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# A Novel Information Processing in IoT Based Real Time Health Care Monitoring System

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**Abstract:** - The recent technology developments and innovations improves the life style of people through smart applications, sensors, wireless communication networks, etc., for all those technologies internet is the backbone and the information processing like accessing, distributing the necessary information is achieved through Internet of Things (IoT). IoT supports multi-disciplinary applications as an active entity in engineering, science and business discipline. Based on the user preference these applications and its services could be framed in IoT. On contrary to the development, IoT has flaws in information processing as huge volume of data is need to be handled in a single environment. Considering these facts, the proposed research work is aimed to develop a novel information processing system in IoT platform through a reliable health care monitoring system. The effective utilization of big data in IoT environment is analysed through the proposed architecture to attain minimum delay in a real time environment. Conventional models are used to compare the performance of proposed design and the experimentation is performed to verify the superior performance of proposed approach using accuracy, cost functions in terms of transmission and storage, f-measure, sensitivity and specificity.

**Keywords: -** Internet of Things (IoT), Big Data, Health care application, Information processing

## 1. Introduction

Data is a familiar term among researchers as the research towards data management is still booming with inventive technologies. In the past few years the amount of data is significantly raised due to the availability of services and ever growing users. Vast amount of data is generated through sensors and actuators in real time environment which frames the Internet of Things (IoT). The data gathering architecture of IoT not only on sensors and also includes various sources like software applications, web resources etc., All these sources vast amount of data and it requires a massive storage system. In addition to physical sensors, virtual sensors are recently developed which works based on a combination of data fusion from physical sensors which is used in the cloud environment. The collected information is termed as raw sensor data and it is collected, stored and processed as useful information which helps to solve data related necessities.

Wireless sensors networks are used to realize the IoT to handle large amount of heterogeneous data and large scale wireless sensor networks are used to manage the data in cloud computing environment. IoT is widely used in manufacturing, health care, industries, smart cities and smart homes etc., By deploying the sensors in an organized manner in a particular region the data is collected in the IoT environment. It collects the data depends upon the service defined for the IoT devices. Though these sensors have limitations such as sensitivity, distance and energy management etc., sensors collect information from the environment and forwards the collected information to the common central node to analyse the data and then necessary information is forwarded to other nodes. Since multiple IoT devices passes information bundle to central node or the main server, it needs a storage unit to store and refine the information to cloud. In order to avoid inaccurate data occurrence, the user is advised to obtain proper awareness about the sensor data.

The development in data collection devices and its applications improves the life style, simultaneously the amount of data is also increases exponentially. So that it is essential to manage, store and analyse such information through internet of things is the recent research trend. Similarly, big data is an important process which process the collected data and convert into essential information to obtain knowledge about the process. Big data is a large volume, variety of information with huge velocity asset that requires an efficient information processing system to enrich the decision making process in an automated manner. Figure 1 depicts an illustration of Internet of things (IoT).



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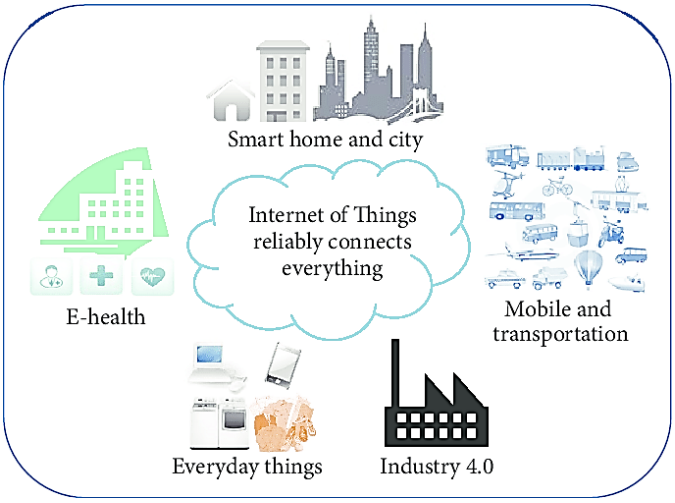


**Fig.1 Internet of Things**

Data analysis is extended to analyse and process the huge amount of real time data which has different structures are termed as big data analytics. It acts as frontier and provides supports in terms of innovation, productivity and forecasting for the exponential growing data to obtain necessary solution. Data becomes obsolete in a short duration so it is essential to deal the data through proper platform when it is active. Big data management is a challenging task as it requires an efficient data management model and still it is inherent for some applications like weather forecasting etc., conventional approaches faces difficulties in processing these large data and it is very difficult to analyse and process. Database management system lags in performance while handling big data in terms of cost and time functions.

