

Role of IoT and Bigdata Analytics in Healthcare for Disease Prediction

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Abstract— One of the major issues to worry nowadays is the busy life cycle people follow and the effect they have on the health. This busy life cycle has made people to neglect their health. In India many people are below poverty line and even majority of population stays in rural places and cost of medical treatment is too high. Under these situations, it is not feasible for people to afford costly medical treatment. We have seen people being admitted to hospitals at the last hour and being forced to follow traditional medical practices and lose their lives. To address this issue, we need a remote health monitoring system that could alert people about their health condition and people can get medical diagnosis done remotely. In this paper, we discuss, the role played by IoT and bigdata analytics in the field of healthcare. We also discuss the benefits, challenges and applications of these technologies. We propose a system to monitor heart condition of a patient using IoT which alerts the patient or doctor if any abnormality is observed. This system could further be scaled to provide real time health monitoring to predict various diseases using bigdata and ml analytics.

Keywords—IoT, bigdata analytics, remote health monitoring

I. INTRODUCTION

Internet of Things (IoT) is a criterion that augments various objects available in the environment with sensors that support remote device management over internet for interaction between physical and computerized world. IoT supports connection of various devices to collect and transfer data [1]. IoT is been used extensively in almost every field like healthcare, water and waste management, industry automation etc., and this heightened usage of IoT has increased the number of devices coupled with internet. As per reports of cisco, the number of devices attached to the internet would be around 50 billion by 2020 and would beat the number of homo sapiens in the world [2].

IoT based healthcare supports remote health monitoring by providing flexibility to patients and doctors in every aspect. It represents a system that consists of sensors, apps and devices that communicate with each other to monitor patients' vital parameters and helps to track their health. In the days to come, with the usage of IoT the medical services may become cost effective, improve essence of life. As more and more devices would be connected the amount of data collected would also be increased. This would require usage of bigdata analytical techniques to store, process and analyze huge volume of data. Big data analytics in healthcare provides insight from very large data sets and helps to improve outcomes at reduced costs. Its potentiality is tremendous; but there are challenges that need to be addressed. In flourishing countries like India, the medical facilities are difficult to reach to every individual

because of the cost involved and non-availability of physicians. As a result, the medical industry is in critical stage where people rather than being treated have started avoiding hospital visits which has increased epidemic diseases and death rates. We could make better usage of technology and work together to avoid chronic diseases and make medical facility cheaper and easily available.

II. LITERATURE REVIEW

Minerva Panda, Syed Mohd Ali, Sanjog Kumar Panda [9], addressed the issue of how information from various sources could be integrated in real-time. The author also, highlights the factors that have increased medical expenses and have developed a mobile/web application, which helps patients and doctors to communicate.

Yichuan Wang, LeeAnn Kung, Terry Anthony Byrd [10], have surveyed 26 bigdata deployment cases in healthcare, and identified 5 bigdata analytics accomplishments and outlined the benefits of bigdata analytics in terms of infrastructure, operation, management and recommends strategies for health organizations in adapting bigdata analytical technologies.

Ashwin Belle, Raghuram Thiagarajan, S. M. Reza Soroushmehr, Fatemeh Navidi, Daniel A. Beard, Kayvan Najarian [11], discussed the major threats to healthcare bigdata analytics and focused on some of the looming and upcoming areas of medical research.

Dimitar V. Dimitrov surveys mIoT and healthcare bigdata [12]. The author discusses that wearable devices and mobile apps support health education, robustness, track disease symptom, cooperative ailment administration and care strategy. The author infers that this platform can promote reduction in the amount of time needed for disease prediction by application of reduced data analysis.

Y. Nait Maleka, A. Kharbouch, H. El Khokhi, M. Bakhouya, V. De Florid, D. El Oudghiri, S. Latre, C. Blondia [13], proposed mechanism to continuously monitor and process data in real-time by combining IoT with Big data technology. The authors have performed preliminary experiments and outcome infers the usability of this platform in a real-time scenario.

Md Ileas Pramanik, Raymond Y.K. Lau, Haluk Demirkan, Md. AbulKalam Azad [14], proposed a big data enabled smart healthcare system framework (BSHSF) that suggests hypothetical descriptions of an intra and inter organizational business model in the healthcare context. The authors addresses opportunities and challenges in applying BSHSF to healthcare environment and provides suggestions for efficiently implementing 'BSHSF' in healthcare industry.

Priyanka K, Prof Nagarathna Kulennavar [15], provides an overview about the significance of big data analytics in health sector. The authors discussed how this technique provides new insights that have the capability to increase personal care, enhance health and prevent irrelevant expenditure. The authors address the peculiarities, pros and cons of bigdata analytics in health care.

