An Intelligent Health Care System Based On K-NN Algorithm to Monitor and Alert Patient Health Condition

Siamala Devi S, Anto S

Abstract: ***Health is one of the essential abilities that a human need to go on with his life. That is the fundamental reason that the healthcare provided to human must be offered in abundant methods. Health of an individual can be guaranteed if health monitoring parameters and the medical assistance being given legitimately. The latest methodologies includes the web and the sensors regularly known as the Internet of Things (IoT), which enables the overall ways to deal with the medicinal services based on framework advancements. This directed the health care management system to adopt a constant methodology which supplies certain details relevant to patient monitoring system. Absence of well-planned therapeutic medications elevates the death rates worldwide. These can be closed out through standard health care mechanisms. A better health monitoring system is proposed which relies on sensors. These sensors are used to get the body temperature along with heart rate and tell the specialist or the staff about the condition of the patient. The task utilizes KNN (K-Nearest Neighbors) calculation to anticipate the state of the sufferer to keep them from going into further awful state. KNN is one of the basic but important classification algorithms in Machine Learning. At the point when the terrible state of the patient is detected, it sends mail to the doctor in most crisis circumstance or else in different cases it continues refreshing the detected values in the created web page. The framework additionally incorporates a buzzer beeping situation, where the beeping happens when the medical attendant must be advised to notify the state of the patient. Though, the past frameworks created did not do the foreseeing part, which assumes the most significant job in dealing with the patient. Thus, the proposed system result in the task brings about taking the best conceivable measure in helping the patients to improve their circumstance.***

Index Terms: Health Care, IoT, Machine learning, KNN, Emergency

I. INTRODUCTION

The target of IoT is the unification and reconciliation of all communication systems [4] that surrounds us. Subsequently, systems can get a control and access to all other systems that offer ubiquitous communication and computing with the reason of defining a novel generation of assistance services [1].IoT is supplemented by the use of AI, to learn user behaviour prototype, gain information of the context, describe activity rules for every situation with the user's behaviour etc. In particular, the field from AI that works with the IOT to characterize administrations for the support of people is intelligence and particularly when dealing with healthcare of admitted people with critical condition [3].The principle objective of this paper is to characterize a model based on IoT to minimize the hectic procedure of the medical attendants and doctors to check the conceded patients during critical situations. This proposal for the Internet of things in therapeutic situations depends on three factors: [10]

1. To get the body temperature and heartbeat value of the patient by means of sensors that are fixed with the patients.
2. The buzzer buzzes to notify that the patient is in critical situation who need a medical caretaker present in that specific ward. The medical attendant is given a web page to screen the patient's condition at a standard interim.
3. Finally, a message is sent to the duty doctor's mobile if the number of medical attendants are not enough to treat the patient[8].

The values obtained from the sensors are accumulated in a cloud [6] [12]. The forecast and investigation are done in the cloud and accordingly the message alert is sent to prepare [5].

II. RELATED WORKS

IoT can be coupled with the medicinal services to change into further developed and effective systems [8]. The combination of Internet of things and medicinal field has an incredible effect in the health care sector. IoT has physical gadgets network, embedded system, sensor, servers, software and organize availability to impart remotely and gather information from the framework components. IoT incorporates the robotization, sensor networks, embedded framework, these facilities makes IoT an extraordinary comfort .It is also referenced the health care application with IoT framework can be associated and utilized anywhere, anytime which prompts the smart health care utilization. [4] The viability and extent of Internet of things in human services unit is addressed in [13]. Additionally, it was clarified about the moderate improvement in status of social insurance with the assistance of Internet of things. The wearable medicinal services contraptions, for example, watches , arm ornaments ,rings , hairlaces ,health monitor ,pedometer ,action tracker ,augmented reality headsets brought another way ceaseless moniterization of our health .

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They can screen the parameters related to health care, for example, heartbeat ,circulatory strain ,body temperature ,Oxygen immersion level in blood with the assistance of the wearable gadgets and their families can routinely check their wellbeing report [3].

The structuring of health care system which gathers the patients health condition and other relevant conditions at ongoing and sends to the control centre where it is examined and sent alarm based on the crisis condition[1] .The benefit of the system is it minimizes the observing of nursing staff in the medical centre. Three significant factors are utilized, for example, RFID upgraded remote sensor organize called hybrid sensing system, IoT Smart portal ,User interface for checking the medical report [3].

