A Study on Role of Intelligent Decision Support Systems in Healthcare

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Abstract: The objective of the paper is to summarize the applications of Intelligent Decision Support Systems (IDSS) in Healthcare Monitoring Systems (HMS), that too mainly in monitoring the heart diseases and providing necessary remedial actions. The Decision Support Systems (DSS) are capable of handling the complex and ambiguous scenarios from the earlier statistics. The objective of DSS lies in accomplishing the evolutionary computation and the ultimate decision making nature even in the uncertainty situations. Integrating the Artificial Intelligence (AI) into DSS transforms the traditional DSS into IDSS, which assists the humans in accomplishing the right decisions in a fast and easy manner with higher accuracies. The extensive study concluded that the IDSS had played an essential role in monitoring and remedial actions in the healthcare domain.

IndexTerms Decision support systems, Intelligent decision support systems, Heartbeat, Sensors, Artificial Intelligence.

I. INTRODUCTION

The conventional DSS is defined as a tool that helps to interpret the information and builds a foundation for decision-makers to make an appropriate decision at the right time. The IDSS can be defined as a tool that aids the physicians in making diagnosis and provide treatments in a quick manner by analyzing a huge database and knowledgebase. The role of IDSS in a healthcare plays a vital role, start from gathering the data, monitoring, analyzing the purpose, reviewing the characteristic features from the earlier history and much more. Unlike, DSS, IDSS applies domain-specific knowledge to handle the complex and uncertain problems and suggests/draws the conclusion in an efficient manner.

Even though the IDSS provides decisions based on learning and reasoning methods through knowledgebase and rule-based approaches, few other components integrated with IDSS are as follows: (1) Clinical Decision Support Systems (CDSS): The system which provides the decision through evidence-based knowledge is termed as CDSS. The major components of CDSS are knowledgebase, processing unit and a language system [1] and [2], (2) Artificial Neural Network (ANN), a mathematical model, can learn through example, like human beings.

Figure 1 shows the representation of healthcare monitoring system summarized from [3]. It consists to four modules namely, (1) Analyze the data with domain intelligence, (2) Create the models, (3) Knowledge demonstration, and (4) Processing it. The process starts with analyzing the data followed by creating the models. Later, the knowledge is exemplified and processed for making the decisions.
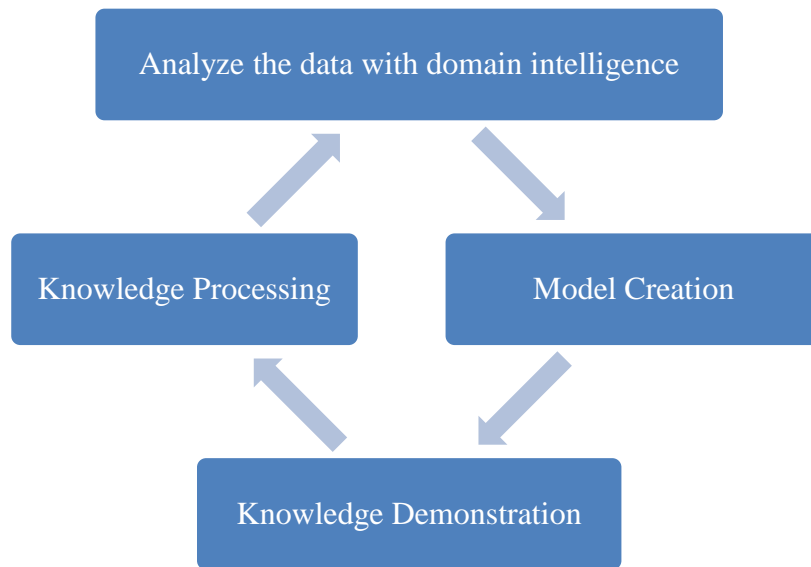
Figure 1 Representation of Healthcare Monitoring System

