example, ontologies as authorize sharing information, permitting diverse assorted elements, conveyed and omnipresent adaptable circumstances, to trade setting data.

Ontological methodologies enhance the help of automatic evaluation, permitting portrayal the complex information, give a formal semantics for setting information and share or incorporate the setting from various sources, provide devices of thinking to evaluate the reliability of an arrangement of networks that portray a logical circumstance.

Last but most critical, the interpretation of a more conceptual setting from arrangement of relevant information and their interconnection, for example, perceive client action automatically.

This examination implemented a cosmology, which permits inductions about the conduct of setting. Specifically, as indicated by the patient association you have with the exclusive situation, the framework will have the capacity to suggestion estimation schedules of their sicknesses and exercises to be completed, in view of on range, status, complete schedule. A similar device permits exchange of information between machine - machine, i.e. (sensor - cell phone, tablet, sound) and PDA customers.

From machine to machine correspondence. the deductions as indicated made by the server and given the transient situation, the model sends data by means of Bluetooth sound gadget originate in the home of the spread out individual, to discharge a note educated from glucose take-up that alternatively diabetic or different estimations are made. These correspondents customized to deal and educate the patient regarding his exercise schedule. This framework can alter the exercise schedules, estimation and interfaces as indicated by the sort of infection. For instance, a patient gets up at 6:00 A.M, the schedule setting-based framework instantly ‘ll be displayed outwardly and an advanced mobile phone utilizing the sound gadgets, patient include inside at home, recording to be performed toward the start of the day, in Figure 1 indicates how the philosophy display.

First step in the formulation of a CPOMS is the extraction of physical attributes from which the physical state of the person being examined can be evaluated. To attain the physical attributes and transform them into tangible ones, we will start a procedure called mass spectrometry, which enables us to extract various physiological features from the sample, which in our case will be a sample from blood. The next step will be the preprocessing of data obtained from the mass spectrometry. In this stage, quantity of physiological attributes from the blood sample will transformed into measurable data points that can be feed into the ML algorithm. To precede more, feature extraction will be performed onto the preprocessed data to extract vital information from the data and to remove redundant or unwanted data. The step will be the calibration of the data from the previous step so that we attain a uniform tangible data points to be fed into the ML algorithm. Feature selection and evaluation is the locus of this chapter. The data from the previous step will organized into symbolic representation with Support Vector Machines (SVM’s). SVM will enable us to separate data and enable us to reach a decision based on separation of data, through comparison with edge values, regarding the presence or absence of the physical condition of our interest. The SVM will be implemented through the employment of kernel function, which will assist us in a coherent separation of data so that a solid conclusion can be reached about the presence of physical attributes of our interest.

One of the main tasks on ML in CPOMS is to reduce the cost and time needed for monitoring and diagnosis of a patient. The fall in both cost and time of the procedure will be performed through a recent approach in ML known as Optimal Decision Path Finder (ODPF). The framework for ODPF will be explored in this chapter with emphasis on its model design, its algorithm and the concept of inheritance, which speeds up the process of execution. The last part of this chapter will deal with evaluation of the framework that presented in this chapter.

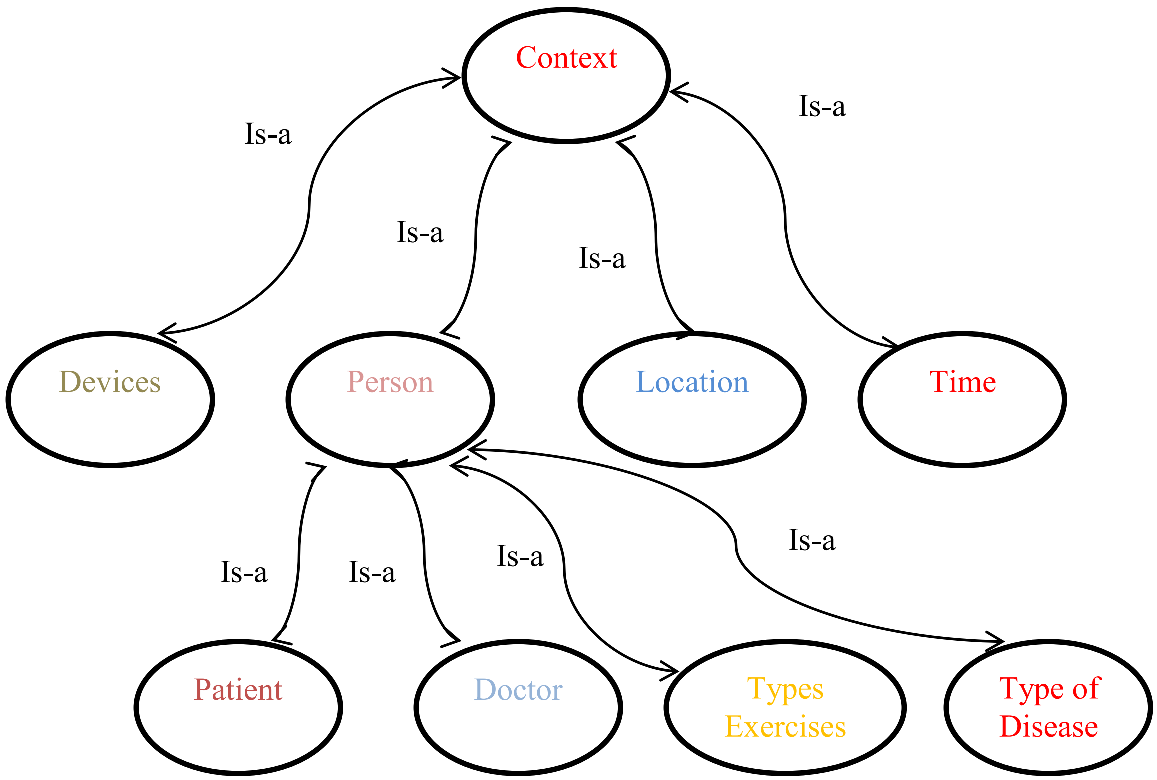


Figure 3.2: Context Model.