Extracting the necessary information from large data set has exploited in wide range of applications such as health care, public economic development, smart management systems etc., compared to conventional data sets, big data is unique in the storage process as the information are stored per byte so that the entire dataset is need to be analysed to obtain the necessary information. The collected raw data are processed to obtain useful information as volumes which can be identified as patterns. Big data analytics has features such as smart decision making, efficient operation, service system, efficient operation and product development. The important features of big data processing are data capturing, data cleansing, data association, data processing, data indexing, data distributing, data mining, data relocating, data analysing and data visualizing which are widely used for real time data processing. The analysis helps the technical as well as academic users to obtain a prior knowledge about the data. It transforms the information into features and forecasts the data into respective applications as specified in the design analysis. In big data analysis, volume, variety and velocity are the three important terms are frequently mentioned. In which volume represents the increasing nature of data in terms of bytes and the variety describes the heterogeneous nature of data sources such as sensors, machines and other data generating applications. Velocity refers to the rate of data generation and it describes how far the generated data is suitable to meet the necessary requirement. Various applications of big data is depicted in figure 2.



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**Figure 2 Big Data applications**

The other necessary features of big data are summarized other than volume, variety and velocity are veracity, which provides authentic data transfer from various sites and locations, value, which is used to represent the significance of stored data and its worthiness for computing. Collected information are stored and processed in big data architecture, the time period to store and process the data is defined in terms of validity. Similarly, the information flow is dynamic in big data environment as most of the applications are employed to process the real time collected information, so it is essential to discuss about the changes in the data in terms of variability. Venue is an another key feature of big data which defines the details about specific location where the data are stored and retrieved. Generally, these locations are termed as data centres. The raw information is useless unless it is analysed properly, so it is essential to describe the nature of data in terms of vagueness and finally vocabulary is used to define the readability and other grammatical notations of data. All these key features are comprised together to manage the information in a better way in big data analysis.

Big data analytics is broadly classified into four categories such as descriptive analysis, predictive analysis, diagnostic analysis and prescriptive analysis. In which descriptive analysis is an initial stage data processing operation which defines historical data to define the data structure. Descriptive analysis uses effective data mining methodologies to organize the data and supports to obtain necessary information from the uncovered patterns. The future prediction could be possible in descriptive analysis based on the probabilities so that the user will get a clear view about the further process. In case of predictive analysis, the previous information is used to predict the further process in future. It is similar like forecasting model which uses various data mining techniques along with artificial intelligence to obtain necessary information by analysing the present and past data. In case of diagnostic analysis, the root cause for the issues are identified to obtain necessary details about the system behaviour. Continuous attempts are performed in diagnostic analysis to define the issues, so that it could be rectified or avoided in future which improves the data handling efficiency in big data environment. While handling big data, prescriptive analysis is used to perform decision making process based on the analysis of raw data. By providing essential historical data and forecast details through predictive analysis mechanism, this prescriptive analysis provides better solution to the issues in big data management. Figure 3 depicts the classifications in big data analysis.