Ejaz Ahmed, Ibrar Yaqoob, Ibrahim Abaker Targio Hashem, Imran Khan, Abdelmutlib Ibrahim Abdalla Ahmed, Muhammad Imran, Athanasios V. Vasilakos [16], have explored and addressed the basic necessities for handling and enabling approaches in big data analytics for IoT systems. The authors have identified the opportunities emanating from the merging of bigdata analytics and IoT. The author further discussed about the importance of big data analytics in IoT applications and have presented various susceptible challenges.

III. PROPOSED SYSTEM

Today healthcare industry is in critical condition because of unavailability of doctors, costly medical treatments, health ignorance etc. We need a system which collects real time data of patients and predict disease risk. Such a system could use efficient machine learning algorithms and bigdata analytical techniques to help patients to remotely monitor their health at any time being at anyplace.

We propose a system which monitors patients heart condition and sends alert message to patient/doctor. This system would be interfaced with sensors using Arduino Uno. The collected data would be stored in ThingSpeak cloud and using ThingHTTP app an SMS alert would be shipped to the registered mobile numbers of patient, caretaker or doctor. Based on the alert message received appropriate decision could be taken. This system would help patient to monitor their health remotely and delay in treatment could be avoided thereby reducing death rates.

IV. INTERNET OF THINGS IN HEALTHCARE

In India, 80% population is not rich, the medical facilities have become costlier [3] and everyone cannot afford costly medical treatment. Lot of technological advancements have been taking place with which people could get medical diagnosis at home and can visit hospital only when needed. This may even benefit people staying in remote places. This type of medical facility would even provide flexibility to elderly people, physically challenged to get health checks done at regular intervals being at home. The main reason for patients dying in hospitals is the delay in hospitalization. To reduce death rates, it better to have a system that performs health check regularly at frequent intervals and track the condition of patients and reduce the need for hospitalization during emergency. To achieve this IoT and Bigdata analytics together would do miracles.

A. Benefits of IoT in Healthcare

IoT has tremendous benefits in the healthcare industry which help to improve the essence of life, efficiency of treatment and boost the fitness of patients. Some of the benefits are as follows:

- **Concurrent broadcasting and monitoring:** IoT allow continuous health tracking and monitoring by collecting patients' vital signs and processing at regular intervals to

reduce medical emergencies like cardiac arrest, diabetes, asthma attacks, etc.

- **Point-to-point connectedness and affordable:** To deliver effective medical assistance, IoT facilitates interoperability, communication between machines, data and information transfer efficiently.

- **Data collection and analysis:** The volume of data collected by various healthcare devices are huge and difficult to store and analyse. This vast data cannot be evaluated manually. However, IoT devices have the capability of collecting and storing data in real time. Using IoT, healthcare organizations could be benefited in obtaining insights from huge data with the usage of healthcare analytics and can speed up error free decision making.

- **Tracking and alerting:** One of the major problems faced by hospitals today is keeping track of deadly diseases in real time. It is even difficult for these organizations to warn the patients about this. However, IoT allows devices to collect information about crucial parameters and transmit collected data to doctors for real-time tracking and generating alerts for life-threatening diseases via mobile apps. Thus, IoT enables alerting in real time, tracking and monitoring, which improves patient care, provides efficient and accurate treatment.

- **Remote medical assistance:** Remote patient monitoring allows a patient to perform regular health check-up by using mobile medical devices and send the data to a medical practitioner in realtime. The devices that support remote medical assistance are glucose meters, diabetes and heart monitor, or blood pressure cuffs, voice apps etc. RPM is basically used to benefit elderly people, physically challenged, ICU patients etc. [4].

B. Challenges of IoT in Healthcare

We have seen that IoT provides more flexibility and benefits in handling health services. However, there are certain challenges that have become barrier in IoT application implementation and advancement.

- **Data security & privacy:** In real time, the IoT devices collect and transmit large amount of data which is very much unstable and confidential and demands security. There is a risk of data theft, manipulation and misrepresentation. As we know that, the IoT devices do not follow specific data protocols and standards and there is compelling uncertainty regarding data ownership governance. These factors make the information extremely vulnerable and hence this data could be mistreated by malicious users to purchase medicines, medical appliances, for counterfeit insurance claim etc.

- **Integration of multiple devices & protocols:** The implementation of IoT health application is affected by the integration of multiple devices and the absence of communication protocols and standards. The connection of various devices not only complicates the process of data aggregation but also diminishes the mechanism of decision making and affects the scalability of healthcare IoT.