A desktop application for checking the wellbeing status of patient themselves was proposed by [7] and the application is easy to use for the patient. It detects the blood glucose level through a conventional IoT based medicinal acquisition detector. Electrocardiogram observing is finished by convenient remote procurement transmitter and remote receiving transmitter. Blood Pressure observing is employed by the BP equipment with the correspondence module with the patient's body. Body temperature observing is finished by home passage which transmits the temperature by using infrared identifier [13].

The security parts of the health care system in hospitals is guaranteed in [9] and the information security is done in six viewpoints , Data integrity ,Data freshness, Authentication, Anomaly, Secure restriction and this system has body sensor network which permits the association of all the body sensors connected to the patient ,they screen the patient intermittently and gathers the information and sends the information to the server. The system gets the parameters, for example, Electrocardiogram, Electromyography, Blood weight [7].

A vigorous IoT framework that screens the patient naturally in a particular interim of time and sends the health report to the duty doctor. It diminishes the significance of accessibility of doctor all the time in medical centre and remotely gain access to the health record of the patients .It gathers the values of health parameter, for example, pulse , body temperature ,patients pulse. This system utilizes the smart sensor system and it is later investigated by the doctors and in the meantime updating a database for the health record additionally gives a superior track of the patients health condition [9].

A smart health care system empowered by the IoT [6] is the most significant technique in which the physical and mental health status is gathered by different types of sensors. These information are processed and analyzed and made accessible always. This training may achieve a development in the act of medication. It additionally empowers customized medications and other management options for the patients. It helps in minimizing the expense of health care and at the same time improving the worth of services [7].

Information and Communication Technologies are being embraced broadly for the proficiency of health care treatments[11]. Investigators have been started and begun in different fields with the presentation of IoT. In the health care environment, the staffs and medical experts are allowed to improve and adapt new services by the utilization of Wi-Fi. This is finished by utilizing IoT equipment which is melded with the Wi-Fi module of the RFID, NFC labels and some little sensor hubs. The distinctive manners by which IoT can be actualized in health care services foundations plays a major role. Moreover, the integration of micro controllers with the sensors are added to improve the productivity. The outcome incorporates powerful yield against therapeutic crises [11]. Universal diary of nursing studies[10] said that the most encouraging nature of cutting edge innovation in prescription and nursing is the patient consideration and wellbeing. Notwithstanding the product applications built up, the embedded systems and hardware can play a wide job. Few are wearable sensors, medical equipment and implantable gadgets. Various papers proposed on nursing care are of the essential dimension and the advancements are yet to created and utilized. The IoT idea is broadly utilized in the innovative fields and isn't greatly created in the nursing zones, which should be done in the nearing future. It is referenced that the cutting edge innovation can be widely used to beat the difficulties in the medicinal and nursing regions [10]. The fundamental target in the health care is to screen the pulse of the patient, i.e., observing of the ECG flag[5]. They authors have utilized a model with a guiding wheel to screen the ECG of the patient. As the internet and World Wide Web assume a significant job in all the technologies developed, the installed web server is utilized here which is a blend of web and embedded gadgets. A pulse identification technique based on continuous wavelet transform has been utilized. Likewise, skin electrodes have additionally been utilized to screen the nerve voltages of the heart beats[5].Demand for new medicinal services innovations with bunches of enhancements in the field of IoT[1] is increasing day by day. Fundamentally, there exists an association between the sensor networks and the web in the improvement of any heath monitoring system with the help of IoT. This association is normally made for interpreting the conventions that are utilized in the networks and the sensors. This also have the whole control on the measure of information that is being exchanged and its security. Thus, a keen e-health entryway by providing certain capacity, information handling, information mining is introduced. The energy efficiency, adaptability, and reliability are some essential difficulties confronted and can be rectified[1]. It is more significant to give legitimate health care to adults and elders with the wide increment in the entire populace issues concerned with health care[2]. The intention is to throw light on latest clinical development. To accomplish a worldwide network between the emergency clinic, medical experts and the patients is to incorporate IoT techniques. This is done generally to improve the effectives of the patient's records. Along these lines an architecture is developed that gives adaptability of communications, control and monitoring. These are finished by the utilization of 6LoWPAN and RFID/NFC for secure communications. Also, these are conceded using high specifications with low power utilization to improve the security models. Here notwithstanding these cryptographic sim cards are being utilized for validation and encryption to communicate with the medical devices[2].

