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IOT in Hypertension Attack Control – IOT-Fog Based System for the Identification and Diagnosis of Hypertension Attack

P.Brindha, R.D.S.Terese Sheeba, T.Thanka Geetha, P. Adlin Shibi

Assistant Professor, Department of Electronics and Communication Engineering, DMI Engineering College, Chennai, Tamil Nadu, India

Assistant Professor, Department of Electronics and Communication Engineering, DMI Engineering College, Chennai, Tamil Nadu, India

Assistant Professor, Department of Electronics and Communication Engineering, DMI Engineering College, Chennai, Tamil Nadu, India

Assistant Professor, Department of Electronics and Communication Engineering, DMI Engineering College, Chennai, Tamil Nadu, India

ABSTRACT: Hypertension is a one of the chronic diseases causing risk and gives rise to different kinds of disorder like kidney failure, hypertension attacks, cerebrovascular attacks, cardiovascular diseases etc. (*High blood pressure (hypertension) - Symptoms and causes - Mayo Clinic*, 2022). For the prevention of the risks related to such diseases, the statistics with reference to hypertension is necessary to be taken into consideration which is necessary to be analysed in a real time basis. In this study, an Internet of Things Fog-based healthcare system is proposed which facilitates the monitoring of the statistics related to hypertension and the analyses it on a real time basis. It identifies the various stages of hypertension based upon the various health parameters of the user which are collected using the IoT sensors used in the fog layer. After the identification of the hypersensitive stage, hypertension attack risk level in the user of various remote sites is predicted using ANN. The major part of the paper lies in the instantaneous generation of the emergency alerts related to blood pressure fluctuation arising out of the fog system for hypertensive users on their mobile phones. As a result, the analysis results along with the medical information of each of the users are getting compiled and stored on the cloud-storage for the purpose of sharing the patient information with the doctors, relatives of the patient and the clinic providing the treatment. Then the fog layer generated temporal information is then deployed for providing the necessary precautionary measures and suggestions upon the wellness of the patients. The results of the experiment reveal that the framework hence proposed shows a low response time, high value of bandwidth efficiency and high accuracy.

KEYWORDS: Internet of Things, Hypertension,Artificial Neural Network, Fog-Cloud Computing

I. INTRODUCTION

Hypertension or high blood pressure is often referred to as the condition in which there is a long term force of the blood as flowing against the artery walls which results in heart diseases(Sarnak *et al.*, 2003). The amount of heart pumped blood and the resistance exerted to the blood flowing in the arteries contributes the blood pressure(Ellwein *et al.*, 2008). The higher the amount pumped by the heart, the higher will be the blood pressure(Knowlton and Starling, 1912). It is infact given by the unit of mercury in millimetres (mm Hg). It is commonly represented by two values(Gillmann*et al.*, 2021). The first one is the systolic pressure and the other one is the diastolic pressure(Cushman *et al.*, 2002). The systolic pressure represents the pressure arising out ofthe arteries when the heart beats(Patterson, Piper and Starling, 1914). While, the diastolic pressure is the pressure arising out of the arteries between the time-period of heart beat(Cournand *et al.*, 1947). Hypertension or the high blood pressure can silently take hold of the roots on the body for years without showing any symptoms(Test *et al.*, 2016). It can even lead to heart attack and stroke at times. The Internet of Things based healthcare systems are currently used in various domains especially with the addition of the medical sensors data which get stored over the cloud for analysis and compilation purposes. A fog computing platform basically runs upon the proximity of users enabling new Internet of Things (IoT) delivering services with reference to

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computing, storage and control at various scales of needs to be met by the end users. The proposed Internet of Things Fog based model helps in the identification and control of the hypertension attack at an early.

