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An Experimental Analysis of Blockchain enabled Intelligent Healthcare Monitoring System using IoT based Deep Learning Principles

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Abstract—In present days health assisted concern are more to every individuals and all are wish to monitor the health summaries frequently. But the practical complexity is quite different, in the sense the physical enrollments in hospitals and checkups are vague and it is a time consuming process. So, that a smart devices are introduced to assist people to check their health conditions instantly without any dependencies and hurdles. However, the devices are strucked up with certain extent and create some complexities in surveillance of individual's health. The general health monitoring schemes are associated with sensors and display their report to the display screen instantly without any delay. This is of course useful to individuals who wish to monitor their health by own, but in some cases the children are wish to monitor the health summary of their parents from remote places due to the job nature. The present schemes of health monitoring are not providing such sufficiency to monitor the health records properly from remote places. In order to fill such range based gap, an efficient interface called Internet of Things (IoT) is utilized in this health monitoring approach in association with Deep Learning Strategies. These innovative health assisted technologies are integrated together with the powerful data management technique called Blockchain. The interfacing of Blockchain enabled mechanisms is necessary to manipulate the continuous data acquired from Smart Device used to monitor the healthcare summary of the respective individual or patient. The proposed approach associates these multiple logics under the single consortium to provide an efficient support to patients in an efficient manner, in which the proposed technology is named as Blockchain enabled IoT Health Assistance (BIoTHA). The Smart Device associated with the proposed approach consists of several healths related sensors such as Heart Rate Monitoring Sensor, Body Positioning Identification Sensor and Body Temperature Monitoring Sensor. Based on these three Sensors the Smart Device is operating and accumulate the health related values from device end and pushing that detail to the remote server end without any delay. Further the process will be handled by the server end by means of Blockchain enabled technology. The concept of Blockchain is applied over this paper to identify the patient criteria based on age factors as well as improving the security concerns of the patient health monitoring system. The age factors of the patient are categorized into blocks and process the health related data based on the related blocks, so that the details can easily be processed and provide the exact status of the respective health records. The resulting section proves the efficiency of the proposed approach called BIoTHA in terms of data manipulation accuracy and health predictions accuracy.

Index Terms—Healthcare, Internet of Things, IoT, Blockchain enabled IoT Health Assistance, BIoTHA, Deep Learning, Blockchain

I. INTRODUCTION

In terms of statistics solutions, an Artificial Intelligence enabled devices and Internet of Things has led to significant growth and development. In short, since it is the most subjective to patient-oriented record maintenance and has to numerous sensors assisted technologies are required to keep this system in clear manner as well as the healthcare is the one which is the most unpredictable field. Since this architecture is located at the clinic, the sensors will form an extremely broad health monitoring scheme based on the smart device interlinked with the surveillance scheme. In which the health related data are maintained over the remote server with the help of Internet of Things enabled network that monitors and collects sensor data from the devices and computers inside the hospital units or personal home. However, since this network connects all of these Internet of Things enabled services around all time without any sustainable interval, it is more susceptible to snooping and data manipulation vulnerabilities. Software attacks in

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the healthcare industry pose a major threat as they can lead to harmful diagnoses and inappropriate treatment, which could place patients in life-threatening circumstances. In order to avoid these kinds of imposters, we use Blockchain for data transfer to guarantee that the sensor data is transmitted in its original form. The Blockchain is the underlying technology behind a wide variety of crypto currencies, such as Bitcoin [8]. The centralized and mainframe process is used to keep data in a trustworthy state by encrypting, validating, and archiving all of the network activity as a matter of public record in the system. Due to the rise of crypto currencies, the world of academia has thoroughly experimented with the use of Blockchain for data security, for the first time. Proposal to build a stable healthcare monitoring system: a block is appended to the Blockchain whenever a sensor generates information that is validating Using edge nodes allows faster and more responsive IoT devices to be used, while also offering better control over the data gathered. It is important to keep in mind that each sensor will have its own block at the node and only the actual information will be conveyed [9].