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Different investigation is done in advances particular one those of the therapeutic field ones[14]. This is chiefly done to improve and reinforce the current innovations of heath care services. Among different methods, IoT have contributed an indispensable job to interconnect the accessible medical resources and give smart health care services which are progressively more effective and reliable particularly to the older patients. Additionally the difficulties and prospects of these advancements are likewise talked about. Their future upgrades incorporate self-learning and and self-improvement to empower quicker researches. Likewise new and diverse required hardware and standardization with improved protection and security could be incorporated [14].

The quality health care and services are offered with the improvement and advances in the IoT ideology, where technological advancements are colossally expanding step by step. With the high number of increments in the older and debilitated individuals, there is a demand for effective framework for dissecting the patient's record so preventable deaths could be evaded. Health IoT is essentially the mix of conventions, sensors, and hardware that aid in the process. This system gathers the ECG through cell phones and sent to cloud for security reasons. Watermarking, signal enhancements and different investigation are improved to recognize thefts in the processes. The future work will incorporate testing the proposed system for information security and incorporating test trials with patients and medical experts [12].

III. EXISTING SYSTEM

All the related works that have been done by various analysts that are identified with the present research are as follows,

- A Health-IoT Platform Based on the coordination of detecting and showing the information from the sensors [9] [2].
- RFID Technology for IoT-Based Personal Healthcare [11].

3.1 A Health-IoT Platform Based on the coordination of detecting and showing the information from the sensors

The health monitoring systems developed as of now, just deal with the piece of detecting the attractive values through the sensors and showing them in their separate hosting page. Somebody must be available there to always see the patients and deal with their conditions [2]. The persistent checking of the value from the sensors and the relative facilitating page is one of challenging tasks to do [9]. Humans will do mistakes , Man is constantly planned to do botches, so if the focus the individual checking the patient redirects, a few mis happenings may happen [13] [7].

The burdens are,

•Continuous manual work despite the fact that, the system is automated.

• Only the most recent qualities from the sensors will be available, so no forecast should be possible with the values.

3.2 RFID Technology for IoT-Based Personal Healthcare

RFID innovation is at present created to give some segment of the IoT physical layer for the individual health care in keen situations through insignificant effort and expendable sensors. . Based on a review, it is clear that RFID is much helpful in health care system to monitor the patients' living condition. Numerous accessible choices are set apart out up to the application level with certain instances of RFID systems that are ready to gather and practice multichannel information about the person conduct in consistence with the power exposure. The drawback is, that the concepts using wireless communication is established in RFID technology that covers only short area.

IV. PROPOSED SYSTEM

This work focuses at designing and developing a hospital management system using machine learning techniques. The physiological features of the patients is gathered with the help of sensor network in normal environmental conditions and stores the information in the server where it is anticipated by the prediction algorithm. It shows the present information in the website page and it sends signal according to the prediction in case of emergency.

It is made out of three fundamental parts I) Sensing framework ii) Health status prediction system iii) Emergency alert system. Fig 1 shows the circuit diagram of the entire system.

4.1 SENSING SYSTEM

4.1.1Body temperature sensing

Body temperature is a standout amongst the most fundamental piece of health care services that can say whether a patient is ordinary or abnormal. Body temperature is the definitive essential sign in the support in homeostasis. The temperature measurement system is implemented by the sensor (LM35) and the esteem is changed over to the type of Celsius by analog to digital convertor setup.

The sensor is embedded to the bed of the patient as a test and the temperature is noted in certain interval of time. The converted value is stored in the server in the raspberry pie and further utilized later. The principle segments for body temperature detection are sensor and the analog to digital convertor setup

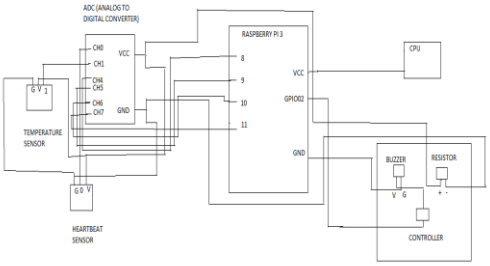

Fig1- Circuit diagram

4.1.2 Heart beat sensing

Heartbeat is the very important necessity for a fine health of an individual. The observing of the electrical activity of the heart and rhythm of the heartbeat is significant. The heartbeat detecting is actualized by the heartbeat sensor and the value is converted using the analog to digital converter. The value is gathered occasionally and accumulated in the server which is a inbuilt part of raspberry pie. The heartbeat sensor is attached to the bed as a test to the patient in emergency unit. . The component which is essential in the heartbeat sensing are sensor and analog to digital converter.

