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ABSTRACT

Technological advancement has shown incremental growth in each and every field from communication to healthcare. It made our lives easier and comfortable. One of the outcomes of technology revolution that proved as a boon to mankind is Internet of Things enabled Wearables. IoT wearables are the smart Internet enabled devices that can send data recorded from the human body for proper health monitoring and analysis. Benefits of this connected device driven technology will serve the purpose of both doctors and patients. It becomes possible to get accurate diagnosis and right treatment at the right place without wasting time and efforts. This research paper will focus a light on various IoT wearable devices for healthcare discussed in literature and also study the working of Wearable devices with their weaknesses.

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Technological advancement has shown incremental growth in each and every field from communication to healthcare. It made our lives easier and comfortable. One of the outcomes of technology revolution that proved as a boon to mankind is Internet of Things enabled Wearables. IoT wearables are the smart Internet enabled devices that can send data recorded from the human body for proper health monitoring and analysis. Benefits of this connected device driven technology will serve the purpose of both doctors and patients. It becomes possible to get accurate diagnosis and right treatment at the right place without wasting time and efforts. This research paper will focus a light on various IoT wearable devices for healthcare discussed in literature and also study the working of Wearable devices with their weaknesses.

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I. INTRODUCTION

Health is important for every human being. In case of illness, it is equally important to get prompt and appropriate treatment. In sudden critical situations or medical emergencies, it becomes impossible to take patients to hospital for diagnosis followed by course of treatment. Even the hospitalization cost is expensive.

Internet of Things enabled wearable devices are a much-needed solution to get health information remotely. The world is changing fast with the

growth and evolution of IoT Technologies. With IoT, Medical Practitioners can continuously monitor the health condition of patients under their treatment and take necessary action whenever required.

Internet of Things are the hardware devices that communicate over the Internet through processors, sensors and actuators [1]. Healthcare applications are providing medical services at remote places with improved accessibility and reduced cost [2]. IoT based healthcare devices provide automated disease monitoring, predictions and treatment [3]. This automated interconnected system not only helps to get fast access to patient data but also to provide accurate diagnosis and treatment by medical practitioners.

In recent times, IoT sensors have shown their applications in early detection of illness based on physical factors such as blood pressure, heart rate, oxygen level etc. [4]. This paper reviews various existing IoT wearables used in healthcare, further it explains the working of connected devices for gathering data. This paper focuses light on future challenges for researchers who want to develop IoT devices for detection of illness not detected yet.

The structure of this paper is as follows: Section 2 highlights the review method, Section 3 emphasis on various IoT devices in healthcare and sensors used to detect and predict early stages of illness based on data gathered from the human body. Section 4 focuses on future challenges in development of patient specific customized IoT wearable devices. Finally, section 5 concludes the paper with conclusion.

II. LITERATURE REVIEW METHODOLOGY

The method of systematic Literature review started with searching keywords: IoT, Wearable Technology, Healthcare, sensors, disease detection. The search strings used for finding related literature are “IoT wearable Technology”, “IoT wearable devices in Healthcare”, “Disease detection using Wearable sensors”. For reliability of published content, the search was carried out

using reliable sources like Google Scholar, Springer, IEEE Xplore, Science Direct. The journal articles and research papers published in the recent 4 years were considered for study. The relevance and applicability of content were the factors used for filtering publications. The process of filtering results in: published in 2019(4 papers), published in 2020 (3 papers), published in 2021(8 Papers) , published in 2022(1 paper).

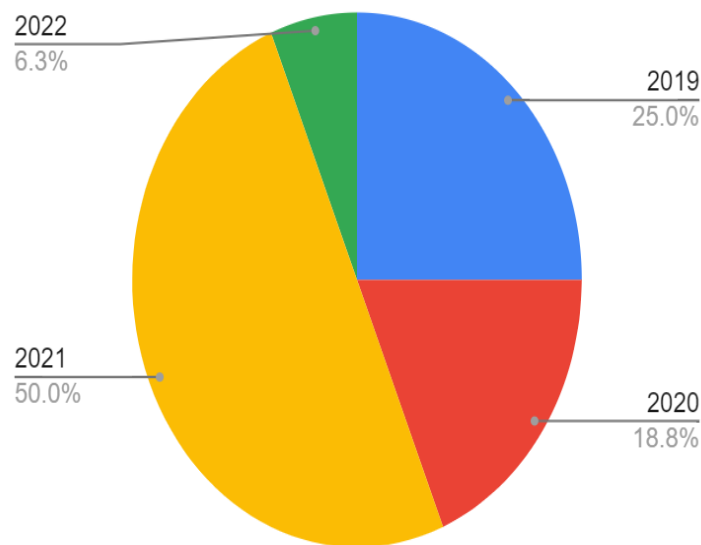


Fig. 1: Related Papers Reviewed between 2019-2022

III. STUDY OF IOT WEARABLE DEVICES AND SENSORS

3.1 Devices

The first wireless wearable device, a Webcam was invented by Steve Mann, a Canadian Researcher in 1994. Since 1994 a Technology revolution took place on a large scale which gave birth to Internet of Things enabled devices. This technology influenced many fields including healthcare. In the healthcare domain, wearable technology becomes a much-needed solution. Below part focused on various disease specific devices:

(i) *Smart Heart Disease Prediction [5]*: This paper proposed a smart Edge-Fog-Cloud integrated wearable device for accurately predicting chronic Heart Disease. Heart features were extracted through signals for continuous monitoring and detection.

