

Medical Data Processing and Prediction of Future Health Condition Using Sensors Data Mining Techniques and R Programming

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Abstract:

The rapid development of the internet of things, cloud computing and big data, is more Comprehensive and powerful tool in healthcare application. In healthcare management, a large volume of patient data is generated from the clinical notes and sensors. The analysis of healthcare parameters and prediction of subsequent future health condition are still in the informatics stage. A cloud enable big data analysis platform is best way to analyse the data generated from the sensors. We propose health sensors and temperature sensor to monitor the patient health. The patient data are collected from the sensors transmitted to the microcontroller and using cable the real and dynamic patient data are transmitted to the system. The data from the COM port are obtained using Net beans and saved in SQL database. The real time data can be monitored by both patient and doctor and the respective doctor to monitor the patient health. The real time data are processed from Net beans as an excel file to R programming studio for data analysis. In R programming k-means clustering and navies Bayes classification are processed to predict the normal or abnormal conditions of patient. Also the patient data are encrypted using blowfish Encryption algorithm and stored in cloud namely Drop box.

Keywords —Data mining, classification, clustering, cloud, security, healthcare.

I. INTRODUCTION

The current trend in internet of things and cloud computing and big data analysis make it believable to build smart technologies resident for the improving healthier life [1]. Where, smart healthcare system cannot be ignored due to the rapid growing elderly people around the world. Now-a –days the ever growing number of elderly people coupled with limited resource in the terms of medical facilities and personnel in many countries, the burden that conventional healthcare system carry is becoming heavy [16]. On the other thing is Traditional human face-to-face communications are

mostly replaced by networking in social and cyber spaces, which is causes various unhealthy living habit such as un time job, insufficient physical exercise and unhealthy diet, irregular sleeping [19]. Therefore, it is a great challenge to design a cost – effective healthcare system for handling disease, especially considering the large population elderly people and empty nester most of whom suffer [20]. To address the frequent repeated issue, we should lower the operating cost and improve their scalability, reliability, of healthcare organization so in order to provide basic service like, patient monitoring, early warning about their abnormal condition [18]. Privacy and security plays an

important role in the healthcare service, many fraud and intrusion are rapidly increase happening in the healthcare organization [21]. To avoid such fraud in healthcare services. With big data growth in the biomedical and healthcare communities, accurate analysis of medical data benefits early disease detection patient care and communities' services. Quality healthcare is one of the most important factors in how individuals perceive their quality of life [36]. People use health care services for many reasons: to cure illnesses and health conditions, to mend breaks and tears, to prevent or delay future health care problems, to reduce pain and increase quality of life, and sometimes merely to obtain information about their health status and prognosis [13]. Healthcare organizations today are capable of generating and collecting large amounts of data [26]. The huge amounts of data generated in the healthcare transaction are too complex and voluminous to be processed and analyse by traditional methods [15]. This increase in volume of data requires automatic way for these data to be extracted when needed. With the use of data mining techniques it is possible to extract interesting and useful knowledge and regularities [23]. Knowledge acquired in this manner, can be used in appropriate area to improve work efficiency and enhance quality of healthcare [11]. In healthcare data mining is becoming increasingly essential to receive better and more affordable healthcare service. Problem which are identified in the existing system is existing the wired sensors are used to collect the data from the patient body, the wired sensor network only with the help of electricity .if the power gone the patient monitoring will completely affect [29]. The wired is a traditional method which used in the hospital wired sensor integration, the pulse sensor is installed around the wrist, the body temperature sensors put in the underarm, a set of ECG sensor is mounted on the chest, shoulder and ribs, the myocardial sensor is embedded in the left chest and spo2 sensor is deploy in the left or right arm with the wired sensor network the accuracy of usability, wash ability and monitoring will be affected. In [7] with the wired a wearable cloth is introduced the cloth is washable by washing the cloth embedded with sensor may be affected and

lack in data accuracy with wired wearable cloth the sensor do not have touch with skin directly, so the data value will face a problem on accuracy and also make very discomfort to the user, and the long stay patient faces many challenging issue. Prediction of future health condition is an upcoming technology I future healthcare service which improve the quality of service and quality of experiences [22].