As a result, the transaction rate is increased and in a parallel manner and the use of local nodes only connects a small number of sensors to the Blockchain leads to the occurrence data exchange. These nodes may be located in public health facilities or at community gathering points and relay the sensor data to the cloud. So long as edge nodes have a finite resources and store only the systemic diseases instead of storing the whole records based on Blockchain logic. If smart devices are linked with the Internet of Things med, they will be able to use [10] decoupled Blockchain to communicate with each other. The key innovation behind Blockchain decoupling is that a single block does not have to endorse the request and can be split into two known as blocks: the primary transaction and the known transaction. Just the block header is needed for validating patients while uploading patient computing resources can be replicated and stored. Basically this system operates based on the Blockchain logic with the categorization of patient age groups under certain security perspectives. All these details will be summarized further in clear manner over this paper.

*A. **Proposed Approach Inspiration***

Healthcare mechanism and the related activity is more important as compared with the other metrics. The health related summary monitoring and the related activities are not in the expected level now-a-days. So, in this paper logic of latest technologies are associated and define a new methodology for healthcare manipulation, in which it is called as Blockchain enabled IoT Health Assistance (BIoTHA). This approach is inspired from several latest innovations called Internet of Things, Blockchain logic and Deep Learning procedures. The Internet of Things medium is useful to transfer the health related data from the patient end to the server end without any interference as well as the Blockchain logic are used to process the data depends on two strategic factors such as age and security. The age factor is useful for identifying the category of the patient and the security factor is considered to provide efficient security aspects to the patient health related information [1][2].

As well as this security concern is enabled to provide the concentrated crypto provision to manipulate the health summary against server attacks and related spoofing. The Deep Learning principles are used to train the system based on the previous health related summaries and provides the proper testing data processing scenario in an efficient manner. Clinical information system must be protected, because sending the information from an smart device end of the monitoring system to a local or centralized remote server end presents a privacy threat. If this information falls into attacker hands, the patient's privacy is endangered. At worst, the data might result in severe or fatal effects for patients. It is hard to guarantee the safe and secure transportation of data, though, as the sensors need finite power. Therefore, there is a need for a light but safe form of communication, which allows for medical privacy and information exchange while protecting the data. Based on these latest technologies and the associated innovations the proposed approach of BIoTHA is designed with all security and privacy management aspects with powerful health summary monitoring provisions [3].

*B. **Major Contributions***

The following are the major contributions associated with the proposed approach implementations, in which those details are summarized as follows:

(a) To design the generalized health care monitoring system in association with latest technologies such as Internet of Things, Blockchain and Deep Learning.

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(b) Maintain the health related data from the Smart Device end to the remote cloud server by using the IoT bridging medium.
(c) To utilize the Blockchain model to manipulate the server end health care data in an intelligent manner with respect to age and security related factors.
(d) To design the blocks based on age factor, so that it is easy to categorize the patient in clear manner.
(e) The Security aspects are the major need to provide an intense health care mechanism with privacy enabled factors.
(f) To implement the Deep Learning procedures to provide an intelligent training and testing process for analyzing the exact health status and report that to the client end without any delay.

The remaining portions of this paper describe regarding Related Study over section 2, further section of Section 3 illustrates the proposed system methodologies in detail with proper algorithm flow and the Section 4 illustrates the Result and Discussion portion of the paper and the final section, Section 5 illustrates the concept of Conclusion and Future Scope of the proposed paper. These all will be explained in detail over the further section summaries.