(ii) *Novel Smart Watch Care Up [6]*: According to WHO about 46% of adults suffering from hypertension are unaware of disease conditions. This paper proposed a smart watch for calculating blood pressure in real time using Photoplethysmogram. Two Oximeters installed with the device take the signal to identify the time delay in pulse count.

(iii) *Parkinson [7]*: This paper suggested a system based on wearable sensors and Artificial Intelligence to avoid misdiagnosis of Parkinson disease. Movement data of individuals are recorded with sensors which helps in detecting neurodegenerative disorders accurately.

(iv) *Blood Glucose Monitor [8]*. This paper proposed an IoT enabled E-Healthcare system with wearable Technology. These devices can be worn or implanted in the body for remote monitoring of critical illness. This paper suggested

a sensor based implantable device to be implanted in abdominal tissue for tracking blood glucose sugar.

(v) *Elderly care [9]*: This paper presents a review of different solutions used for elder care. With the growing age, old age people need more attention and care. In such situations IoT wearable devices are helpful to individuals as well as for caregivers. Paper focuses on effectiveness, accessibility and accuracy of devices.

(vi) *Sweat Sensor [10][17]*: The study presented in Literature states that sweat can be used as an alternative body fluid as its contents are similar to Blood, Urine and Saliva. Sweat was considered to be an important measure to detect electrolyte imbalance. An IoT enabled wearable device was used to study the composition and concentration of Sweat released from the human body during exercise.

Beside these chronic disease detections, there are many uses of IoT wearables in healthcare [11]. IoT healthcare applications use devices like Remote Patient Monitoring, Mood Monitoring, Connected contact lenses, Robotic surgery, sleep quality etc.

3.2 Sensors

This paper presented a review of past literature studied on IoT, E-health and healthcare. Two

types of sensors highlighted were Wearable and Environmental. Various sensors studied in the review are:

1. Galvanic skin response (GSR) system: To detect physiological activities.
2. Smartphones and Wrist band: To collect real time data.
3. Portable ECG: To detect long term Electrocardiogram.
4. Wearable Body Area Network (WBAN): To measure body temperature and heartbeats.
5. Fog based sensors: For remote sensing
6. SPHERE- A smart home application: To monitor people at their living places.

3.3 Communication Technology [13]

The four commonly used communication Technologies for Sensors are ZigBee, LoRaWAN, WI-FI and Bluetooth. These are the most popular wireless communication protocols used for retrieving data from remote sensors. LoRaWAN is applicable in long range communication whereas ZigBee, Wi-Fi and Bluetooth are applicable in short range communication. Data transmission rate is higher in LoRaWAN as compared to other three technologies.

3.4 Overview of IoT Architecture [14]

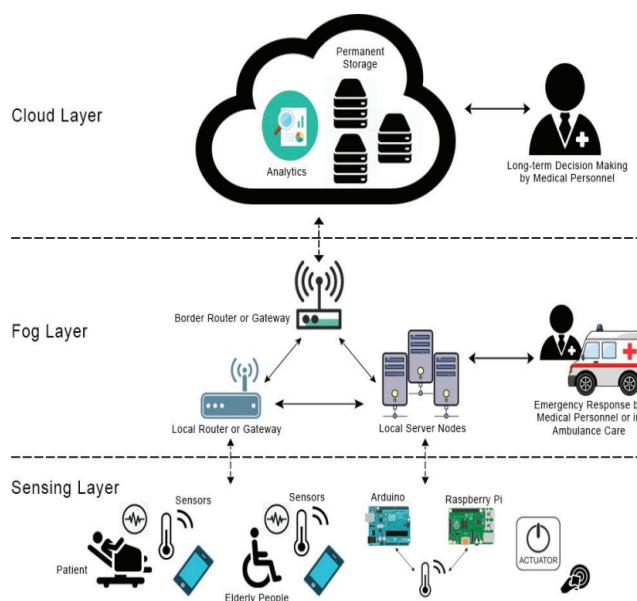


Fig 2: Architecture of IoT Wearables for Healthcare [14]

Above figure shows the layered architecture of IoT wearables discussed by many researchers in their work. The architecture consists of Sensors, communication technologies, Open-source platforms and Gateways. The sensing layer senses the data through Wearables. Data obtained from sensors is passed to the Fog/Edge system through gateways and routers. Analysis of data takes place at the cloud layer. The outcome of data analysis is sent to mobile applications which are used for remote sensing.

VI. CHALLENGES IN DEVELOPMENT OF IOT WEARABLES [15][16]

The rapid growth of Information and Communication Technology generates the scope for improvement in existing wearable technologies. Development of IoT based wearable devices specific to healthcare need to face challenges related to data sensing, data processing, data security and privacy.

The customization of Wearable devices is yet another challenge for future IoT development. There is a need to design more sensors that directly take crucial parameters from the human body. More accurate data collection and processing is required for healthcare specific to elderly care.

V. CONCLUSION

With this survey paper we found that IoT-enabled healthcare devices can improve the remote monitoring of patients, more specifically the elderly people and people receding in old age homes or day care facilities. For the growing population of senior citizens all over the world, IoT wearable devices are a very helpful solution. These sensor-based devices are beneficial for detection of severe illnesses like heart attack, asthma, Parkinson, diabetes, depression, blood pressure and so on. In Spite of many challenges, IoT researchers and developers will definitely find their path in the development of more accurate and customized sensor based IoT based healthcare devices.

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