II. REVIEW OF LITERATURE

Many researchers worked on the influence of IoT devices and healthcare. The researchers have developed several models for the purpose of monitoring patients with Hypertension through the means of IoTs. A system of Hypertension or Blood Pressure monitoring system was proposed by Jiang et al which was called icareSHU(Jiang *et al.*, 2010). The Blood Pressure readings are measured in the system by wearable which transmits the data across the data server which are monitored by the healthcare professionals. The paper provides the idea of immediate feedback but the transmission channel is yet to be explored. Later in 2012, an internet based survey towards the self-monitoring of blood pressure was studied by Mcmanus(McManus *et al.*, 2014). The survey was providing insights into the issues faced but not the apparent steps to be taken. Mellilo et al. who researched the area, worked on a platform which was designed and validated for the automatic analysing of biomedical signals for the assessment of risks in the case of vascular events and the falls in the case of patients who are hypertensive(Melillo *et al.*, 2015). The study investigated the platform with a better accuracy but a better analysis of the signals would have been proved beneficial. Vilaplana et al. studied the hypertension patient monitoring methods and proposed a control application for patients which was cloud based. This enhanced the sending of sms or email of the hypertensive patient information to the cloud data center(Vilaplana*et al.*, 2015).This helped the monitoring of paitents in real time but requires much more technical feasibility for the same. Zhou et al. is another researcher who focussed on the health care system on cloud(Zhou *et al.*, 2019). His work also focussed on cloud computing and mobile internet. The study offered a system with powerful computing service providing the blood pressure status of the patients but the monitoring levels are to be done with more accuracy. Hypertension of patients was analysed by Fernandez et al. in the year 2017 focussing on the detection of weaknesses(Ruiz-Fernández*et al.*, 2017). The study developed an architecture comprising of the IoTsensors . The study provided the deployment of all sensors but more working of the sensors is essential for the output generation of the user. The above research works used in the study deployed the IoT based sensors which consider real time decision making and applies fog computing for the purpose of patient monitoring. Along with this, the studies provide a comparative analysis too which is deployed in the study withrespect to RTP, PM, CS and FC.

III. PROPOSED SYSTEM

The proposed system consists of three main subsystems. The systems are:

- IoT based user sub-system
- Health Fog Sub-system or Smart gateway
- Cloud sub-system

The framework of the proposed system is shown in figure 1.

Procedure

- The user sub-system employed deploys several devices of IoT and sensors for monitoring the parameters in a manner.
- For the purpose of real time processing and diagnosis, the data hence accumulated is transmitted to the health fog subsystem.
- Upon the diagnosis of the disease, an alert message is generated by thesystem over the phone aimed at the action of precautionary measure.
- Simultaneously, the results get stored in the cloud for realtime analysis and compilation of the same medical information with respect to each of the patients providing an easy accessibility to the concerned staffs and the related healthcare professionals.

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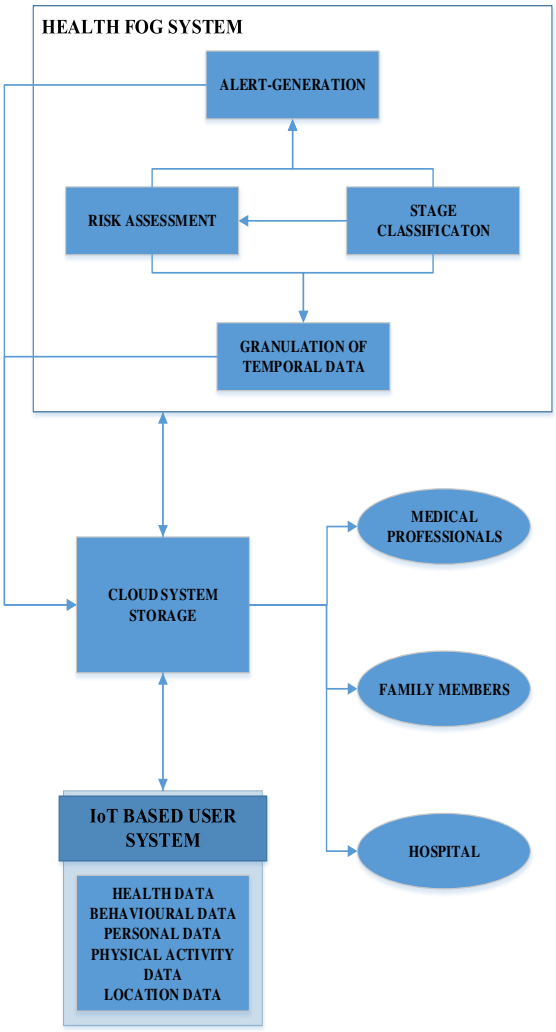

Figure 1: Framework of the proposed system

The classification response time with and without granulation is shown in figure 2.

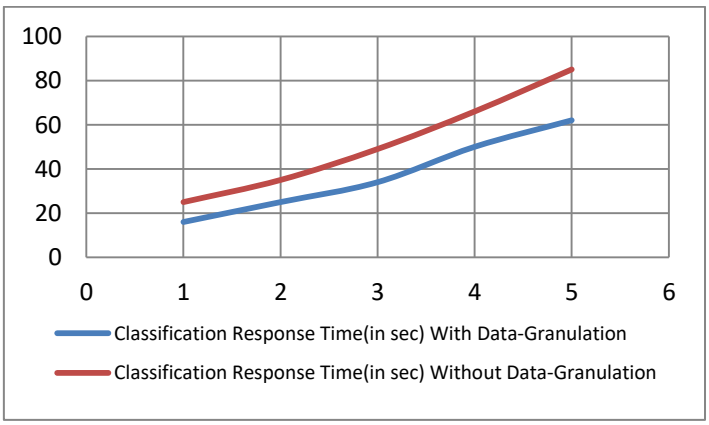

Figure 2: Classification Response Time with and without data-granulation

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IV. RESULTS AND EVALUATION

The variation between the various parameters is represented in percentage as shown in the figure 3.