1. **Person:** This feature associates a person inside the model or framework, which can be an expert or a patient. The master information perceived with their calling and capacities under the careful gaze of never-ending ailments and to treat such patients will treat. Inferable from the patient was taken as reference, the information related with patient's illness, prescriptions and schedules of exercises, nutritious patterns and other hazard factors. In this manner, there is control on perceptions and estimations performed every day to screen their conditions.
2. **Time:** Which the patient associates with the model at that time, either in light of the fact that it has a movement of an exercises routine and estimating a portion of their

infections. The time can be passed for a specific date, time or a particular period, for example, a therapeutic meeting with a healthy expert.

3. **Devices:** These are cell phones used to collaborate quiet with the specific circumstance. Inside the data they give is the gadgets bolster (GPS), Bluetooth Low Vitality, principal area about outside conditions and the second for indoor area and correspondence with sound gadgets that enable you to tune in to sound-related data for the patient.
4. **Type of disease:** Refers to every single ceaseless disorder with which the patient is related, examine, medicines, chance components etc.
5. **Type Activities:** It relates to control the exercise agendas, the patient as showed by the sorts of endless illnesses.
6. **Location:** Refer to area of the patient, your home, specific or designated center or at facility of the doctor. This system can change the area on based data, the GPS facilitates is taken in open air conditions to inside situations and works with sensors of BLE related to rooms, lounge rooms, restrooms, kitchens, among others, such connection is unstated and is accomplished from interlink among machines.

The figure below defines us to the practical engineering of the framework. Here the beat rate, temperature and gas sensors are the contributions for the framework which will be utilized to acquire the parameters which are the contribution for the framework. Utilizing the simple contribution from these sensors the processor registers for the information required and handles the circumstance in light of the supplies of our framework.

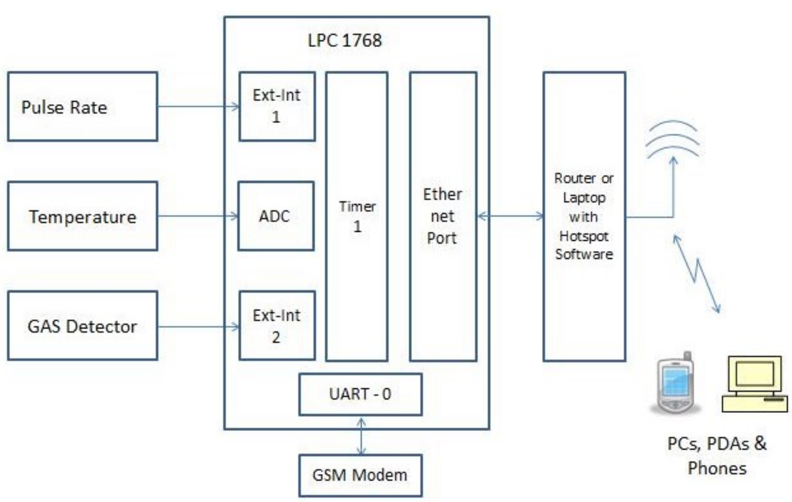


Figure 3.3: Block Diagram of proposed system

In this paragraph, tried to explain how system behaves after receiving signal from detectors of sensors. After taking signal from detectors then compared with level of limitation values in the general characteristics. When the signal passed through this process then signal sent for alarm alerts through modem if the signal value is high or low.

3.5 The Performative Architecture

Engineering design outlined works under the reasonability of client/server in Figure, it shows the transmission of plan. Following are the features of the parts of the server and client.

Server: Comprises of three fundamental parts:

⇨ **Detector setting:** This segment is account of getting or built-in data. The digital data information is traced through the fitting reactions from web benefits that make correspondence available between the server, the database patients and sorts of activities, disease and the master.

⇨ **Reasoning motor:** This is responsible for creating the surmising in light of the respective data given by locator setting. Philosophy makes recommendation the exercise schedules to patients and indicate that minute record is on learning layers. These derivations design through Semantic Web Govern Language.

⇨ The Apache Tomcat Server, because of solicitations from benefit of web is expended normally via versatile customer, which is for situation of patient's cell phone, which develops the applications as per communication that is being generated at the time with the specific situation.

Reasoning motor also known as Interference engine. This engine use to couple the hardware and software system. This block like to work as coupler take inform from hardware components and give to the software system to analyze the data and display on screen on different devices. The Server works as controller.

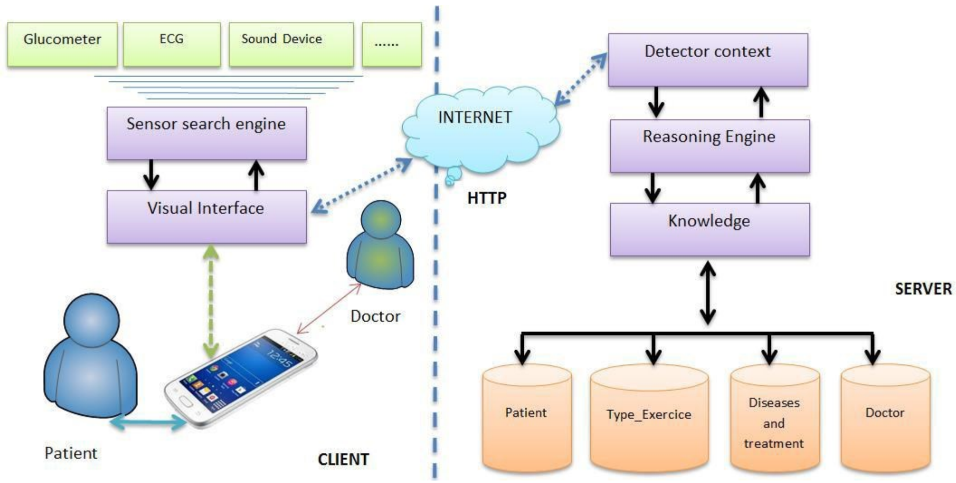


Figure 3.4: Architecture of POMS system

⇨ **Consumer:** This structure is created on Android 4.4, which consist on two fundamental covers are the Visual Interface, which design the customary web server orders, that presents on the screen as the occasion that demands the communication with the patient, specifically, perusing the pulse, meter of blood glucose among others. In the occasion that is perusing, the sensor for internet searcher is actuated for obtaining the information and advice the patient hear that readings and exercise schedules to be performed must be finished. In interim, the specialist can examine the historical backdrop of patients. View the conditions of the patient readings are external the ordinary capacity, the framework directs ready warnings for specialist from this he gives an account of the readings gotten by the patient.