II. RELATED STUDY

Saurav-Saha et al., 2020 [4] proposed a paper related to Blockchain enabled Internet of Things based Health Care management system with respect to Access-Control logic. In this paper [4], the authors described such as the users must be able to monitor access the mobile device of the Internet of Things user while they are on the hospital's trusted network to give him/her permission to do his/her job. The user and respective persons in hospitals create a secret key after mutual authentication. Safe hospital data is transitions take place on a common key through different hospital authorities within the network of private Blockchain hospitals. Hospital administrators are the only ones that build the structures in the Blockchain since health care data is considered as sensitive and personal. To handle this critically important problem, the proposed novel private Blockchain [4] are utilized. There are numerous thought-out attacks to which the proposed strategy is resistant and in addition, it offers improved protection and functionality, while being much less costly and demanding in terms of bandwidth [4].

Aujla et al., 2020 [5] proposed a paper related to Blockchain based secured information manipulation system with respect to edge enhanced V2X framework. In this paper [5], the authors described such as the increasing computing, especially in wearable devices, has moved toward the edges of the network for example, vehicle to anywhere communications (V2X). Such a network structure enables users' final results to be processed/desires to be acted upon at the extremities of the application; thereby, minimizing latency and maintaining the confidentiality of user data. There are several difficulties in implementing an edge computing platform, however. Inappropriate use of network resources occurs at the 'edge nodes' (1) for VX applications that require a vehicle's mobility, (2) presents problems for cache and data integrity since the connection is broken and subsequently reestablished (s). Therefore, we build a Blockchain enabled protected security mechanism for an environment where edge devices are predicted to play a significant role. For instance, the implementation of a multiple objective optimization method has been implemented into BlockeD V2 The key advantage of BloCards' container-based data processing and Blockchain enabled data management is minimizing linkages between documents and reducing lag time. For this example, we introduce and measure the effectiveness of the method in Chandigarh City, India.

Kaur et al., 2020 [6] proposed a paper related to the use of tensor assisted data realization of smart systems for dimension reduction. In this paper [6], the authors described such as the smart grid integrates conventional energy distribution with sophisticated information systems to allow bi-directional power flow between grid customers. a large quantity of information is being created in SG system because of Smart Grids (also known as smart grids) People can generate a great deal of data in smart grids, which could prove difficult for communication infrastructure to handle. Thus, in this setting, a suitable Quality of Service needs to be transmitted to end users' offers an appropriate wireless communication process. The data created by digital sensors in SG is typically contains a diverse set of attributes and time-varying attributes most of the built solutions will be kept back in the RAM for longer times as the high-dimensional data also hampers the output Many of the previous reductions for the purpose of decision making had extremely complicated formulas which will impair the efficiency of any applied solution. To better handle these problems, a make a positive impression big data management is recommended for dimensionality reduction on big data that originates from multiple system sources is proposed in this study. To address the high-order tors (used for

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data representation), the Frobenius norm is first applied on tensors with the goal of reducing the reconstruction error. Finally, an empirical-theoretic route is designed to transfer reduced data to optimize network load and bandwidth organizations are leveraging software-defined networks. The architecture aims to reduce the data latency from one node to the next. To assess the feasibility of the proposed idea, we've carried out extensive simulations using `R' scripts and on trace data produced in MATLAB. Those large data sets are measured in tens of millions of lines of code

Zheng et al., 2020 [7] proposed a paper related to the opportunities and threats presented in Blockchain model as well as analyzing the technology governing Blockchain technology and online services. In this paper [7], the authors described such as many potential advantages exist with the Blockchain technology, such as security, persistence, and anonymity. The several existing Blockchain implementations include all the following three spheres: crypto currencies, financial services, the internet of things (IoT), and social networks. Although multiple inquiries have assessed the features of the Blockchain, there is no research that goes into all aspects of its technology and practical use. In order to plug this hole, we've conducted a Blockchain technology survey. This paper also presents taxonomy of Blockchain implementations, provides an overview of the strengths and limitations of Blockchain consensus protocols, and critically analyses Blockchain ventures. This paper shows where the Blockchain technology is headed to in the future [7].