Figure 2 shows the conventional architecture of IDSS adopted in healthcare monitoring system. The data from the database, knowledgebase and IDSS are processed in the central server. Based on the complexity and severity of the issues, the concern instructions are provided to administrator, doctor and patient modules for necessary actions.
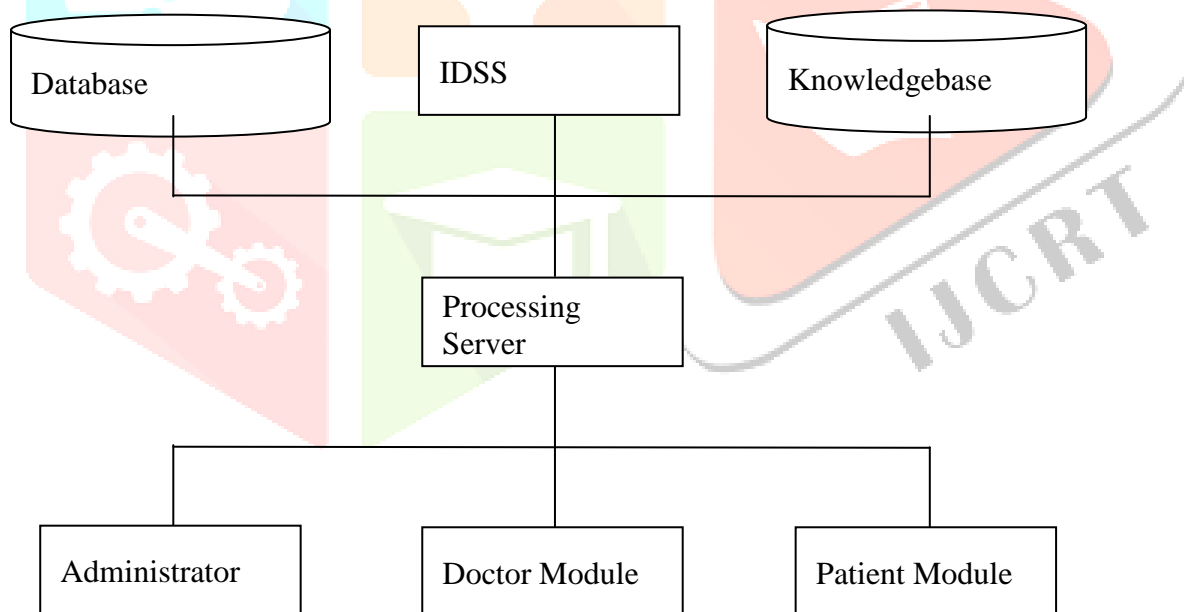

Figure 2 Architecture of IDSS in Health Monitoring Systems

II. EXISTING METHODS

The following section deals with the summary of existing IDSS adopted for monitoring the heartbeat rate along with the remedial approaches.

Farin, Sharif, and Mobin proposed a Heart Rate Monitoring (HRM) system [4] to monitor the heartbeat rate using intelligent microcontroller unit and an ear-clip heart rate sensor with Arduino unit. The specialty of this system was that user could determine the database rate from monitoring body and management unit. The database was managed over screen via WLAN with a web server, PHP and SQL databases, which can save all the data observed from the monitoring body. The significant advantages of this system were user-friendly and

low cost. Apart from detecting the detect heart rate, this method also determines the death reason caused due to heart rate, through a warning signal during an abnormal situation in a very secure manner.

Chaoli, Xiangpei Hu, Lili Zhang proposed an IoT based heart disease monitoring system for controlling the deaths caused due to heart diseases [5]. The proposed method can monitor the physical states such as blood pressure and ECG. It is very feasible for tracking the practitioners from the remote location, and those long distances are covered by the wireless communications and can be carried to Android platform using Java which can be sensed through Bluetooth with different operational nodes and can be further integrated using Data Stream Management System.

Hanen Jemal, Zied Kechaou, and Mounir Ben Ayed proposed the Intensive Care Unit (ICU) [6] designed for making a medical decision in the ICU combining both logical and perception in which decision is made without any ambiguity. This is done by a process using Fuzzy logic or sets which are grouped into 6area and were introduced for more accuracy and to examine the problem based on the present knowledge and observations. This is done by implementing input variables in fuzzy logic using few calculations based on few rules. The advantage of this technique is that it can handle complexity in a proficient manner. This method can be extended by evaluating subjective and objective features.

Alauddin Al-Omary, Wael El-Medany, Riyad-Al Hakin proposed Heart Disease Monitoring System (HDMS) [7] for monitoring the death rate caused due to lower quality of life, where the system follow-ups the patient condition and send ECG signals from the patient using Personal Computer or Laptop. Later, the signals are sent to the hospital via the Internet to the hospital server. It can be monitored using Android application from both the home gateway and hospital server and updated once in every thirty minutes, where abnormalities are detected and keep track via SMS or MMS system. The benefits of this system are it provides with cheap and affordable ECG system compare to the present system. And this can be further developed using the programmable system on a chip integrated with sensors.

Decision Support and Home Monitoring System using the Internet of Things was proposed by Iuliana Chiuchsan and Oana Geman for monitoring patients affected by neurological disorders and Parkinson's disease [8]. This application facilitates the exchange of information between doctors and patients, consisting sensors, RFID microcontrollers in it. IoT plays a significant role in the field of healthcare which is done through smart devices with the sensing capabilities comprised of modified mouse equipped with three pressure sensors and accelerometer sensors, and also the screening system. It can also collect patients assessment and data via wireless transmission.The advantage of this method is health monitoring timely and in a convenient way with lowering costs of health services using the medical application domain of IOT, artificial intelligence, information and communication technology.