Chapter 4

Proposed Architecture & Project Implementation

4.1 Introduction

In the prior chapter we have provided a complete overview of the POMS. We discussed a complete theoretical framework for implementation of POMS through SELF DECISION MAKER SYSTEM. Chapter 3 received data signals from the human body and culminated in a final decision about the presence or absence of a physical state of the patient we are interested in. It provided us with a rigorous theoretical framework to implement a POMS. In this chapter, we will be dealing with a field analysis of POMS. This chapter may not bar into deep mathematics and technicalities of SELF DECISION MAKER SYSTEM but, will provide us with a firsthand experience on how real-life POMS are operated.

For the purpose of field analysis of the Patient online monitoring system, a trip arranged to Sheikh Zayed Hospital Lahore where various Projects online monitoring system installed being operated on trial basis. The medical staff at the hospital cooperated and explained to us various aspects of the system. Notes about the functionality of the system were jotted down and then further comprehended. Therefore, in this chapter we will provide an insight into how Patient online monitoring system operated in hospitals. This system is installed for live online monitoring of dialysis patients. Because the dialysis patients visit minimum twice a week for dialysis so we used RF (Radio Frequency Operated) Card. This RF Card used for keeps individual identity of every dialysis patient with his/her health record. This RF Card attach with Transmitter, which is installed in dialysis machine. This Transmitter have connector type is RS-232. These connectors are couple/connect with cable connector. This Transmitter received data from patient and display on dialysis machine screen. The transmitter sends the data to receiver (Router). The receiver receives the data from transmitter and display on screen in different portions of screen. Remember this system is operating & controlling through Hospital information software (HIS). For Operating on smart devices and o server, give unique Local IP Address. This system local have unique address, which is 192. 168. 0. 3.

4.2 Overview

In this sub section, we will provide an over view of the POMS and commence the introduction of the system. The diagram below depicts such a system Installed at Sheikh Zaid hospital, Lahore. POMS installed in dialysis ward because the dialysis patients need intensive care and real time online monitoring and best health care management. This figure shows the all basic parameters of vital signs.

Figure 4.1: Machine Display

The following figure explains POMS that has been installed at the above-mentioned hospital. The physical appearance of the system can be well analyzed from the figure. The important aspect to note here is that the system consists of two tubes evolving out from it. One of the tubes passes the blood sample into the machine. The machine than begins its operations onto the fed sample. The other tube sends the processed data if it needs further processing through another more elaborate system. This system, and many systems, possesses a RF card reader. Through scanning the card through the machine, the desired data about the patient being examined is fed into the system, which eliminates the need for most of the manual entry of data points. This diagram shows the first stage in the commencement of diagnosis and monitoring through POMS.

4.3 Live Display of the System

The figure below is display of the system. At this stage of the analysis various controls are selected from the screen such which test we interested to perform or which physical condition of the patient and interested in monitoring.

Figure 4.2: Live LCD Display

The display of system where the operator of the system is at liberty at choosing various controls of the system. In this stage of preprocessing of the data, certain parameters can be set as control parameters i.e. those parameters whose effects we do not want to inhibit with the preferred results we are searching for. Such control parameters include various physical parameters of the human body such as blood pressure, blood flow rate, pulse rate and blood glucose level in the blood. At this stage of the diagnosis, the system illustrated in the figure, the input data from the RF allowed card can also be viewed to look. It can be verified whether the data is sufficient or more input has to be given to the system for enhanced correctness. In addition, at this stage in the process of diagnosis, the time for diagnosis and the desired degree of accuracy we desired can set.

4.4 The Data Sheet

The data sheet of the patient represents all the information that saved into the repository of the RF scanned card of the patient. At this point in the diagnosis process the user can thoroughly look into the data that has been saved.

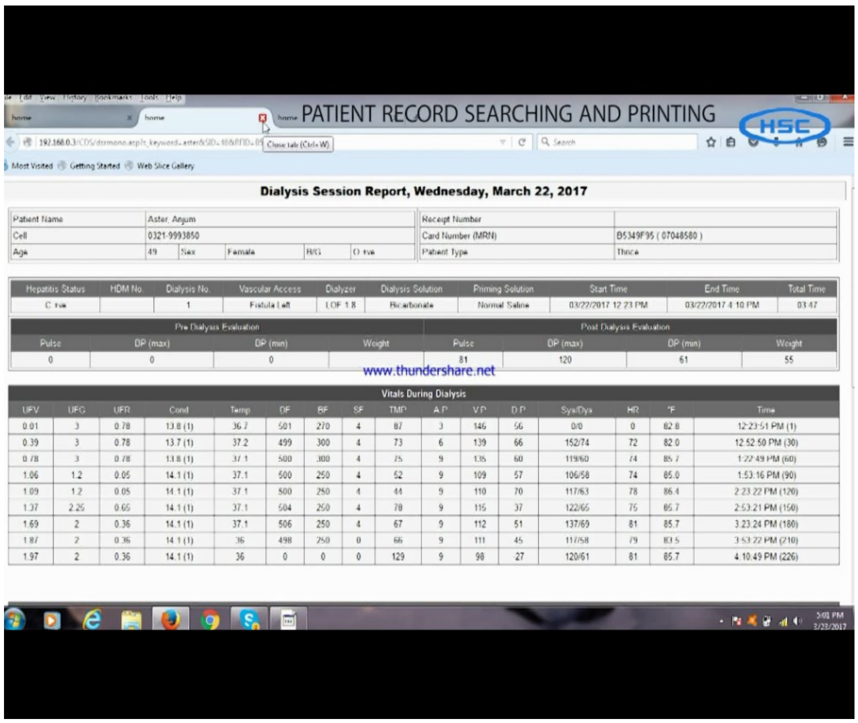


Figure 4.3: Patient Data Sheet.