III. PROPOSED SYSTEM METHODOLOGIES

In this paper, a new multi-technology assisted health care monitoring service is initiated with several supportive features. The proposed approach is called Blockchain enabled IoT Health Assistance (BIoTHA), in which it associates the latest technologies such as Internet of Things, Deep Learning and Blockchain mechanisms. The association Internet of Things with the proposed approach of BIoTHA enables the Smart Device to carry the health related data from the local region to the remote cloud server for processing. The Blockchain methodology is used to manipulate the data based on Deep Learning training as well as the health records are deviated under certain age factors and the information security is also preserved.

The proposed approach train the health records dynamically based on the user inputs. Initially the records collected from the patients are maintained into the server for future reference and the health summary is validated according to the model created on runtime. This entire process is called as Training and the Model Creation. Once the model is successfully created the testing phase begins with several constraints, in which the health related metrics are collected from the user and cross-validate those values to the trained model to accumulate the proper health status of the respective patient in clear manner. The following figure, Fig-1 illustrates the proposed Blockchain enabled IoT Health Assistance model in clear manner with layer by layer definitions as well as the health care metrics in brief.

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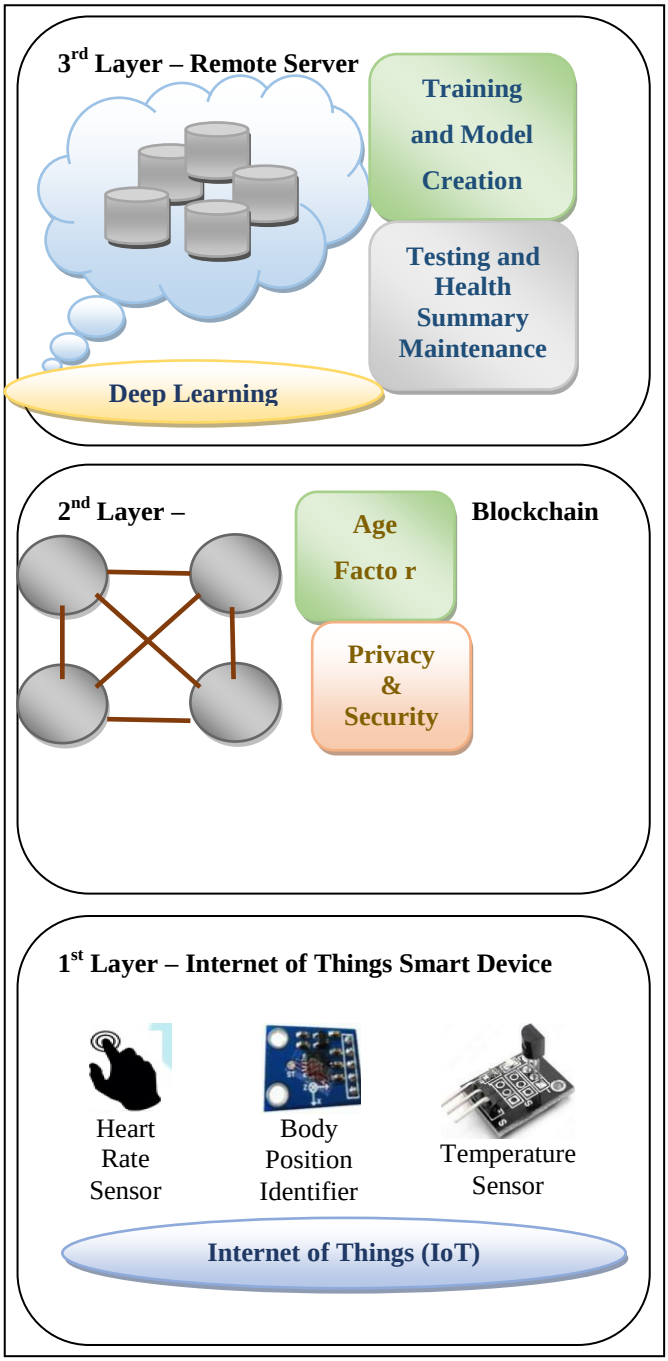

Fig.1BIoTHAArchitectural View

The detailed summarization of pictorial representation mentioned in figure, Fig-1 is illustrated as follows. In those three different layers of processing is handled such as Internet of Things assisted Smart Device, Blockchain Layer and the Remote Server Layer.