II. RELATED WORK

To analyse data to drive meaning information is highly essential for studying health related raw data and to predict the future health condition [2] In hospital emergency department patient is predicted using a local big data driven random forecast model. However, only clinical data of patient are considered in the existing models ignoring the history of symptoms.[3] In future health condition prediction is very crucial and important for the patient with different health status[6] An data mining algorithm artificial neural network technique are used for prediction but ANN takes longer time for training the model due to diversified weight and for the small changes in the input data set is affected the complete model and which produced an unstable output [9]. biosensor such as eeg, emg, and eeg are used to collect the data from the patient body by using the sensor we can produce an accurate data from patient which can produced an accurate result while prediction.[8] By using the sensor the data which collected from patient body are transmit the health data to the database, while transmit the data to the database. Visiting of patient and the doctor are decreased frequently. [10] The body sensor is used for collecting the data accurately; none of them have developed the data collection models of the indoor and outdoor patient[12]. Even physiological data are essential including ECG, heart rate, inspiration, body temperature. Among this ECG and heart rate have higher data priority in terms of accuracy and timeliness[14] Many elderly people have to monitor continuously in door for a long term for this kind of patient sensor are very particular to monitor the patient data.[16] The wearable and washable cloths which contain sensor in the cloth this cloth are which wearer by the patient by using cloth the body

data not accurately collected.[17] The challenging task is smart health systems with data security the physiological data are collected from the patient body are transmitted to the cloud to monitor the patient continuously and also encrypt the data to the cloud storage to secure the data [24].

TABLE I
 COMPARISON OF WIRED AND WIRELESS SENSOR NETWORK

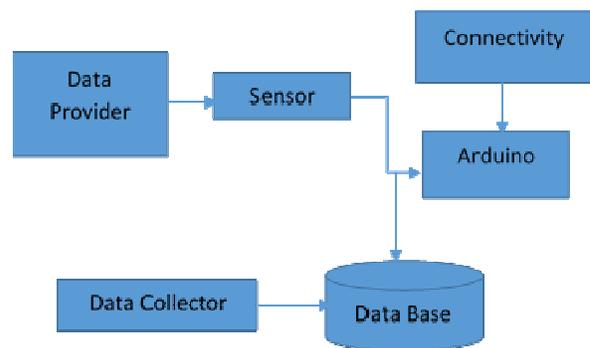
Product name	Wired Sensor Network			Wireless Sensor Network		
	Bracelet	Watch	Heart Rate	Bracelet	Watch	Heart Rate
Category	Wearable	Wearable	Wearable	Wearable	Wearable	Wearable
Comfort	Low	Low	Low	Middle	High	High
Usability	Hard	Hard	Middle	Easy	Easy	Easy
Accuracy	Low	Middle	Low	High	High	High
Real Time	No	Yes	Yes	Yes	Yes	Yes

III. PROPOSED SYSTEM AND METHODOLOGY

A. Proposed System

In traditional healthcare system, the patient data are collected stored and analysis in the traditional manner, which cannot support the diagnosis of complex health condition however in our proposed data model are predict the future health status of the patient on their current health parameters [25]. A patient who admitted in the hospital frequently to know the future health condition. The future health status may save life of lives so to avoid frequent visit to hospital or any healthcare centre. The patients are provided with the wearable (sensor) devices the wearable device is embedded with the sensor [27]. The sensor tightly attach to the skin and accurate produce of data from the body sensor the data based on the sensor feature. Data collector will collect the data from the data provider. The data provider is patient the from the patient body collect from the sensors [30]. The collected sensors data are stored in the cloud storage for future use they are encrypted and transmitted to the cloud. The data are encrypted by blow fish encryption algorithm. The continuous data collect from the patient body are predicted to know the current

health condition [28]. The prediction is done by data mining technique with classification and clustering method. Naïve Bayes classification and k-means clustering algorithm. In prediction of future health condition by trained data set the real data is compared with the naïve B ayes is only with two conditions yes (or) no ie if yes the condition is ab-normal if no result return to normal condition. Suppose if the result turn to abnormal condition, in what variation the result turn to ab normal condition from normal condition to calculate the variation in propose system we use k-means clustering algorithm [48]. Data collector will collect the data from the data provider. The data provider is patient the from the patient body collect from the sensors. The collected sensors data are stored in the cloud storage for future use they are encrypted and transmitted to the cloud. The data are encrypted by blow fish encryption algorithm. The continuous data collect from the patient body are predicted to know the current health condition. The prediction is done by data mining technique with classification and clustering method. The naïve Bayes classification and k-means clustering algorithm. In prediction of future health condition by trained data set the real data is compared with the naïve B ayes is only with two conditions yes (or) no ie if yes the condition is ab-normal if no result return to normal condition.