- **Data overload and accuracy:** As discussed earlier, data collection is affected by the use of various communication protocols and standards. On the other hand, IoT devices collect huge amount of data to gain insights about the vital signs of the patients. This type of data collection not

only affects the process of deriving insights from it, but also affects the quality and accuracy of decision-making.

- **Cost:** As we have discussed earlier the introduction of IoT in Healthcare has made medical services affordable. Another important challenge that hinders the efficiency of health services is the cost. The increase in the Healthcare costs is biggest problem to worry about and we have to work together to make it cost effective and provide solution in such a way that everyone either rich or poor gets benefitted.

C. Applications of IoT in healthcare

The reports of P&S Market Research have predicted that the compound annual growth rate (CAGR) of healthcare IoT industry would be 37.6% from 2015 to 2020. This would be the result of increasing demand for remote monitoring healthcare systems to detect epidemic diseases. Hence, we can infer that IoT has become the backbone for delivering efficient health services. The applications of IoT in medical industry are many, few of them are listed below [5].

- **Real Time Location Services:** Through IoT, it is possible for the doctors to track the patients, medical staff and medical devices misplaced by staff on shift duties using the real time location services. In order to achieve this the devices can be tagged with sensors.
- **Anticipating the Arrival of Patients:** With IoT, doctors can supervise the condition of patient in real time and predict the occurrence of subject in the PACU, ICU, etc. This could help hospitals to manage the number of patients being treated, discharged, operated.
- **Conformity of Hand Sanitation:** With the use of hand sanitation monitoring systems we could identify the extent of cleanness in hospital staff. As we know that, the hospital acquired infections are reason for death of various patient's, hence proper care needs to be taken to prevent infections. The hand hygiene monitoring system detects the infection once the clinicians come in contact of the system and generates alarm. This is done in real time and with this the quality of treatment would improve.
- **Narrow down Budget and Improve Patient Journey:** The main goal of IoT is to provide quality medical care at economical cost. IoT provides seamless interconnection of devices and as a result of this patient data can be accessible from anywhere at any time. Patients need not visit hospital and wait for appointments, rather can monitor their health being at home. With this unnecessary visits could be avoided and to certain extent cost can be reduced. Hence, hospitals must keep track of the budget and provide infrastructure for better patient experience. Another important facility provided by IoT is providing better patient journey by: developing discharge plan, room illumination, communication between near and dear ones via email or SMS services etc.
- **Remote Monitoring:** Through remote monitoring, patient's health can be monitored from anywhere at any time. If any interruption in the condition of the patient is observed same would be alerted to family members or physicians. This type of medical facility can certainly reduce the emergencies such as heart attacks, duration of hospital stay. This is usually helpful for elderly people, physically challenged etc.

V. HEALTHCARE AND BIGDATA ANALYTICS

The large amount of data collected from various sources that are processed and analysed by specific technologies is termed as Big data. It has changed the manner in which we handle, analyse and influence data in any industry. Bigdata analytics has the ability to cut-down cost of treatment, forecast (anticipate) epidemic diseases and boost the essence of life [6].

A popular saying if we are to believe is "precaution is better than cure", with healthcare data analytics this quote could be proved true and we could predict diseases at a very initial stage and take appropriate medication at the beginning. In past years, collection and storage of huge amount of medical data was time consuming and costly. With advancement in technology, it is easier not only to collect data but also to draw useful information from it to provide better healthcare..

A. Need of Big Data Analytics in Healthcare

In developing countries like India healthcare has become major issue, may be it is elderly health, child birth, diabetes, asthma, cardiac arrest, cancer etc. The need for bigdata analytics for healthcare is growing because of the cost of treatment involved. These costs are much higher and since 20 years it has kept on increasing. Only 20% of Indian population is rich and can afford such medical costs. But, we have to think about the remaining 80% who cannot even think of getting treated at reputed multi speciality hospitals. With this technology, we can make system intelligent enough to predict the rate of disease occurrence and inform patient about their condition well in advance.

B. Challenges of Bigdata Analytics in Healthcare

One of the important hurdles in healthcare bigdata analytics is that the data is distributed over many sources and assimilation of these data sources would require development of new strategies and policies. However, the medical industry is facing tremendous challenges, to name a few: data storage, security, visualization, stewardship, reporting, querying, , sharing, and a number of data integrity concerns [7]. The challenges mentioned above are obstacles in development and deployment of bigdata applications, hence we discuss some strategies in the section below to overcome them.