(a) Internet of Things assisted Smart Device: The first layer is associated with the Smart Device, in which it consists of different sensors such as Heart Rate Monitoring Sensor, Body Positioning Identification Sensor and Body Temperature Monitoring Sensor. The 'Pulse' heart rate sensors utilized in this approach to manipulate the heart beat ratio of the person and the body temperature level is manipulated by means of DS18B20 temperature measurement sensor. The position ratio of patient is manipulated by means of Micro-Electro-Mechanical-Systems (MEMS) sensor, so that the patient stand-by position and felt down positions are easily evaluated. The following figure, Fig-2 illustrates the Smart Device integrated sensors perception in clear manner.

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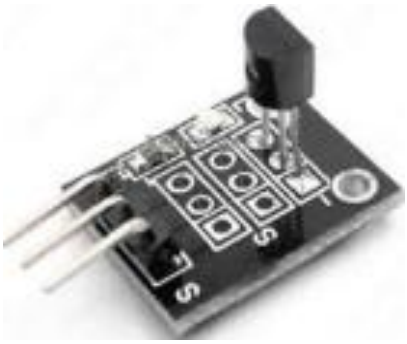
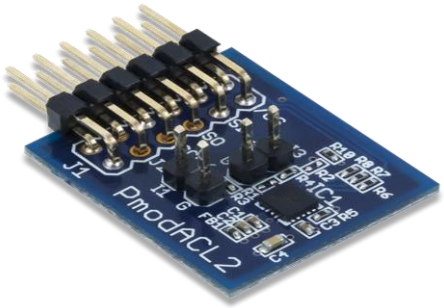
(a)



(b)



(c)

Fig.2 Smart Device Sensor Unit (a) Pulse Sensor (b) Temperature Sensor and (c) MEMS Sensor

(b) Blockchain: The second layer is of BIoTHA is associated with two different form factors such as Age and Security. The patient input parameters are processed with respect to the age factor based categorization, in which it is helpful to identify the criteria of patients and the affection range in clear manner with proper specifications. The Blockchain security metric allows the user to access the system totally flaw free with the help of crypto features as well as the records maintained into the server cannot be hacked by the attackers or intruders at any case.

(c) Remote Server: The third Remote Sensor Layer is integrated with Deep Learning principles, in which the health care model is created with the help of this layer. As well as the server side scripting ensures the performance of the entire approach in clear manner as well as the proposed approach of BIotHA clearly illustrates the logic of training and model creation with proper cross-validations. The runtime records of the patient are considered to be the testing record and that will be processed dynamically based on the model created as well as the resulting emulation will be portrayed accordingly. In parallel that record and the manipulated results will be appended into the created model for further analysis.

The following algorithm illustrates the process flow of the proposed approach called Blockchain enabled IoT Health Assistance in clear manner.

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Algorithm: Blockchain enabled IoT Health Assistance

Input:*Health Parameters such as Heart Rate, Body Temperature and Position*
Output:*Data Categorization*
1. Accumulate the Smart Device Sensor values from the client end, in which it consists of Temperature (T), Pulse Rate (Pr) and the Position (P).
2. Pass the accumulated values to the remote server by means of Internet of Things medium.
3. Training Process: Initially the collected health records are trained under fixed constrain of age factors and the blocks are generated with proper age summarization.
4. Model Creation: Each block contains the patient records of different age factors, which will be specified clearly over the following table, Table-1.
5. Created model is maintained into the server for further processing.
6. Cross-Validation: The random values from the created models are accumulated and apply that to the system for testing the efficiency of the proposed approach.
7. Testing Phase: In testing the runtime patient records are considered and into those vales to the server end to get the proper prediction levels of the patient.
8. Respective health records are maintained into the server end based on the proper age factor.