The figure illustrates a patient data sheet. Once, the complete data has been revised, the redundant data can be removed from the data sheet since, the redundant data not only makes the computational algorithm rum for longer period of time, but also, reduced the accuracy in the predictability of the results. In addition, at this point in the diagnosis process, the user of the POMS can look for data that has been missing and is essential for diagnosis. Therefore, such data can be fed into the system. After this stage, the user of the system does not enjoy any authority at manipulating with the data sets and the controls of the system since, after this the algorithm starts working on the input to reach a decision about the condition that has been fed into the system.

4.5 Monitoring the Physical Conditions of the Patient

Many POMS & Clinical Decision systems addition to providing a decision on the physical state of the patient, provide a constant monitoring various vital parameter of the human body. Patient attached with the patient.

Figure 4.4: Patient Attached with Machine

Once patient attached and insert RF Card in wireless transmitter then POMS start working, give real time image on Computer screen and on Mobile Screen.

The POMS are constantly connected to the body of the patient and provide constant monitoring of fundamental life signatures. Such POMS are often found in the Concentrated Care Units of many hospitals where there is a need to look constantly for any deviations in the state of the patient. Additionally, such POMS are able to provide a conclusion about after a certain period of monitoring of vital signs of the patient. POMS show on screen with real time image. There is no delay of second. This data contentiously automatic updating with after within some seconds.

4.6 Patient online Monitoring on Mobile Phone Screen

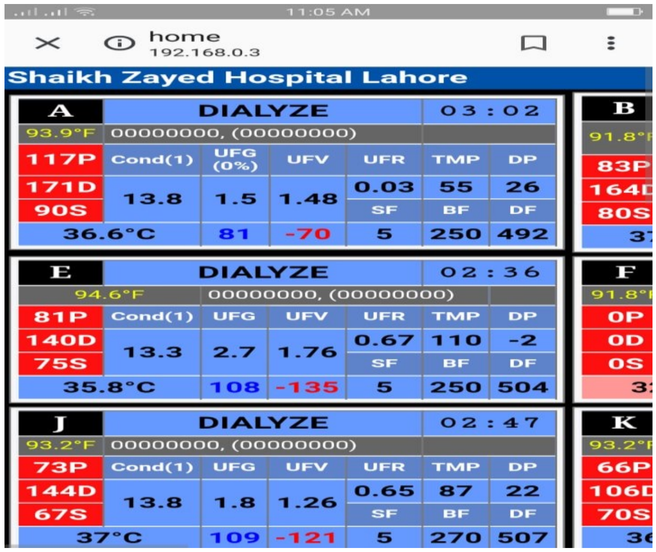


Figure 4.5: Mobile phone display

As the shown in figure this data is from sheikh Zayed Hospital Lahore. The Unique Local IP Address also shown in figure. As this system is a wireless system. Therefore, it has been given a separate Local IP Address, which is 192.167.0.3 to increase its efficiency. So that the patient attendants who comes with the patient can see their patient data on their mobile phone. This system gives very easy and comfort access on data display sheet. This is a very good progress for patients. Due to this system, we will be able to take care of our patient better and well. In this way, we can leave a good effect on the patient's life and health.

As you can see in your real time image on your smart device, this system always contacts you with the patient. You can see your patient's data on a mobile phone via a unique IP.

Chapter 5

Simulation Results

5.1 Introduction

In this chapter, we have implemented POMS through the use of ML. A computer code has been written that depicts the conclusion reaching mechanism in a real time POMS. The software used to implement this task has been chosen as MATLAB. The reason for selecting MATLAB is due to the fact that it offers a convenient channel to illustrate the condition of the patient being examined through a graphical approach. In This chapter, we have conducted two simulations to model the decision-making mechanism of a POMS. The first simulation is run for an individual patient. In this simulation, four main fundamental signs of the human body are measured over a fixed interval of time. These fixed signs that determine the health of a human body are body temperature, heart bear level, upper blood pressure and lower blood pressure. The first simulation has been planned in such a manner that if the value of any of these mentioned parameters falls below or above the normal set value, the systems detects it and displays the abnormality onto the screen of the system. The value set as normal are as follows:

1) Body Temperature: 96 – 101.
2) Heart Beat: 65 – 100
3) Lower Blood Pressure: should be greater than 80
4) Upper Blood Pressure: should be less than 120

The simulation code also plots these values onto the screen of the systems so that the physicians can gauge the trends in these parameters. In the following sections of this chapter, we have explained the code and the plots that depict vital body signs over a range of intervals. Once, POMS measure these signs, they are than transmitted into an excel sheet from where the MATLAB code reads the sheet and processes the data

5.2 Individual Patient Simulation

First of all, the system of the MATLAB reads the values of parameters from the excel sheet. Each column of the excel sheet contains the data for each parameter. For example, column1 of the excel sheet contains the data for the blood pressure, column2 represents upper blood pressure, column3 represents temperature and the last column, column4 represents low blood pressure. Once, the software has read the columns, their transpose is taken to convert them into arrays in the MATLAB. Then, normal states have been assigned to the variables, which is zero. In the next step, we have created vectors containing zeros. The for loop is commenced in the next step which taken each value from the array and places it into the vector containing zeros, by replacing zero with the value of the parameter. Then, 'if' conditions have been set up which checks whether is there any abnormal value. If any abnormal value is detected, it is displayed on the screen of the computer and the value of the normal state changes accordingly.

```
clc
clear all
close all
% Reading Files
file1 = 'Data1.xlsx';
bp1 = xlsread(file1,'A1:A21');
hb1 = xlsread(file1,'B1:B21');
t1  = xlsread(file1,'C1:C21');
bk1 =xlsread(file1,'D1:D21');
%Taking Transpose
bp = bp1';
hb = hb1';
t  = t1';
bk = bk1';

% Assigning Normal State
bp2 = 0;
hb2 = 0;
t2  = 0;
bk2=0;

% PCreating Vectors
 bp3 = zeros([1 21]);
 hb3 = zeros([1 21]);
 bk3 = zeros([1 21]);
 t3  = zeros([1 21]);

 for i=1 : 1: 21
     bp3(:,i) = bp(i);
 end
     if (bp3(:,i) <= 80)
         bp2 = 1;
    fprintf('Lower Blood Pressure is Low\n    ')
     else if (bp3(:,i) >= 81)
         bp2 = -1;
         fprintf('Upper Blood Pressure is Normal\n   ')
         end
     end
```