- **Implementing big data administration:** Lack of administration has made healthcare industry to induce heavy financial costs. This can be overcome by using appropriate data governance or administration policies.
- **Information sharing and interoperability:** Collection of data and information sharing can confront the issue of interoperability. As discussed earlier, the massive amount of data collected is hard to store, share and analyze. This requires utilization of adequate Big Data analytical potentialities which is very much challenging.
- **Applying safety measures:** With the usage of strong encryption techniques, authorization of data sources, access control and verification mechanisms, the data can be made secured and confidentiality can be achieved.
- **Proper training to adopt Big Data analytics:** One of the major problems in healthcare using Bigdata analytics is management of enormous volume of data. The adoption of proper techniques to analyze data would result in accurate

prediction. Hence it is very much essential to have proper training of bigdata analytical techniques.

- Utilization of efficient framework for storage: The huge amount of data collected need to be stored and we cannot risk data loss. The cloud computing platform is the most efficient for data storage.

C. Benefits of Bigdata Analytics in Healthcare

With Bigdata analytics, the patients experience could improve significantly, including quality of treatment, satisfaction, reduced cost, intime prediction. With healthcare data analytics, we can achieve:

- Advanced patient care: Bigdata analytics supports prediction of diseases in advance. To achieve this Electronic health records (EHR) are very much helpful. EHR consists of medical history of patients, treatment schedule, vaccination dates, allergies, radiology images, laboratory and test results etc.[17]. These information can effectively be used to draw inferences about a patient's health.

- Faster treatment: Big data analytics tools are very much useful in increasing the treatment speed. These tools make use of the data regarding lifestyle choices, medical history, disease symptoms to assist doctors to accurately interpret disease occurrence and develop the compelling medication plan in real-time.

- Compressing power costs: Healthcare analytics require continuous monitoring of patients at increased power utilization. With big data analytics the hospital staff can efficiently determine which device are really needed, which device are over utilized, and hence can take appropriate measure to reduce the power consumption.

- Detecting fraud: The two main problem which are being faced by health industry are Medical abuse and insurance fraud. With the adequate adoption of big data in healthcare the above problems could be overcome. The fraud pattern, medical abuse can be detected in advance and can be reduced by inspecting large datasets of claims history.

- Reduction in infrastructure expenditure: By analyzing the past records of components being used and needed, Big Data Analytics could, benefit in predicting the required demand of components, hence reduce the unnecessary expenditure.

- Reduced hospitalizations and readmissions: As discussed earlier, continuous monitoring of patient health and disease prediction in real-time can reduce the number of patient being admitted to hospital during emergency. It also help in monitoring the patient who were discharged from hospital and reduce hospital readmission.

- Finding cure for diseases: Healthcare Bigdata has reformed the field of genomics. Genomics is a wide area and is difficult to study in detail. Every person has different genetic patterns, so two persons having same disease may need different treatment. The field of genomics can improve the disease identification, treatment and prevention of ill health. Nonetheless, Big data analytics can identify unidentified diseases, undisclosed patterns, and insights by investigating huge datasets [8].

VI. RESULTS AND DISCUSSIONS

The proposed system is developed by interfacing sensors to Arduino UNO, that monitors pulse rate, body temperature and ECG of the patients. Fig. 1. shows the components used in the system. The interfacing of sensors used in the experiment is shown in Fig. 2 and 3. As discussed earlier, sensors monitor patients' vital signs and these sensor readings are stored in ThingSpeak cloud.

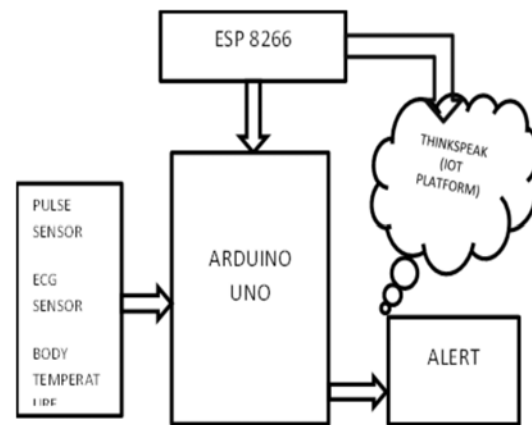


Fig. 1. Components used in heart monitoring system

The reading of heartbeat sensor on Thingspeak cloud is shown in Fig. 4. The ECG graph generated by processing program is shown in Fig 5. Fig 6 exhibits the SMS alert received, this message informs the patient, doctor/caretaker about the condition (normal or abnormal) of the heart and whether hospitalization is needed or not [18].