IV. RESULTS AND DISCUSSIONS

In this paper, a novel deep learning strategy is implemented with respect to the monitoring of health care environment. The proposed approach is called as Blockchain enabled IoT Health Assistance (BIoTHA), in which it associates the latest technologies such as Internet of Things and the Blockchain in hands with Deep Learning principles. So, that the processing efficiency and the performance of the proposed logic is high as compared with the classical machine learning models. The proposed approach of BIoTHA process the data based on the age factor and maintains that into the respective age blocks as crated under the norms of Blockchain model. The following table, Table-1 illustrates the Blockchain age factor blocks specification in clear manner.

Table-1: Age and Respective Block Specification

Blocks	Age Ranges
Block-1	1-10
Block-2	11-19
Block-3	20-39
Block-4	40-54
Block-5	55-69
Block-6	70-80
Block-7	81-89
Block-8	90-100
Block-9	Greater than 100

The following figure, Fig.3 illustrates the data transportation efficiency of the proposed approach called BIoTHA in terms of communication provision between client and server end, in which it portrays the quantity of health related data collected from the Smart Device end and the quantity of records received into the remote server end. In which the x-axis indicates the quantity of records accumulated from the client end's Smart Device unit and the y-axis indicates the range of transportation between client end and the server end.

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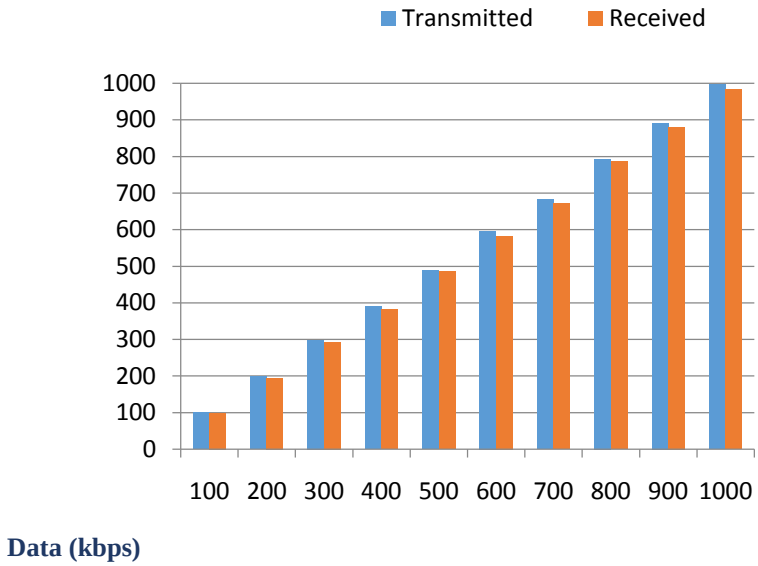

Fig.3Data Transportation Efficiency

The following figure, Fig-4 illustrates the data maintenance ratio of the proposed model, in which this model is accumulated based on the surveillance of real-time data collected from the hospital environment with respect to Smart Device placement for 30 continuous days. The ratio of health related data stored and manipulated into the system blocks are displayed in clear manner with proper range specifications. In which the x-axis indicates the availability of blocks with respect to the mentioned table, Table-1 and the y-axis indicates the health records storage ratio of each block.