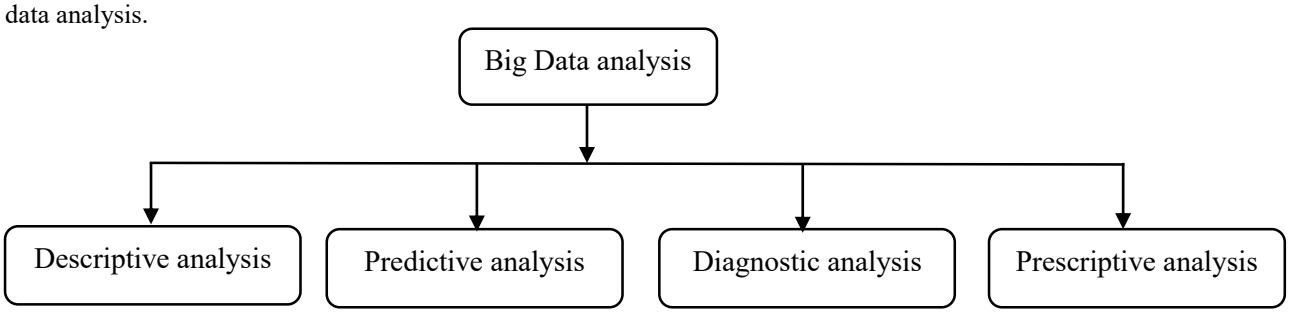


**Fig. 3 Types of Big Data analysis**



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The research article is organized as follows, in section 2 the issues and challenges in IoT Big data environment is analysed as literature survey, proposed model is presented in section 3 followed by experimental results and discussion in section 4. Finally, the observations are concluded in section 5.

## 2. Related works

The challenges and issues in IoT Big data environment is analysed in this section by analysing existing research models. The challenges in IoT big data is initially from the massive amount of information collection is performed in IoT environment through sensors and radio frequency devices (Hongming Cai.*et.al.* [1]). Since IoT has thousands of devices which produces data by their own and this vast data is collected increases the data quantity. This massive data produces issues while storing, processing and transmitting in terms of bandwidth in real time environment. Large amount of bandwidth is required to process the information which is not reliable in some situations. Similarly, issues related to information storage requires large amount of storage space to manage the data so that backup and recovery of necessary information could be possible in future (Anne.*et.al.* [2]) On contrary to storage, processing time will increase of large amount of data to be processed through the system in real time which may affect the system quality of services.

Data collection in a IoT system is not similar to others (Pandian.*et.al* [3]). In IoT, based on the application different types of sensors are employed in IoT design which produces different types of data which is considered as a challenging process in IoT big data. Since the data are semi-structured, structured and unstructured in nature (Michael.*et.al.* [4]) and the system needs to collect that information and store in a single storage space which occupies more space. In this collected information almost 75% of data cannot be processed through conventional techniques as it requires an efficient methodology to process the structured data and unstructured data. Data transmission speed is another important challenge in IoT big data (Bashar.*et.al.* [5]) as it directly defines the term velocity which is one of the major key feature in big data analysis. In real time environment it is essential to process the data to obtain necessary information needs a high speed data analytics which is very difficult (Mao Yi.*et.al.*[6]) Similarly, time series (Bestak.*et.al.* [7]) for effective data analysis is another challenge in IoT big data. Sensors in IoT environment are used to collect information at particular time interval for certain applications and the collected information will be useless at sometimes, unless if any difference occurs. So that the serious issues are need to be addressed through the recorded data (Jonggwan.*et.al.* [8]) Most of the systems facing issues in time series data handling in health care application is one of the challenge in IoT Big data. (Chandy.*et.al.* [9]) (Smys *et.al.*[10])

Finally, security and privacy issues are the important challenge in IoT big data (Hongbing.*et.al.* [11]). The data from sensors to base station is processed through wireless medium which faces issues in privacy and security (Florian Metzger.*et.al.*[12]). The possibility of vulnerable attacks in the network which affects the security of the information. Attacker steal the information from IoT devices either physically or while transmission in progress. Since IoT devices doesn't have any security protocols as self-defence, managing the privacy and security is a major challenge in IoT big data. While the privacy is need to be considered vigorously, authentication (Fan Wu.*et.al.*[13]). for providing access to the information is a challenging process in IoT big data. Considering this challenges, the proposed approach is designed to develop a better information processing system in IoT big data environment (Berihun Fekade *et.al.*[14]). From the above survey it is observed that existing technologies faces issues in information extraction and processing along with security factors. Based on the issues the proposed model is designed and discussed in the next section.

## 3. Proposed work

The proposed approach for IoT big data is analysed by developing an efficient health care monitoring system for effective information processing. The entire process is sub divided into three phases as data accumulation and data aggregation in first phase, information processing such as classification, analyse the collected data in second phase and decision making in third phase. The information processing in health care application is depicted in figure 4.