4.1.3Interfacing of Sensors to raspberry pie

The interfacing of sensors with the raspberry pie begins with analog to digital convertor. The MCP3008 is a transistor that acts as a convertor, it has four simple pins for reading the value and changing over it into digital form. Similarly it has four ground pins and four power supply pins and the pins which is intended for interfacing the sensors.

The temperature sensor ought to be constantly associated with the 0th pin of analog to digital convertor and the heart beat sensor ought to be associated with the 1st pin in the convertor. The four analog pins from the pins are associated with the four digital pins in the raspberry pie for getting the concrete values from the sensors. Every sensor has three pins, they are ground, power and value pins which is connected accordingly to the converter.

4.2 HEALTH STATUS PREDICTION SYSTEM

Despite the fact that the values gathered from the sensor are shown on the website page, it will be even more efficient when the system foresee the abnormality of the patient and gives an alert. This is the place where the machine learning comes into the picture. KNN algorithm has been utilized for the prediction of the sensor values. KNN algorithm is straightforward and works well in many applications. It is used to classify the data points based on a resemblance measure. The data is allocated to the class which has closest neighbour (distance calculation). It does not have specific training phase because it utilizes all the training data set.

KNN is non parametric lazy algorithm which means it works quite fine in the real-world data because most of the real time data does not obey the typical hypothetical statements. KNN algorithm uses all the training data set to predict the result based on the best subset of the training data set. The algorithm is implemented in python which has several methods.

4.2.1 Working of KNN Algorithm

In pattern recognition, the K-Nearest Neighbours algorithm (K-NN) is a non-parametric technique utilized for grouping and regression. In the above said cases, the input information comprises of the K nearest training models in the element space. The yield relies upon whether KNN is utilized for grouping and regression:

- In KNN classification, the yield is a class participation. A data item is classified by a majority vote of its neighbours arranged by a majority vote of its neighbors, with the item being allocated to the class most regular among its K closest neighbours (K is a positive number, ordinarily little). Consider K = 1, then the data item is basically allocated to the class of that solitary closest neighbor.
- In K-NN regression, the output is the property estimation for the data item. This output value is the mean of the obtained values of its K nearest neighbours.

KNN is a kind of instance related learning, or lazy learning, where the function is just approximated locally and all calculation is conceded until classification. The KNN calculation is among the most straightforward of all ML algorithms. In case of both classification and Regression , a helpful method can be utilized to allocate weight to the neighbouring data items.

So that the the closest neighbours contribute more to the average data items when compared to the distant data items. For instance, a typical weighting plan comprises in giving each neighbor a weight of 1/d, where d denotes the distance to the neighbour.

The neighbours are taken from a certain set of items for which the class (for KNN classification) or the object property estimation (for KNN regression) is known. This can be thought of as the preparation set for the algorithm, however no open training step is necessary.A characteristic of the KNN algorithm is that it is highly responsive to the nearby structure of the data.

KNN can be utilized for both classification and regression issues.

Be that as it may, it is all the more broadly utilized in the issues related to classification in the business. To assess any technique, 2 important aspects have to be considered:

1. Simple to yield output
2. Estimation time

It is possible to make limits for each class. These limits will isolate RC from GS. In similar way, an attempt can be made. To know the impact of K value on the class limits. Following are the diverse limits isolating the two classes with various estimations of K.

KNN model can be executed by following the underneath steps:

1. Load the input data
2. Initialise the estimation of K
3. For getting the anticipated class, emphasize from 1 to entire number of training data points

- Calculate the separation between test and each row of training data. Euclidean Distance measure is utilized as the separation metric since it's one of the most prominent techniques.
- Sort the calculated distance values in increasing order.
- Obtain the top K rows from the sorted array of previous step.
- Get the most consecutive class of these rows
- Return the predicted class

4.2.2 Training of Local Dataset

There is no compelling reason to train a model for speculation, which is the reason KNN is known as the basic and instance based learning algorithm. KNN can be helpful if there should be an occurrence of nonlinear information.