Program for automatic self-prescription generate by system.

```
Threat_Level = bp2 + hb2 + hb21 + t2 + t21 + bk2;

if(bp2 == 1)
    fprintf('Lower blood pressure is low. Take Tablet Adronis 4mg\n')
end
if(hb2 == 1)
    fprintf('Heart Beat is High. Take Tablet Lisinopril 10mg\n')
end
if(hb21 == 1)
    fprintf('Heart Beat is Low. Take Tablet Levothyroxine 10mg\n')

if(Threat_Level == 3)
    fprintf('Your Threat Level is = %f\n', Threat_Level)
    fprintf('Serious Threat. Medical Assistance Required Right Now\n')
end

if(Threat_Level == 4)
    fprintf('Your Threat Level is = %f\n', Threat_Level)
    fprintf('Very Serious Threat. Immediate Need for shift to ICU\n')
end
```

This figure represents the code in which we have illustrated how we have calculated the level of threat. In the next step of this code, the algorithm detects for change in the normal state of variables and so, accordingly prescribes medicine to the patient based on the state of the patient.

In this illustration, we have represented the segment of code, which detects the level of threat, prints that level of threat and forwards recommendation for next stage of treatment, such as by recommending 'very serious threat. Immediate need for shift to ICU'

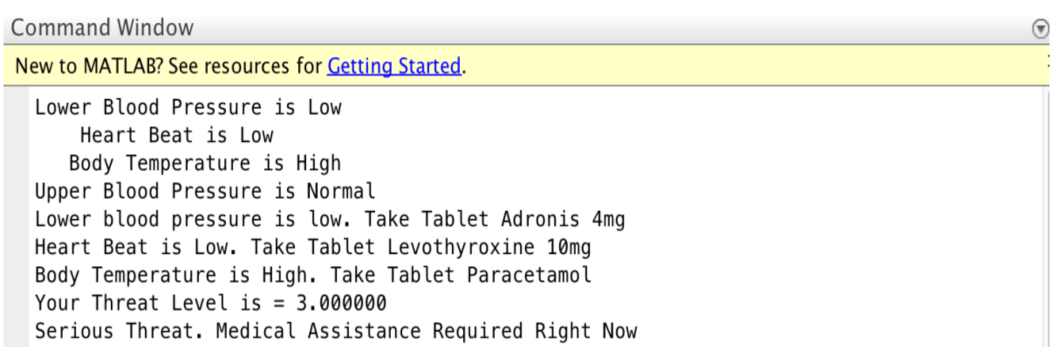


Figure 5.1: Algorithm for single patient

The results of the above algorithm, when displayed onto the command window of the MATLAB, which represents the screen of CDSS as assumed in this case.

Table 5.1: Table of reference value for following parameters:

Sr. #	Parameter	Ref. Value Range
1	Blood Pressure	120/80
2	Temperature	98° F
3	Heat Beat	90-100

Table 5.2: Table for automatic medicine prescriber:

Sr. #	Parameter	Current Value	Patient Category	Prescribed Medicine	Threat level	Assigned Action
1	High BP	140	A	EziDay	1	Take Med
2	Low BP	70	B	Lisinopril	1	Take Med
3	Heart Beat	60	C	Levothyroxin	2	Take Med
4	Temp	101° F	D	Panadol	1	Take Med
5	BP	150/100	E	Nil	3	Inform to Physician
6	Heart Beat	110/50	F	Nil	3	Inform to Physician
7	BP	200/120	G	Nil	4	Shift to ICU Immediate
8	Temp	106° F	H	Nil	4	Shift to ICU Immediate
9	Heart Beat	180/ <40	I	Nil	4	Shift to ICU Immediate

5.2.1 Plots from the Simulation

Figure 5.2: Lower blood pressure has been monitored over a range of intervals. Once, the value falls below the limit set as normal for the lower blood pressure, which is 80, the systems display it onto the graph, changes the value of the normal state assigned as a variable and also displays it onto the screen of the computer.

Figure 5.2: Single patient simulation for lower blood pressure

Figure 5.3: Single patient simulation for Heart beat

Figure 5.3: The heart beat has been monitored over a range of intervals. Once, the value falls below the limit set as normal for the heartbeat, which is 65, the systems display it onto the graph, changes the value of the normal state assigned as a variable and also displays it onto the screen of the computer.

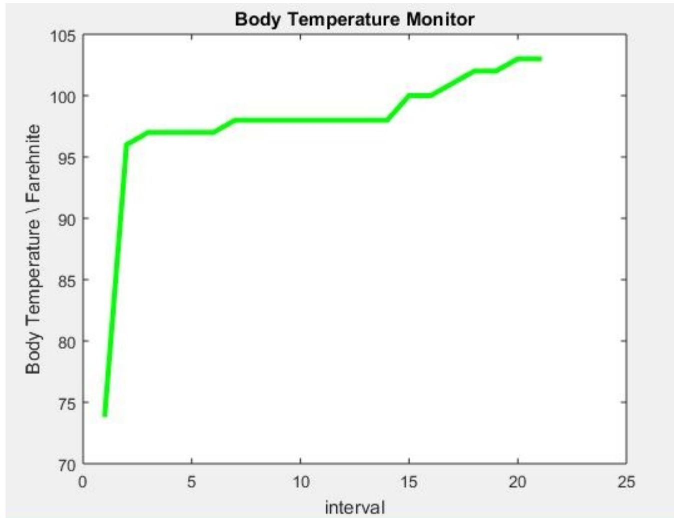


Figure 5.4: Single patient simulation for body temperature

Figure 5.4: Body Temperature has been monitored over a range of intervals. Once, the temperature falls below the limit set as normal for the body temperature, which is 96 or exceeds the upper limit which is 101, the systems display it onto the graph, changes the value of the normal state assigned as a variable and also displays it onto the screen of the computer.