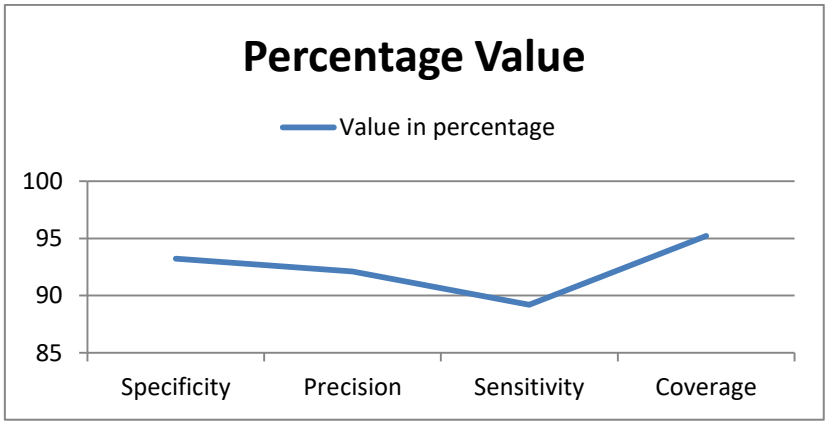

Figure 3: Variation of Parameter values

The values of the statistical parameters as a result are shown in table 1.

Table 1 The values of the statistical parameters in percentage.

Statistical Parameter	% Values
Root Average Square Error	2.23
Relative Absolute Error	5.68
Mean Absolute Error	3.98
Root Relative Square Error	32.4

The efficiency of the delay time is represented in the figure 4. The figure represents the variation of the delaytime in the case of Fog monitoring, cloud monitoring and manual monitoring based alert.

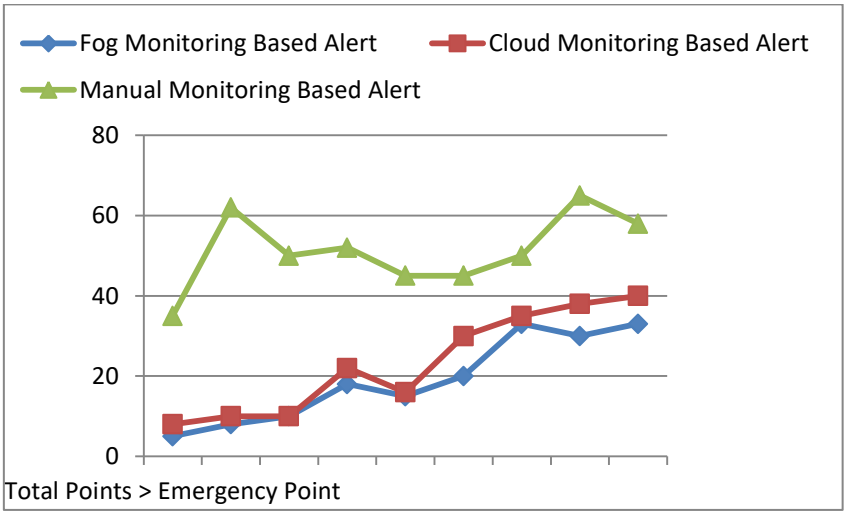

Figure 4 Efficiency of Delay Time

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The system is monitored for the determination of the efficiency of the alerts generated. Different parameters like specificity, coverage, root average square error, sensitivity, precision, root relative square error etc. are examined in the system proposed. The values are represented in the form of tables and graphs.

V. CONCLUSION

One of the major issues faced by the majority of the nations across the world is high blood pressure. The high mortality rate due to most of the cardiovascular diseases arises from the reason of High Blood Pressure in most of the cases. Many government agencies concentrate on the same. With the invention of the IoT devices, there is a widespread development across this area proving it to offer real time monitoring of the same. This enables the easy identification of the risk arising out of the concerned hypertension enabling an easy access to the early risk prevention measures. In the study, an IoT Fog based healthcare monitoring system is proposed for the monitoring of the same. The continuous changes in the blood pressure rate is sent as an alert to the user via mobile phone. The results which get stored on the cloud with the experts of the corresponding domain are later analysed and compiled for each of the users and the suggestions are delivered to the concerned person on time. The experimental results upon comparison with the cloud computing technology reveal that the current framework offers better efficiency incase of various parameters including that of bandwidth, higher accuracy in response time and minimum delay.

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