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It can be used with the regression problem. Output value for the object is calculated by the average of K closest neighbours' value.

The table 1 shows the local dataset used for training.

Table 4.1 Local Dataset

Temperature	BPM	STATE
31	99	Normal
32	100	Normal
10	98	Abnormal
33	26	Abnormal
55	10	Abnormal
53	30	Abnormal
31	80	Normal
18	33	Normal
15	44	Abnormal
44	20	Abnormal
100	0	Abnormal
40	100	Normal
40	110	Normal

4.3 Emergency Alert Using Buzzer

4.3.1 Buzzer Connection

The buzzer cannot work alone it should be connected to a resistor and a controller. The figure 2 shows the buzzer connection. The buzzer has three pins ground, power supply and a value pin, the value pin is connected to the controller and the power supply should be given through the resistor which has 1*k* resistance and the ground is given to the negative pin in the resistor and the controller power supply is given through the raspberry pi.

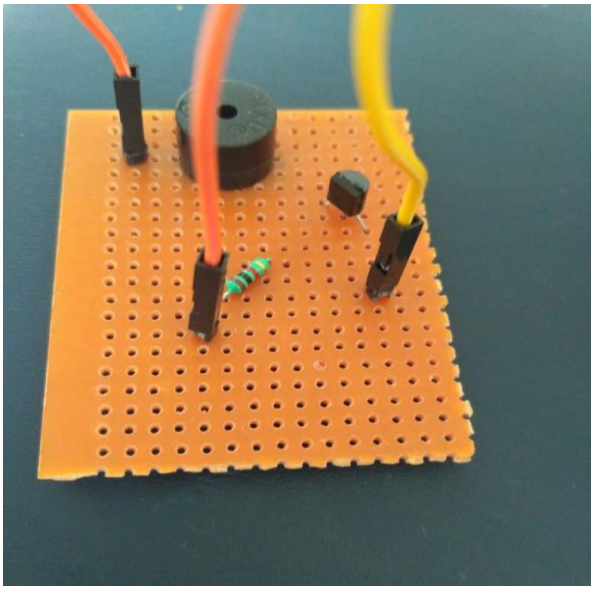


Figure 2 Buzzer Connection

4.3.2 Interfacing Buzzer and Raspberry pi

The data out which is set to give signal should be connected to the data in of the controller which only switch on the buzzer when the signal is received and the power supply is given through the 1*k* resister and it is also grounded and when it gets the signal from the raspberry pi it turns on the buzzer and gives signal to the duty nurse available. The figure 3 shows the interfacing of the buzzer with raspberry pi.

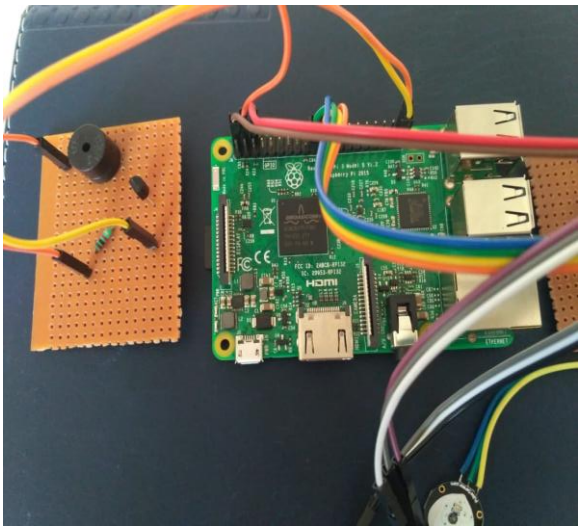


Figure 3 Interfacing of buzzer and raspberry pi

4.4.2 Emergency Alert Using Mail

The patient condition becomes much worse, the nurse supervision is not enough to handle the patient critical condition, it also sends alert in the form of the mail to the current duty doctor.

There are many steps in this

- Allowing access to the Gmail Account.
- Standard Authentication.
- Two Step Verification.
- Allowing Gmail Simple Mail Transfer Protocol (SMTP) access for accounts with standard authentication.

V. PERFORMANCE METRICS

Some samples were taken to analyse the proposed IoT based health monitoring system. They are described in detail in the following explanations.