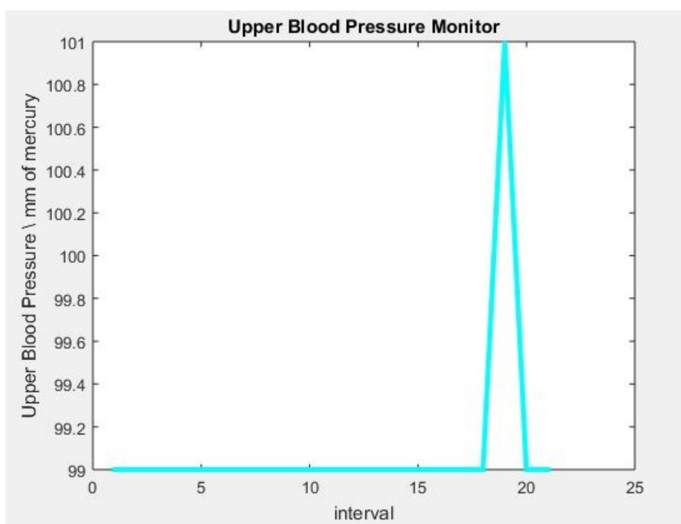


Figure 5.5: Single patient simulation for upper blood pressure

Figure 5.5: Upper Blood Pressure has been monitored over a range of intervals. Once, the upper blood pressure exceeds the limit set as normal for the upper blood pressure, which is

120, the systems display it onto the graph, changes the value of the normal state assigned as a variable and also displays it onto the screen of the computer.

5.3 Multi Patient Simulations

In this simulation, we have included a total of 51 patients whose various parameters we are measuring in this simulation. In this algorithm the aim is to detect the total number of people being monitored and the number of people with the value of various parameters above or below the optimal level. This simulation assists the health care observers in maintaining a coherent record of the data. In such a manner, the overall progress of the hospital in providing effective healthcare to the patients and the monitored. It can also be analyzed how much proportion of patient suffer from a particular aberration in a particular symptom.

```
clc
clear all
close all
% Reading Files
file1 = 'Data1.xlsx';
th1 = xlsread(file1,'A1:A21');
hb1 = xlsread(file1,'B1:B21');
th = th1';
hb = hb1';


a = th(find(th >= 101));
b = th(find(th <= 96));

c = 1:length(a);
d = 1:length(b);
e = 1:length(th);

f = length(th); % Total No of People Monitored For Body Temperature
g = length(a);  % Total No of People Monitored For High Temperature
h = length(b);  % Total No of People Monitored For Low Temperature
```

The algorithm takes the same form as the algorithm for the single patient simulation. The only difference is that instead for the loop; we have used an inbuilt function of the MATLAB to find the number of values greater than or less than a particular value of the parameter. Also, this code, explicitly displays the total number of people, people with values of a parameter below a certain level and the number of people with a value of parameter higher than the optimal value. Each category of patients is plotted separately and the x-axis is plotted, which is equal to the number of patients for that particular category, is plotted in such a manner.

5.3.1 Plots from Multi Patient Simulation

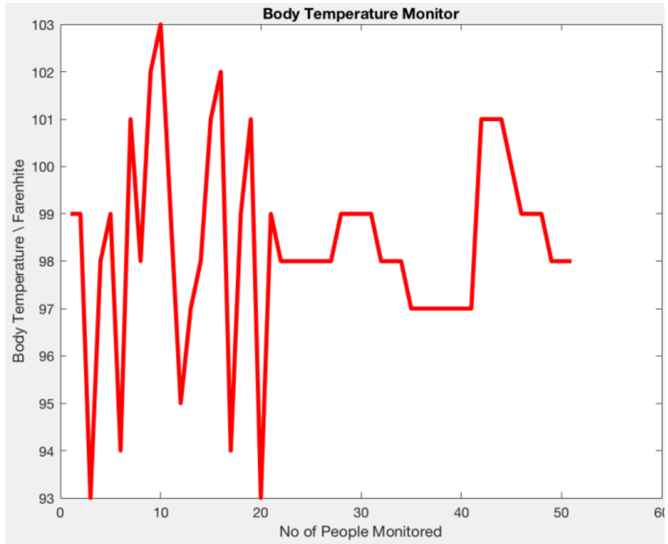


Figure 5.6: Multiple patients' simulation

Figure 5.6: The diagram illustrates the total number of people being monitored for body temperature which is equal to 51. Each unit on the x-axis represents one patient.

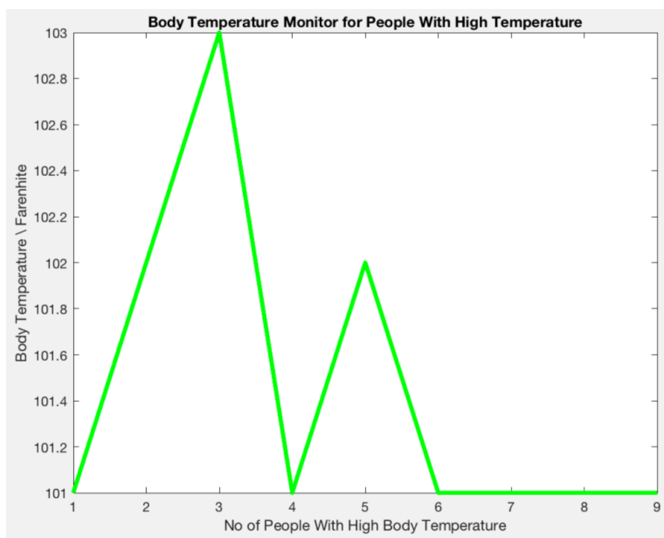


Figure 5.7: Multiple patients' simulation with high Body Temperature

Figure 5.7: The graph illustrates the total number of people monitored for high temperatures, which are 9. The temperature of each patient is given on the y axis.