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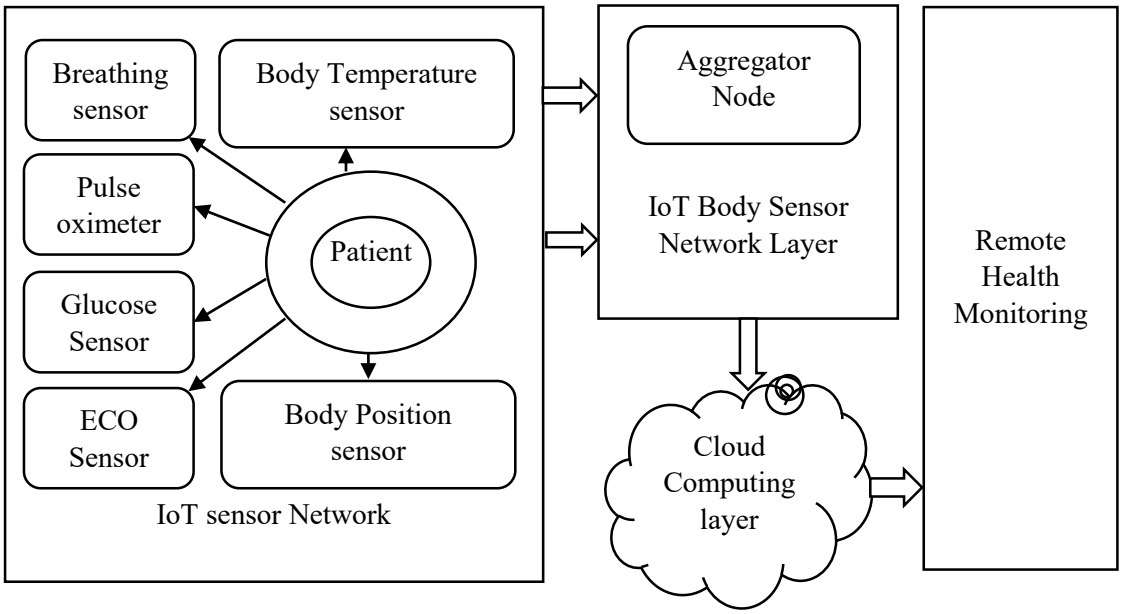


**Fig. 4 Information processing health care application**

IoT is widely used in various application in engineering and science, though the necessity to improve health care system, IoT is employed in recent times. Cloud computing provides support to various applications and its related services which are further improved by incorporating cloud with IoT. In health care applications the significant features such as remote data processing requires high degree of dependability. While employing cloud computing for this scenario, cloud offers better data pre-processing which ensure the process of clean forward of data which improves the efficiency of health care applications in an innovative manner.

Generally various sensors are used in health care monitoring applications such as ECG sensor for heartbeat monitoring, glucose sensor to measure the glucose level in blood, breath sensor for breathing status of patient, temperature sensor for measuring the body temperature. Using these sensors, the health condition of the individual could be processed as data which is collectively termed as IoT sensor networks. The collected information is processed to IoT body sensor network layer which has data accumulation, encryption, aggregation and compression process. In which data accumulation process collects the information related to physical condition of a person and their surroundings. Based on environment, health and locality the data is collected from the sensor devices placed in the user body, environment and locality through wireless networks. Accumulate and deliver the confidential data in the accumulation model is a complex process. It requires an efficient data protection operation for IoT based health care application which shares the data in wireless network. The proposed approach reduces the issues in data confidentiality through hierarchical data encryption and compression. In this process all the information is need to be shared along with the secret key and the key is shared among the user and device nodes. While if the sensing nodes satisfies the query condition which are predefined then the encrypted as cipher text.

Data encryption is used by sensing nodes to share the data through secret key to the base station and similar encryption key and the compressed message are transferred to aggregate node. If the aggregate node is the only possibility to share the data to base station, then the data transfer process is initiated else aggregate nodes shares the collected information to neighbour aggregate nodes and considered that node as mediator. Mediator helps to exchange the information and aggregates the data with its own data so that the difference in data could be achieved in the proposed process. Data pre-processing deals with information analysis, normalization, extraction, filtration and classification. The information exchange is performed from base station to cloud layer as encrypted and aggregated messages from all the aggregate nodes. Normalization of data is used to standardize the aggregate data. The proposed approach used max-max normalization technique for efficient normalization in IoT environment. Figure 5 depicts the proposed model process flow in detail.