Priyanka Kakria, Tripathi, and Peerapong Kitipawang developed a Real-Time Health Monitoring System (RTHMS) [9] to monitor various cardiac diseases like a heartbeat from remote areas. The RTHMS consist of two interfaces, namely, one for doctors and the other for the patient. The three-tier architecture provides the interface through wearable biosensors, smartphone and web portal for processing it. The system also contains GPS for locating the patient's location and generates an alarm in an abnormal condition(s). The device aims to determine the ability, accuracy, and better performance in deciding the issues related to the heart of the Human being. The primary advantage of using the system lies in monitoring the remote patients by providing the latest health services and remedies using wireless technology. The only drawback of this method lies in the generation of a false alarm due to battery issues of sensors and smartphones.

A Survey of Multi-Agent based Intelligent Decision Support System was presented by Hanaa Salem, Gamal Attiya, Nawal El-Fishawy for several medical diagnoses [10]. Here, machine learning algorithm was used to diagnosis rules from the description and treat the patients. The collections of independent intelligence in multi-agent system consists of Intelligent Decision Support Systems with Artificial Intelligence to solve the complex issues and improves the decision-making scenarios. The advantage of this method is the consistency in decisions, explanations, and justifications for specific recommendations. And this technique can be enhanced by implementing more agents which can run on different machines located in diverse places.

Development of wearable heart disease monitoring and the alerting system was proposed by Hyuma Watanabe, Masatoshi Kawarasaki, Akira Sato, Kentaro Yoshida for monitoring the heart diseases [11]. Through this approach, E-health was introduced to give medical support. Dentan with wireless ECG sensor and smartphone were used to communicate through Bluetooth to monitor the ECG and report in case of abnormal heartbeat behaviors. Further, this device is light weighted, small in size, comfortable to wear, durable with power saving options with different levels of alerting abnormal ranges. The benefit of this system lies in the identification of abnormalities in the early stages of patient's heart problems. Sometimes, the complication arises in wearing the wireless ECG sensor.

Intelligent Decision Support for Real-Time Health Care Monitoring System was proposed by Abdelhamid Salih Mohamed Salih and Ajith Abraham for healthcare monitoring and supporting the patients with chronic Diseases using data mining algorithms [12]. The significant role of wireless sensors is to gather the required information using different sensors during the monitoring period and notifies the doctors and nurses when mobile network or WiFi system trigger a danger zone alarm. The different Base Classifiers are used to evaluated and measure the performance at various scenarios. The advantage of the method is to provide better accuracy and performance when compared to the traditional way of medication. The only drawback of the proposed approach was the generation of the false alarm and subsequent increase in error rate due to malfunctioning of sensors.

Juan Ramon Castro proposed an Intelligent Decision-Making Support (IDDS) [13] in Health Information Systems (HIS), Maldonado, and Edaniel Figueroa to monitor the health condition of a patient. Here, the data mining techniques are used to handle and evaluate the patient's physical conditions, and decisions are made according to the circumstances. The advantage of this system lies in the lightweight class library, which provides better performances in identifying the abnormalities. The drawback of this method is that diagnosis is a complicated process. This method's performance may be improved by incorporating more hybrid data mining techniques and test scenarios to the application.

Tan, Zhang, and Jiang proposed an Intelligent Decision Support System for Skin Cancer Detection from Dermoscopic Images [14]. Here, the long-term health monitoring was carried out for efficient disease diagnosis. The Decision support system was used to identify the nature of skin disease and classification took place through Genetic Algorithm based feature optimization including many pre-processing keys. Different segmentation algorithms are used to resolve the shape, color, and texture from the affected part to detect and differentiate the healthy and cancerous regions. The advantage of this system lies in the more straightforward calculation of accuracy, sensitivity, and specificity for evaluation. The performance can be improved by integrating Genetic Algorithm for identifying more discriminative features for accurate classification.

A Real Time Patient Monitoring System for Heart Disease Prediction Using Random Forest (RF) Algorithm was presented by Sreejith, Rahul, and Jisha for monitoring the patient's heart rate and blood pressure using wireless technology [15]. The system architecture consists of a wearable sensor, a heart rate monitor,

Bluetooth smart heart rate sensor composed of two main parts, namely, the Client side (Patient) and the Server side (Doctor). The RF technique was used to identify and predict the diseases. The application will trigger an emergency alarm to the doctors and relatives in case of emergency situations. Further, integrated Global Positioning System technology helps to get the current location for immediate medication. The device also sets a reminder to the patient to take medicine on time.

III. CONCLUSION

The integration of AI and DSS, that is, IDSS, makes a remarkable change in the medical field for diagnosing and treatment recommendations. The thorough study reveals that incorporating the IDSS in monitoring and analyzing the heartbeat has a significant impact in the identification and recognition of abnormalities. Apart from examining the existing procedures of the various algorithms, the paper incorporates the method for refining the performance of the IDSS in monitoring the healthcare.

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