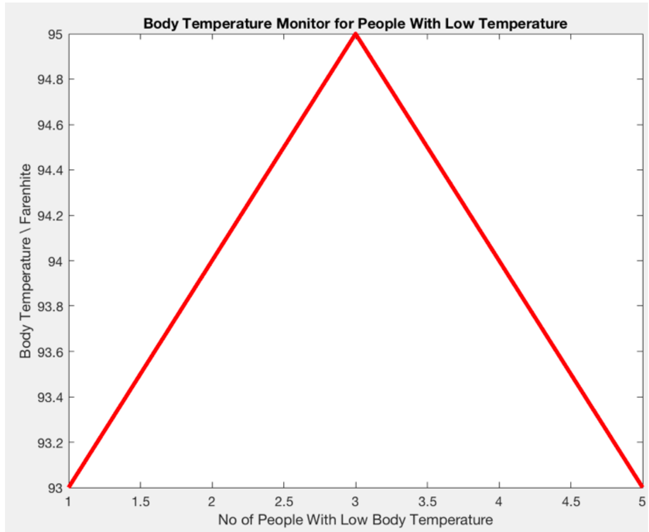


Figure 5.8: Multiple patients' simulation with low Body Temperature

Figure 5.8: the number of people being monitored with low body temperature.

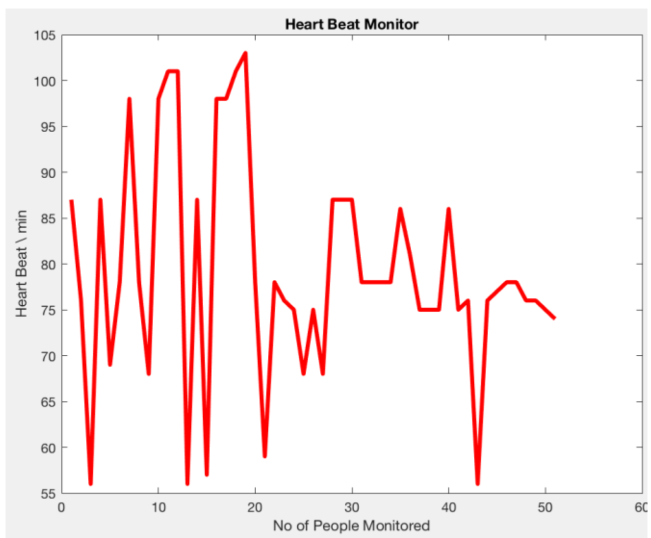


Figure 5.9: Multiple patients' simulation for heart beat monitoring

Figure 5.9: The graph illustrates the total number of people monitored for heart beat rate. In this representation, a total of 51 people has been monitored and the heart beat rate of each patient has been depicted on the screen of the CDSS, as assumed in this simulation.

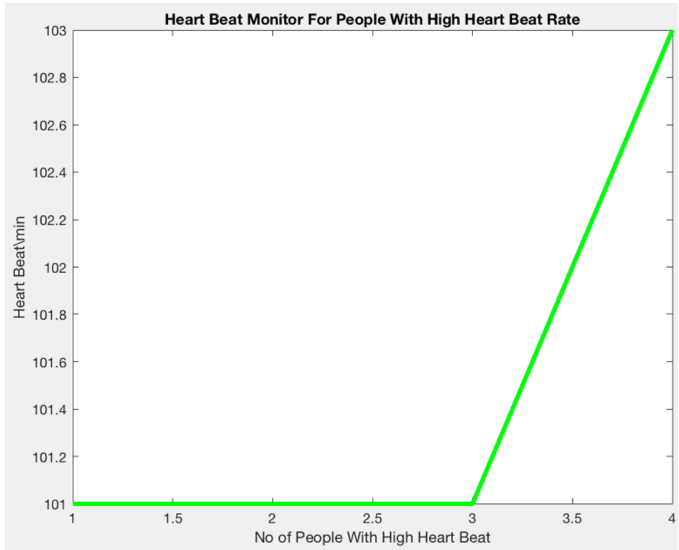


Figure 5.10: Multiple patients' simulation with high heart beat

Figure 5.10: The number of people with the higher heart beat rate.

Figure5.11: Multiple patients' simulation with low heart beat

Figure 5.11: The total number of people with heart beat rate lower than a pre-defined minimum level.

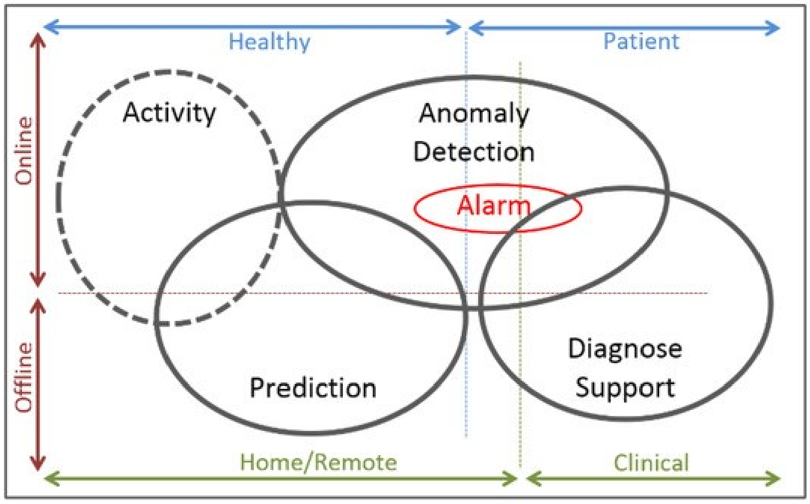


Figure5.12: Reference value and alarm system

This diagram is showing the system when will generate alarm. When the value current value exceeds or decreased from the limits, that is given to the system. Then the system will generate alarm for physician and paramedical staff. This method is use for patient health, safety and better management.