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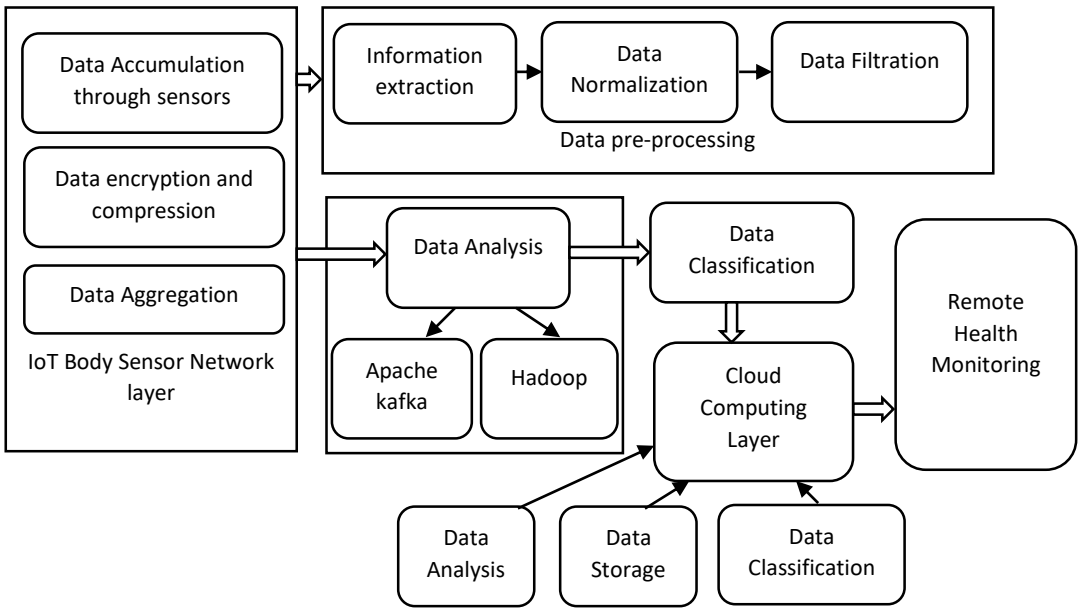


**Fig. 5 Proposed Information processing architecture**

Data filtration is used to remove the noise and unwanted features from the collected information. The proposed design used kalman filer for better noise removal process it separates the important unnecessary noises which simultaneously increases the speed of the system in data processing. Data analysis is the final step in health care application. Once the filtered data is obtained, an in depth core analysis is need to be performed in data analysis. In order to manage massive data in health care applications with high speed, the master nodes split the high speed data into different fixed size data packets. These data packets are split into fixed size data as master node and those split data are processed in slave nodes simultaneously. Hadoop is used in the proposed approach to perform data packet distribution to all slave nodes through its distributed file system (DFS). Map function is used to process the data packet if more than one packet is need to be processed by the slave nodes. However, Hadoop has limitations while handling real time data so the proposed approach uses apache kafka, a high throughput distributed message system for real time data processing. Using apache kafka, the necessary parameters are extracted and based on the extracted features and Data classification results the real time monitoring is progressed in the proposed approach. The necessity of such health care system is to reduce the individual risks and the abnormal changes are identified immediately, so that using proper medication the patient life could be saved from anyplace which is an extra advantage of the IoT based healthcare monitoring system.

## 4. Result and Discussion

The proposed model is experimentally verified in simulation by deploying various health sensors over 1000x1000m and the experimentation is performed using python and the network consists of aggregate nodes and sink to perform compression, encryption, transmission, decompression and decryption operations using the respective algorithms described in proposed work section. In order to validate the performance of proposed work, parameters such as accuracy, cost functions in terms of transmission and storage, f-measure, sensitivity and specificity are compared with existing hierarchical clustering and back propagation neural network models. Table 1 provides the details of simulation parameters used for the proposed work experimentation.