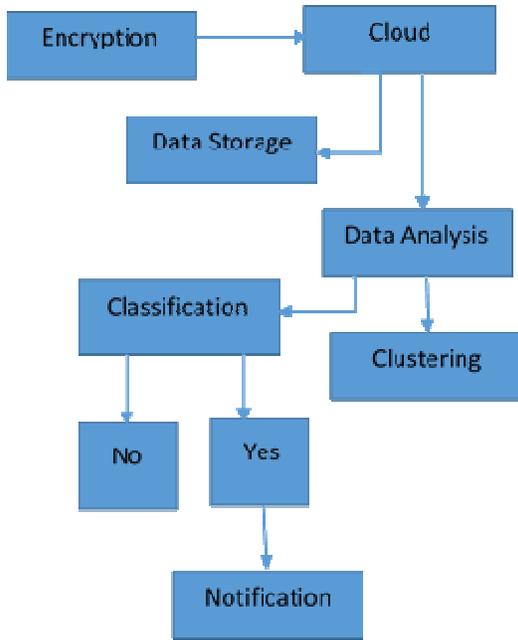


Fig. 1 Proposed System

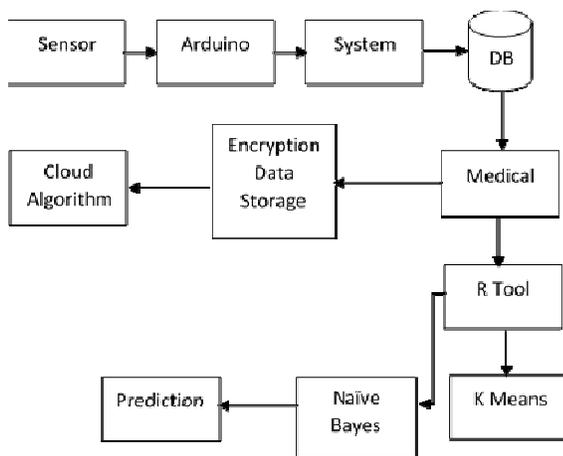


Fig. 2 Architecture diagram

B. Implementation

Architecture of wireless sensor network: Traditional wired sensor is replaced with wireless sensors network with the continuous improvement of wearable sensor network the wired sensor is replaced with wireless network. Where the wireless network is more efficient than the wired network with the usability, reliability, accuracy, wash ability and also support for real time monitoring system

and also wireless network improve the quality of services and quality of experiences of upcoming generation healthcare services.

Data provider: The elderly people or the disease affected people and the sick people physiological data health value like (heart rate, bp, sugar level in blood glucose) these value are called health data or named as medical data. The data provider is monitoring patients and the data is medical data these data are collected using sensors. Sensors: Sensors are used as electrical based medical equipment used to convert the various form of stimuli into electrical signal for analysis. Sensor can increase the intelligent of medical equipment such as biosensors. Sensors can enable new type of patient monitoring to support more independent patient life style patient need to be monitored pre-hospital, in-hospital, before, during, after, procedures at home or hospital in long term care. Sensors used to collect the data in various environments for data analysis. Sensor is an electrical device which is used to collect the data from the body and also used for continuous monitoring [31].

Wearable device: Sensor integration: The sensors are integrated has one wearable device like watch, bracelet, etc. The sensor are integrated into one device is called wearable device. The wearable device is wearers by the patient are monitored continuously and the data are collected frequently.