5.1 CONFUSION MATRIX

Confusion matrix depicts the total performance of the model. It is otherwise called as error matrix. The rows represents the instances in the predicted class whereas the column denotes the actual class. It is a kind of contingency table, a table of values in a matrix structure that illustrates the frequency distribution of the variables, with two measurements ("actual", "predicted"). In the proposed model , the grouping framework has been prepared to recognize " normal, abnormal (buzzer), abnormal (mail)". In an example of 150 datasets – 50 ordinary, 50 abnormal (buzzer), 50 abnormal (mail). In the confusion matrix represented above, the framework anticipated the quantity of typical datasets as 49 however 1 was considered as abnormal (buzzer) where rather than typical condition the attendant must be there, which is actually unnecessary.

The same is done with abnormal (buzzer) and abnormal (mail).

There are 4 terms used here, namely,

1. TRUE POSITIVES: Prediction : YES and Actual output : YES
2. TRUE NEGATIVES: Prediction: NO and the Actual output : NO.
3. FALSE POSITIVES: Prediction: YES and the Actual output : NO.
4. FALSE NEGATIVES: Prediction: NO and the Actual output : YES.

Table 1- Samples

		ACTUAL CLASS		
		Normal	Abnormal (buzzer)	Abnormal (mail)
Predicted Class	Normal	49	0	0
	Abnormal (buzzer)	1	48	3
	Abnormal (mail)	0	2	47

Table 2- Prediction

n=150	PREDICTED: NO	PREDICTED: YES
ACTUAL: NO	3	6
ACTUAL: YES	0	141

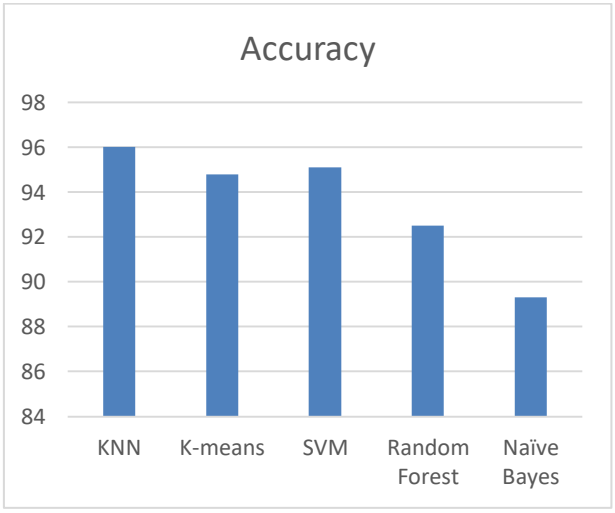
Error rate = True positives + False negatives / Total samples
Error-rate = 141+6 / 150 = 0.98
Thus, the error-rate in the model predicted here is very less as shown from the above steps.

5.2 CLASSIFICATION ACCURACY

Classification accuracy is the percentage of accurate predictions. It is for assessing the classification models. Accuracy is the fraction of predictions the model got right.
Accuracy = Number of correct predictions / Total number of predictions.

Table 3- Accuracy comparison values

Algorithms	Accuracy
KNN	96.02
K-means	94.8
SVM	95.1
Random Forest	92.52
Naïve Bayes	89.3



Graph 1- Accuracy comparison depiction

Thus, the algorithm used is comparatively better than the other algorithms used. It also works best for real-time data processing and analyzing of data.

VI. CONCLUSION AND FUTURE ENHANCEMENT

Rapid progressing IoT and AI advancements have given extraordinary chances for developing the healthcare sector. Despite of all these progressions, there are also some setbacks that have to be addressed later. A few regions for the future redesigns are recorded as follows.

Security: The fundamental essential for the IoT system is giving security to its users. The protection of patients ought to be made sure to avoid illegal recognition and monitoring. At this point of view, more the level of autonomy and IoT, the more challenges the protection of identities and isolation would emerge. Moreover, the IOT applications are very vulnerable because of two fundamental features:
(1) Majority of the communications are wireless, which makes spying on the information tremendously easy;
(2) Most of the IoT segments are considered by low energy and low computing capabilities, thus they can barely actualize complex stratagem on their own to ensure security. Hence, to conquer these cloud offices can be utilized.

Hardware: In the advancement of wearable gadgets, the achievement of discreteness is considered to be major challenge, since comfort is normally a fundamental concern. This requires a great deal of manual time and capacity to make the embedded system.

App: the android application must be developed so that every time the medical specialist or staff need not login to the mail or the site to check for the patients' state.

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