**Table 1. Simulation Parameters**

| S.No | Parameter | Value |
|---|---|---|
| 1. | Network area | 1000x1000m |
| 2 | Number of devices | 50 |
| 3. | Gateways | 6 |
| 4. | Physical memory | 512Mb |
| 5. | Capacity | 1Gb |
| 6. | Request per second | 10 |
| 7. | Bandwidth | 1Mbps |



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The specificity and sensitivity comparison of proposed model and conventional model are depicted in figure 6 and figure 7. It is observed that proposed information processing system attains better sensitivity and specificity among other algorithms. The performance is evaluated in an increased fashion based on the requests and its actions in the range of 5,10,15,20,25,30. The online and offline operation achieved through Hadoop and apache, provides better results for all the actions and the proposed approach attains better performance on an average of 96% of specificity which is 2% greater than back propagation neural network model and 4% greater than hierarchical clustering approach. An average of 95% of sensitivity is attained through proposed approach and it is depicted in figure 7.

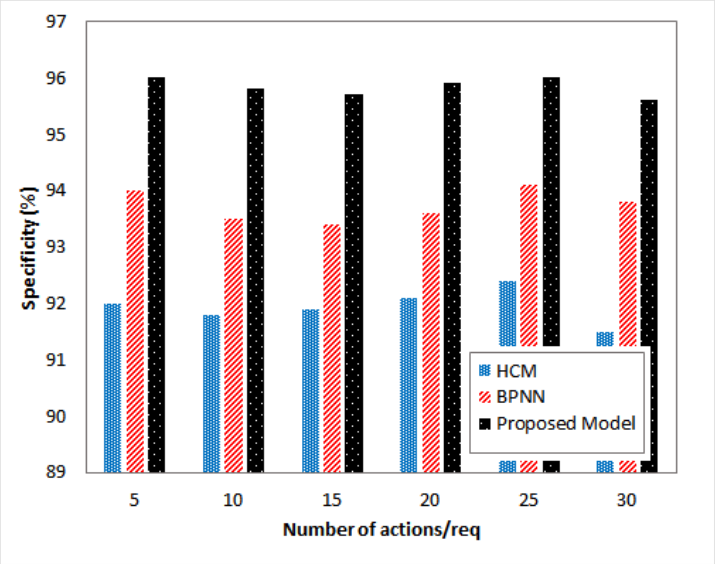


**Fig. 6 Classification efficiency- Specificity**

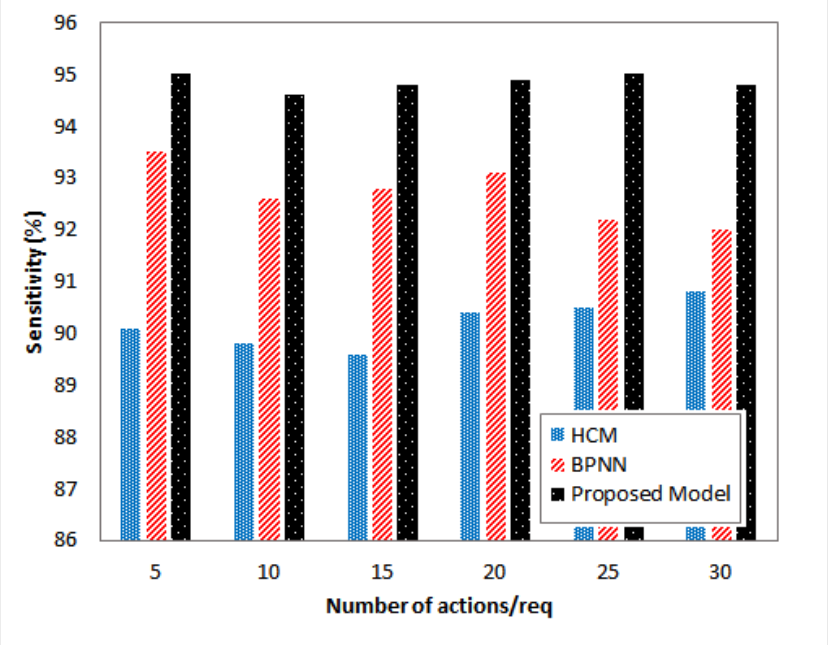


**Fig. 7 Classification efficiency- Sensitivity**



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Figure 8 depicts the f-measure comparison for all the three models for the data processing requests and its actions. It is observed that proposed model attains better f-measure compared to other algorithms. The average f-measure value of proposed approach is 96% which is much better than hierarchical clustering model.