Data collector: The data produced from the patient body using sensor the value are collected from the sensor is microcontroller.in this proposed architecture an Arduino microcontroller is used to collect the data from sensor. Microcontroller is only capable of the collecting the data from the sensor. Arduino uno: Arduino uno is a microcontroller based on the AT mega328 (data sheet) which as 14 input and output pin from them 6 can be used as pwn output pins with memory with 32k. Arduino uno has transformer which reduced the voltage (ie) 12V step down it has a bridge rectifier. Bridge rectifier is used to convert the digital signal when the analogue circuit is converted as digital circuit. It provided with ultra-capacity to reduce the noise which produced .Microcontroller is attached with crystal oscillator, the crystal oscillator is used to

generate the value to the microcontroller which produced by sensor. Database: The collected data from the patient body are stored in the database. The data are transmitted to the cloud storage. The database is used to receive the value from the sensors and used to store the value.

Cloud storage: Cloud is deliverable of service like storage and security where they shared resources, software and the information provided to other derived devices as utility over a network. In cloud storage and security is an important impact.

Healthcare cloud storage: Normally cloud storage system is considered to store a large amount of data which produced [4]. The produced data can be accessed anytime and anywhere. Similarly, the patient data and the details are stored in the cloud by this the patient can see the data anywhere, no to carry a paper of report, the report may cause damage, are may be lost somewhere, more over the patient can forget the report while bringing to the hospital to visit doctor. This may cause problem to the patient. When the details are stored in the cloud, the patient can retrieve and transmit the data anywhere at any time but the retrieval and the transmission of the data through wireless network in the cloud storage without proper authentication and protection cause security issues [5].

Healthcare data security and privacy: Data storage in the cloud is designed so that the user can use to upload, download, and synchronize information through cloud computing anywhere at any time but the authentication is very much essential in retrieval and transmission of cloud storage. In healthcare cloud application, some of the security and privacy requirement are essential.

Ownership of data: In basic owner is the creator of the information here, in the healthcare the owner is the patient because the data generate from the patient .Establishment of ownership of the information is necessary for prediction against unauthorized access or patient medical information. Integrity and confidentiality: The integrity of the medical data which stored in the cloud storage should be maintained, the integrity should maintain throughout the cloud storage it's only by authentication of data.

Authentication: The authentication in the cloud storage is only done by the key generation, the data collected and stored in the database, the data from the database is transmitted to the cloud storage the transmitted data are encrypted and transmitted to the cloud storage.

Encryption and key access management: Encryption is an interesting piece of technology that works by scrambling the data so it's unreadable by unintended parties. Encryption and the decryption are based on the key generation. The data in the database is encrypted using a key, the same key is used to decrypt is symmetric key encryption .Public key and a private key are the two different key used for both encryption and decryption is called asymmetric key encryption. Asymmetric key encryption is time consuming process because two different key is generated for encrypt and decrypt. Here in the propose system symmetric key is used encrypt the value in cloud storage.

Blow fish encryption algorithm: Blow fish encryption algorithm is symmetric key encryption algorithm a common key is used to encrypt and decrypt the value (data) [33]. Blow fish is replacement of des, where reduction of CPU time by encrypts faster than other encryption algorithm and blow fish is unbreakable and very strong. A plain text will be input and 18 keys needed to give for performance encryption it has 64 bits data than break into two parts 32bits per part again the data is divided further as 16 to 8 bits. Till now no attack has been discovered to break the blow fish.

Data Analysis: Data analysis is defined as researching, organizing and changing data in order to bring out the useful information [22].

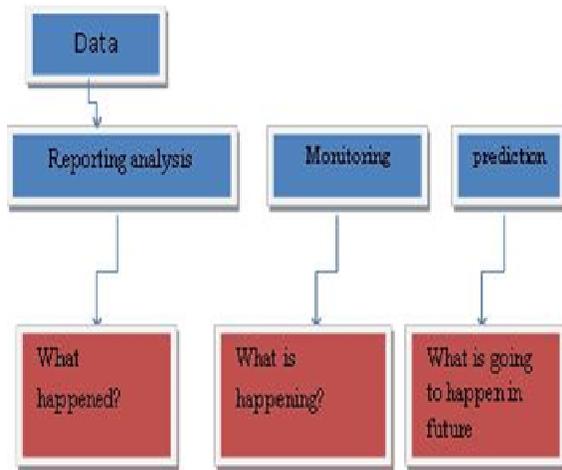


Fig. 3 Predictive analysis

Predictive analysis is the practice of extracting information from existing data sets in order to determine pattern and predictive future outcomes and trend in predictive model and analysis are typical used to forecast future probabilities [34]. Data analysis is done by R-tool. The amount of data are collected for analysis those bulky data sets are divided into small number of data set. The each partition of data set analysis using r tool