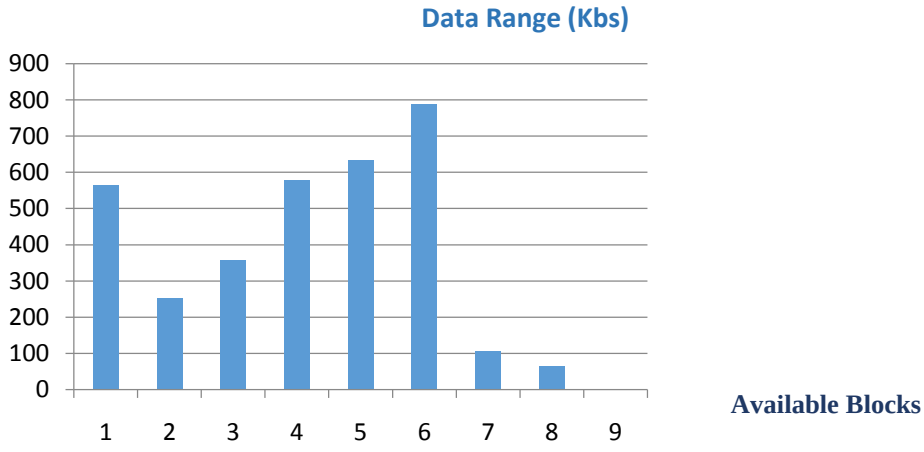

Fig.4Data Storage Ratio with respect to Available Blocks

The following figure, Fig-5 illustrates the data categorization accuracy of the proposed model, in which the health records of the patients are required to categorize under certain age factors with respect to the blocks available into the server end. The proposed approach of BIoTHA accumulates the incoming health record over the server end and split out the age value from the patient record and maintains the respective data into the corresponding block. This process will be handled over a microsecond at every interval, so that the chances of packet loss may happen in this time. The following figure, Fig-5 portrays the data categorization ratio in clear manner.

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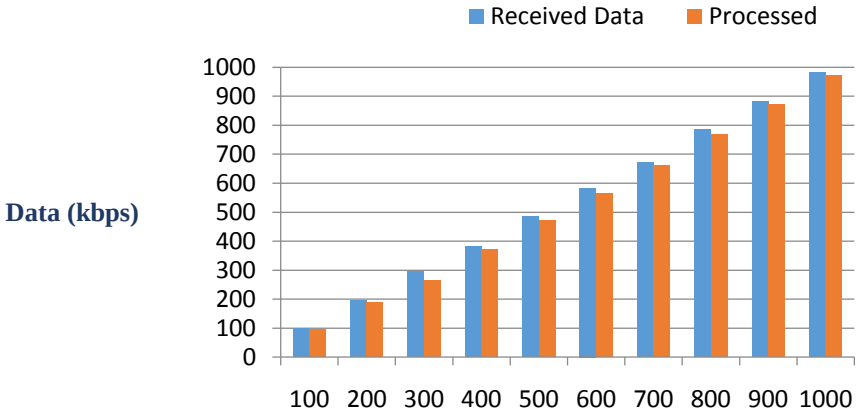

Fig.5Data Categorization Accuracy

V. CONCLUSION AND FUTURE SCOPE

The proposed deep learning model called Blockchain enabled IoT Health Assistance provides an efficiency and intellectual pathway to monitor the health summary of the patients in clear manner with proper specifications. The latest technology associations of the proposed approach improve the processing ability of the server more as well as the time complexity is reduced in drastic manner. The data handling efficiency of the proposed approach is improved and the resulting section figure, Fig-3 illustrated that in proper graphical perception as well as the block storage ratio is clearly stated over the figure, Fig-4. The health related data classification accuracy is improved over this proposed approach and the resulting section figure, Fig-5 illustrated that in proper way with graphical proof. For the entire proposed model provides a good solution to health care industry for data maintenance and support in terms of latest technology associations.

In future the implemented work can further be enhanced by means of adding some Digital Image Processing (DIP) logics to process the input data with respect to scan reports and summaries to provide more efficiency. As well as the constraint of considering the medical image handling will save the doctors' time in drastic manner to properly analyze the disease structure and affection levels in clear manner.

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