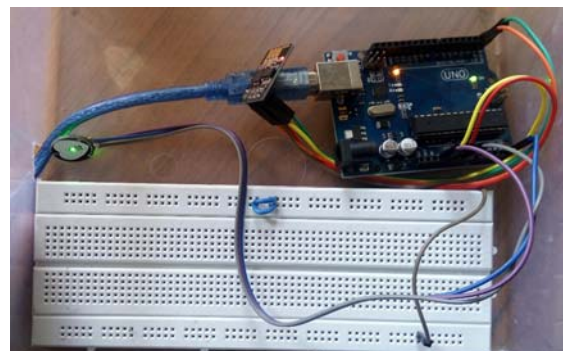


Fig. 2. Sensors interfaced to ArduinoUno.

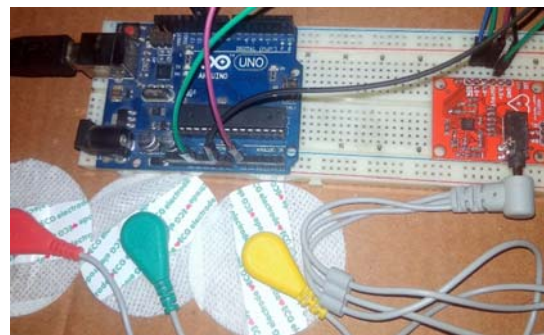


Fig. 3. ECG Sensor connected to ArduinoUno

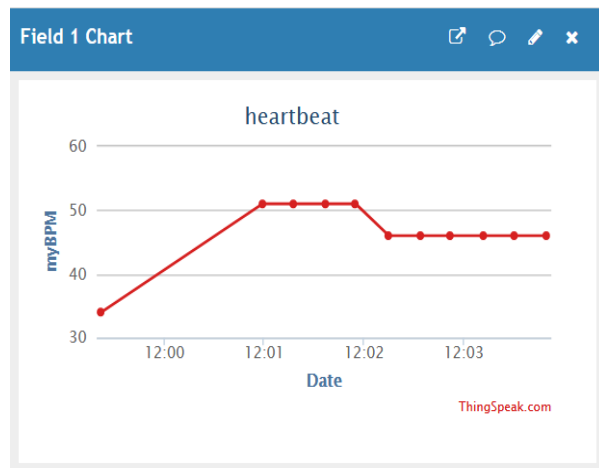


Fig. 4. Graph obtained in ThingSpeak

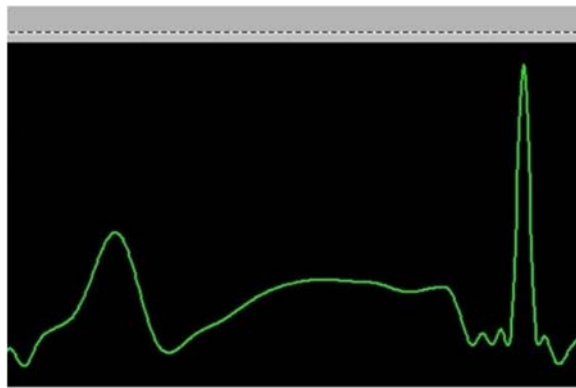


Fig. 5. ECG graph generated by the processing program

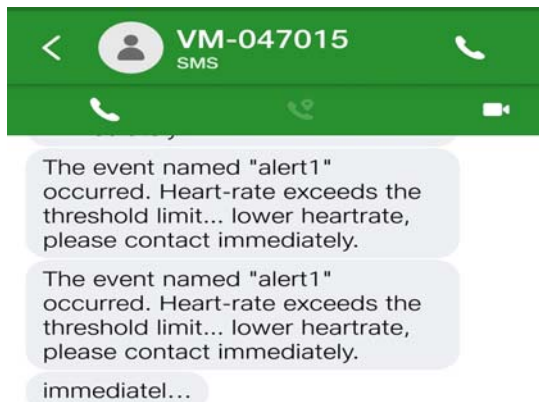


Fig. 6. SMS Alert received on mobile

VII. CONCLUSION

This paper discuss about the benefits, challenges and applications of IoT and Bigdata analytics in disease prediction for healthcare. We designed and developed a Heart Monitoring System using IoT, which collects vital signs of patient and continuously monitor the condition of heart and sends SMS alert when the readings surpass predefined

threshold. This system would be of great help to elderly people or physically challenged people who require continuous monitoring. However, the capabilities of IoT alone is not sufficient to accurately predict the disease occurrence and it is very much essential to use some accurate bigdata analytical techniques and machine learning algorithms to make system efficient. We would further scale the system to efficiently predict diseases using efficient bigdata analytical technical techniques and Machine learning algorithms.

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