Future health prediction model: Predict the future health status of the patient on their current health parameters [39]. A patient who admitted in the hospital frequently to know the future health condition. The future health status may save life of lives so to avoid frequent visit to hospital or any healthcare centre. The patients are provided with the wearable (sensor) devices the wearable device is embedded with the sensor [41]. The sensor tightly attach to the skin and accurate produce of data from the body sensor the data based on the sensor feature. The collected sensors data are stored in the cloud storage for future use they are encrypted and transmitted to the cloud. The continuous data collect from the patient body are predicted to know the current health condition [47]. The prediction is done by data mining technique with classification and clustering method by using naïve Bayes classification and k-means clustering algorithm. In

prediction of future health condition by trained data set the real data is compared with the naïve B ayes is only with two conditions yes (or) no ie if yes the condition is ab-normal if no result return to normal condition. Suppose if the result turn to abnormal condition, in what variation the result turn to ab normal condition from normal condition to calculate the variation in propose system we use k-means clustering algorithm [32].

IV. ALGORITHM & METHODOLOGY USED

A. Naïve Bayes Classification Algorithm

A Naive Bayes classifier is a simple probabilistic classifier that depends on Bayes' theorem with strong i.e. naive independence assumptions. It is also be called as "independent feature model". In [35] general terms, a naive Bayes classifier assumes that the presence (or absence) of a particular feature of a class is unrelated to the presence (or absence) of any other feature. Naive Bayes classifiers are trained to work in supervised learning [42].

Bayes' Theorem: Probability (B given A) = (Probability (A and B)/ Probability (A)) Assume X as a data tuple. Let H be any hypothesis. P (H|X) is posterior probability of the H that is conditioned on X. In the same way, P (X|H) is the posterior probability of X condition on H. $P(H|X) = \frac{P(X|H) P(H)}{P(X)}$ P(H) is prior probability of H.

Algorithm

1. Assume D to be training set of tuple. Every record can be represented by n-dimensional attribute vector i.e. $X=(x_1, x_2, \dots, x_n)$, predicting n measurements on tuple from n attributes, i.e. A_1 to A_n .
2. Let me number of class for prediction (C_1, C_2, \dots, C_m). as for record X, the classifier predict that X will belong to the class with maximum posterior probability that is conditioned on X. Naïve Bayes predict that the tuple x will belong to class C_i only if $P(C_i|X) > P(C_j|X)$. Therefore we have to maximize $P(C_i|X)$.
3. Because P(X) is constant in all classes, therefore $P(X|C_i) * P(C_i)$ need be maximized.

4. As then assumption of class conditional independence is done. Therefore it is pre assumed that value of attributes are conditionally independent of each other. Thus,

5. To predict class of X, $P(X|C_i)P(C_i)$ is calculated for each class C_i . Naive Bayes predict that class label of X is C_i class if

Naïve Bayes [44] classification algorithm is easy to diagnosis the health condition, naïve Bayes is independent of one another which has trained set of data here a patient data is continuously collected and stored in the cloud storage every value in the dataset is compared with the trained data set. By this we can accurately find the health condition of the patient, naïve Bayes plays a crucial role in accuracy [51]. Firstly, Naïve Bayes algorithm has trained dataset. The program receives patient record from the interface and uses this data to Naïve Bayes algorithm [40]. By using the Naïve Bayes method, possible attributes will be determined and probability of each attribute will be calculated. Then yes or no probability of each attribute will be computed, and depending on these results the information about risk will be returned. If the probability is yes then return the condition is abnormal else return as normal condition [50].