Chapter 6

Conclusions

6.1 Summary and Outlook

The POMS and Self-decision maker online system flag channels can be utilized to separate signs online from non-stationary, hysterical, and exception degraded internet checking time arrangement from concentrated consideration. By looking at flag appraises rather than crude assessments to upper and lower caution detains, the quantity of limit alerts can be lessened.

The assessment of POMS and Self-decision maker online system for an application for first successful trail has been done in light of logged information in emergency unit. This information record, each alter has been simplified contemplatively as either noticeable or false. Keeping in view the end goal to assess the POMS and Self-decision maker online system caution frameworks, we gauge their affectability (SE) yet not their concisely. The rational is that for a completely estimation one needs to choose as far as possible violation of the new framework inside "alerts off" periods, implying that either this is new or old caution system is favored. Henceforth, this is concluded from assessing concisely and identifies the false alert decrease rate of the new framework (FARR).

Patient online monitoring system & online prescription generator introduced new structures are dictated by developing false and genuine caution interims that comprise of a specific data focuses after deciding a false and genuine alert, individually. On the off chance that the POMS/Self decision maker online system flag estimations damage as far as possible inside a genuine alert interim, the agreeing genuine caution is viewed as distinguished. Analogically, a bogus alert of the old framework is viewed as smothered by the new framework, if its flag estimations don't disregard as far as possible inside the false caution interim.

An investigation of the database demonstrates that around more than 90% alerts were caused by ART.S, ART.M, HR, and SpO2. Thus, our focus was on investigation about four essential signs. Besides, more than 50% alerts were plotted “WARNING”. These alters do not need swift activity yet are beneficial. Since this assessment procedure depends on obvious/false choices, we review warning cautions as false or genuine.

The use of POMS and Self-decision maker online system is performed reflectively. Since the decision of the base window greatly affects the POMS/Self decision maker online system flag extraction. The capacity its self-decision maker online system has been connected square insightful with one square comprising of blood vessel blood weights and one of pulse and heartbeat; oxygen involvement fabricates a claim square, implying that the multivariate Self decision maker online system calculation.

We witnessed that the two channels can smother around a quarter to 33% of every false alert while giving no less than 95% affectability. For example, only requesting something like 90% SE, a POMS or Self decision maker online system alert framework can decrease 31 to 38% of all edge cautions.

The requirement for a change of the real circumstance on concentrated consideration units is self-evident. Preprocessing the crude observing information by the POMS or Self decision maker online system channel is a decent plausibility to accomplish this point. The proposed channels could be actualized into the checking frameworks. At that point, the down to earth execution of a separating based alert framework can be contrasted with that of the "old" framework in a test stage. Be that as it may, one needs to remember the lower affectability of sifting based alert frameworks. In this manner, the doctor must approach both the separated and the crude estimations at the bedside.

The capability of the POMS and Self decision maker online system flag channels isn't limited to false alert concealment. For example, this is likewise to be used for comforts of persistent checking. Since even flag, removals are less demanding for translating than energetic and anomaly debased estimations. The POMS and Self decision maker online system flag removal can equally be profitable in different fields for instance, estimations of high-recurrence from industry/fund.

Moreover, POMS & Self decision maker online system can be better more for advancement and more purpose can be served for different channels. For example, there may be better standards for the adaption of window width, potentially in light of techniques for the recognition of auxiliary breaks; for the Self-decision maker online system, a programmed and time-subordinate decision of the connection squares would be a change, particularly for multivariate time arrangement with an vague and conceivably changing reliance structure.

6.2 Conclusion

In this dissertation, we have presented a design of a Patient online monitoring &Clinical decision support system, which has been implemented through ML. CDSS hold paramount significance in today's healthcare system. There are four main fundamental signs in the human body. These signs include body temperature, heart beat rate, blood pressure and blood glucose level. Such signs in the human body are a precursor to almost all further ailments that can potentially occur in the human body. By monitoring and examining the trends in these parameters, one can deduce the ailment in the human body. Hence, these parameters need not only to be monitored but also analyzed in a coherent fashion.

A vast number of deaths occur due to the lack of monitoring. In most hospitals in metropolitans across Pakistan, CDSS are provided, but are only available in the Intensive Care Units (ICU). In general, wards, such support systems are not available and so these wards lack a sound monitoring system. Therefore, there is a need for a system that not only monitors the vital sings in the human body but also maintains a check on these signs. If an abnormality is detected than the systems alerts the health care staff. In such a manner an efficient patient monitoring is achieved and so can prevent many medical conditions from aggravating and in some cases, it can prevent fatality. Additionally, these systems limit the burden on the healthcare staff.

Getting inspiration from the above-mentioned conundrum, in this dissertation the theoretical framework for development of CDSS was studies in deep detail. Precursors to understanding the development of such a system were to learn the fundamentals of ML.

Hence, the first task accomplished in this dissertation was to grasp the main concepts of ML and learn how to use them in real life. Once, the ML was learned and theoretical framework for development of CDSS through ML was gained, the next step fundamental for this project was to gain understanding of a real time CDSS. For this purpose, we visited Sheikh Zayed Hospital in Lahore and understood the working of such a system in detail. I would like to express my shear gratitude for the staff of the Sheikh Zayed Hospital for letting me gain access to the system. In the last stage for this dissertation, the system for which we presented a theoretical framework was implanted in MATLAB. The system that we designed in the MATLAB had the capability to monitor the signs in the human body and look for any abnormality. The system that we had implemented also had the capability to detect whether the value of the abnormality was above or below the optimal value.

The aim of this dissertation is to realize the significance of CDSS in the health care system of Pakistan. Pakistan has a very high mortality rate. The main cause for such a high mortality rate can be attributed to the lack of effective monitoring. Hence, I believe that my dissertation can motivate the people aspiring to continue the work further in this field and benefit the community.

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