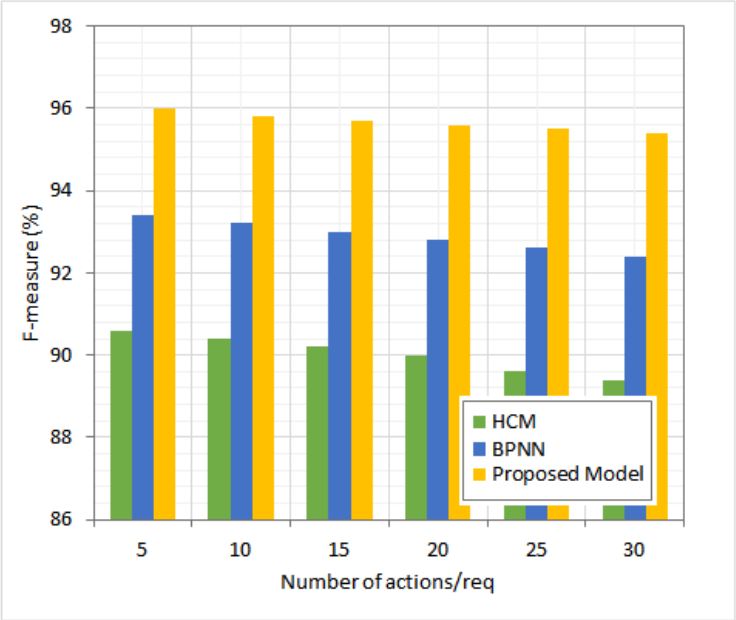


**Fig. 8 F-measure Comparison**

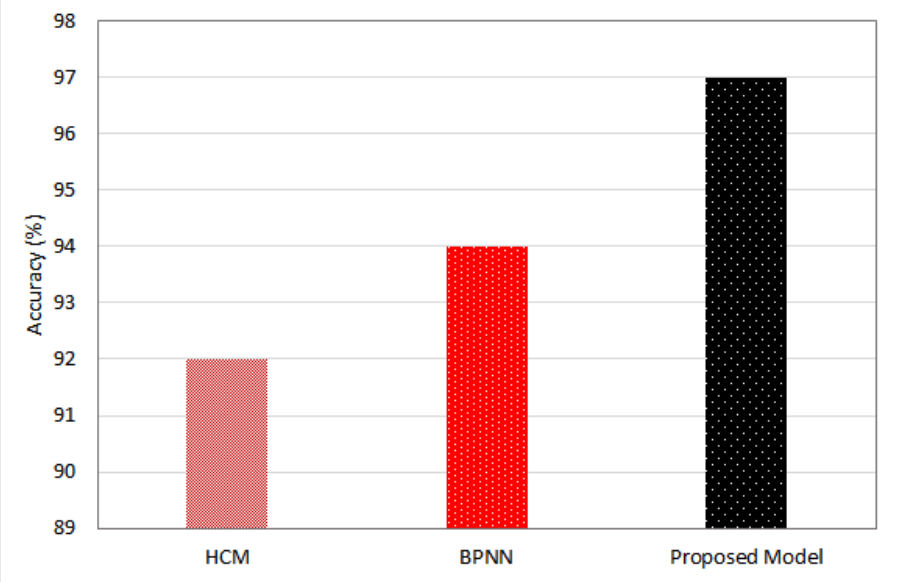


**Fig. 9 Accuracy comparison**

The accuracy of the proposed model is compared with hierarchical model and back propagation model and it is depicted in figure 9. The better information extraction from the raw data and performance of aggregate nodes are considered to define the accuracy parameter. It is observed that proposed model attains better classification accuracy as an average of 97% compared to other models.



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## 5. Conclusion

The research work proposed a novel information processing in IoT based health care monitoring system for effective management of big data in IoT environment. Data management in IoT systems are one of the crucial and essential task and existing big data based solutions are adequate to meet all the requirements. It is essential to improve the data handling performance in IoT Big data environment as most of the systems are adapted only for real time data collection process. In order to satisfy the necessity in real time data collection along with offline process, the proposed model used Hadoop and apache kafka. Experimental results describe the proposed approach performs efficiently in data handling and information extraction process compared to conventional hierarchical clustering model and back propagation neural network model. The proposed model achieves an accuracy of 97% which is a remarkable improvement in information processing in IoT Big data environment. The future scope of the research could be improving the performance using optimization models.

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