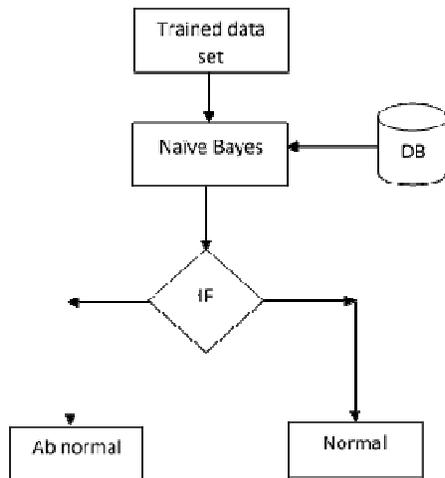


Fig. 4 Bayes prediction

B. K-Means Clustering

K-means Clustering is often referred to as unsupervised learning [43]. Because there is no

need for a marked data, learning algorithms without a teacher are suitable for many applications where the labelled data are difficult to obtain [37]. Uncontrolled tasks such as clustering, as often used, which would investigate and characterize the data set before starting a controlled learning objectives. The steps of the above flow chart are as follows:

Step1: Enter the number of clusters; this is “k” value.

Step2: After calculate the initial centroids from the actual datasets. Divide data points into “k” clusters.

Step3: By using Euclidean’s distance formula (1) move the data points into clusters and recalculate new centroids. These centroids are calculated on the basis of average of means.

Step4: Repeat step 3 until no data point is to be moved.

Firstly, clustering algorithm [45] is simply effective to find the variation between the values, here in prediction of health condition we use clustering algorithm ,when the patient data are collected using sensors,the collected data are transmitted to the k-means clustering algorithm the data are clustered by calculating the centroid and distance using k-means clustering algorithm by this we can find the variation of the data,if the patient result return to ab-normal condition ,the k-means clustering find the variation between the normal and abnormal condition that is in what value the patient result return abnormal condition [38].

C. Blow Fish Encryption Algorithm

Blowfish is a symmetric block cipher. Blowfish algorithm takes a variable key length, from 32 to 448 bits, making it ideal for domestic and exportable use. In this 64-bit plaintext message is first divided into 32 bits. The „left L” 32 bits are XORed with the first element of a P array to create a value called P”, the „right R” 32 bits of the message to produce a new value called F”. F” then replaces the „left L” half of the message and P” replaces the „right R” half, and the process is repeated successive members of the P array.

Four 32-bit S-Boxes consist of 256 entries each:

- S1, 0, S1, 1... S1, 255
- S2, 0, S2, 1..... S2, 255

S3, 0, S3, 1..... S3, 255
 S4, 0, S4, 1.....S4, 255

Blow fish encryption algorithm is symmetric key encryption only one key is used for both encryption and decryption of data. One secret in is used for both encrypt and decrypt the data values [46]. The data collected from the patient body using sensor are transmitted to the cloud storage the value that is encrypted before transmitted to the cloud storage. Blow fish encryption algorithm is used to encrypt the value transmitted from the data provider [49]. Firstly it generates a key and encrypts the plain text and become cipher text. Similarly using a same key the cipher text is decrypt to original plain text.

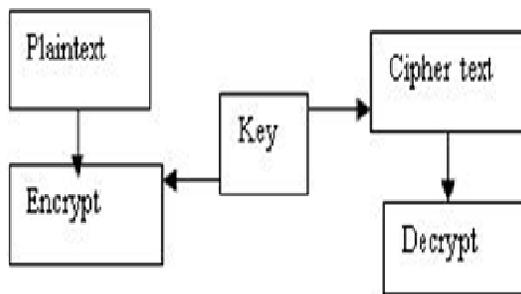


Fig. 5 Key generation

Algorithm: Blowfish Encryption

Divide x into two 32-bit halves: xL, xR
 For i = 1 to 16:
 xL = XL XOR Pi
 xR = F(XL) XOR xR
 Swap XL and xR
 Swap XL and xR (Undo the last swap.)
 xR = xR XOR P17
 xL = xL XOR P18
 Recombine xL and xR

V. CONCLUSIONS

In this paper, we propose a sensor based prediction of future health condition using naïve Bayes classification, k-means clustering algorithm and r programming .we can utilize wearable devices to collect users data and in order to protect users privacy, we use encryption mechanism to make sure the transmission of users data to the cloud in security for the purpose of prediction we use data mining technique to predict the future health

condition. In the proposed system firstly, the user’s physiological data is collected and transmitted to the cloud storage. Secondly, the collected Data are correlated with predictive analysis to analysis the future health condition of patient based on the health status. Thirdly, for privacy data protection in cloud we use blow fish encryption for data encryption .The encrypted data are stored in the cloud storage namely drop box. Finally, the encrypted data are analysed using classification and clustering technique and also integrated with r tool.

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