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Monitoring In-House Patients During Pandemic using Internet of Things

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***Abstract*: There is a worldwide issue that has increased the number of patients at hospitals, especially as a result of the pandemic. It is difficult for the survivors to attend routine checkups after their surgeries. Our model is helpful to solve the problem. Internet of things (IoT) arrives as a modern technical model, presenting communication and scalability, to clean this challenge. The wireless body space community is gaining quality for IoT related valuable resource packages as wearable devices enter the market. The aim of this paper is to expand the network by incorporating wearable and unobtrusive sensors to track far-flung patients after their surgeries and to receive direct assistance from doctors during an emergency.**

***Keywords*: Internet of Things, Wireless Body Space Community, Pandemic, Scalability, Wearable and Unobtrusive Sensors.**

I. INTRODUCTION

There may be an emerging movement in the scientific field to reduce the need for hospitalization by moving some exercise treatment procedures from hospitals (health facility-centric) to patients' homes home-centric [1] [2].This technique has gained popularity due to its ability to improve patient well-being and care efficacy across a wide range of health problems [3]- [5]. It can also reduce the costs of the global public exercise device and its performance, which has been threatened in the last decade by the aging population and the growth of chronic diseases [6] [7].There may be an emerging movement in the scientific field to reduce the need for hospitalization by moving some exercise treatment procedures from hospitals (health facility-centric) to patients' homes (home-centric) [1] [2].

This technique has gained popularity due to its ability to improve patient well-being and care efficacy across a wide range of health problems [3] [5]. It can also reduce the costs of the global public exercise device and its performance, which has been threatened in the last decade by the aging population and the growth of chronic diseases [6] [7]. Furthermore, the latest COVID-19 epidemic has highlighted the significance of spontaneously scaling the exercise device and keeping domestic patients who are at high risk but not severe enough to be hospitalized [8]. IoT provides the scalability needed for this function, allowing for continuous and accurate health surveillance on a global scale.

This model is rapidly becoming a pivotal epoch in healthcare [9]. As a result, the aim of this paper is to expand the platform proposed in [12] [13], which was originally developed for pandemic-related ICU bed persistence, by incorporating wearable and unobtrusive sensors to track patients.

This builds on the authors' previous work from [14] by realizing the concept and architecture for healthcare applications for patients who have undergone surgery who need continuous monitoring during the pandemic. We demonstrate how wearable and unobtrusive sensors may be integrated into the proposed framework and used to obtain and process patient data in order to facilitate rapid treatments whilst preventing contagion among medical team members and inflamed patients.

Barroca and Aquino [15] presented on the Systematic literature evaluations approach [16]. Its aim become to realize the contemporary kingdom and future developments in IoT-based healthcare applications. thus, the research questions that addressed the overview have been related to the primary characteristics (requirements), protocols, challenges, and opportunities associated with these programs. Regarding the main characteristics of these applications, we collected their functional and non-functional requirements from the studies. Therefore, the requirements described in the papers are the patient's body and environment monitoring. The electrodes mounted to the patient's body (body monitoring) are the pulse oximeter, heart rate, galvanic skin, transpiration, muscle function, body temperature, oxygen saturation, blood pressure, airflow, body movement, blood glucose, respiratory rate, and ECG [11] [17] [22].

Sensors placed in the patient's atmosphere (environment monitoring) collect data on temperature, light, humidity, location, body posture, motion data, SPO2, ambient pressure, and CO2 [23][26]. Scalability, reliability, ubiquity, portability, interoperability, robustness, performance, availability, safety, integrity, authentication, and protection are among the nonfunctional specifications listed in the papers [17] [18], [23] [26]. According to the research, there are various challenges associated with IoT-based healthcare packages, such as records preservation and maintenance (e.g., physical storage issues, affordability, and upkeep), availability of heterogeneous sources, protection and privacy (e.g., permission management, data anonymity, and so on.), and unified and ubiquitous access location [27].

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Every other challenge is how to offer constant monitoring, particular sensing, interoperability, and how to make the whole system unobtrusive for patients. Mukherjee, S. K. Ghosh Buyya [28] proposed that a situation in which a sensing layer composed of numerous sensors like body temperature, coronary heart price, blood pressure may be used to degree crucial signs and symptoms of a patient. From that, this facts may be collected and turn out to be available to medical body of workers even at some point of the patient transfer in an ambulance. The main problem is how to provide this information whilst transferring. The authors in [29] endorse a fog-based totally framework to be able to provide actual-time task scheduling. the main trouble is the fact that some facts on healthcare is time sensitive. in order to cope with awesome conditions, the authors made use of a couple of traditional assignment scheduling algorithms such as Earliest closing Date First (EDF), Smallest Slack Time First (SSF) and Smallest Workload First (SWF). For each state of affairs, all algorithms were implemented so that it will look at the great one appropriate. The authors of proposed a novel approach for adaptable time-critical cloud systems in [30]. The papers demonstrate that the switch framework is capable of dealing with monitoring of offers through adaptive software, dynamic real-time planning, and Quality of Service applications while considering three time/critical bundles. According to Yang et al. [31], in the light of Industry 4.0, the therapeutic subarea has changed significantly as a result of additional technical support from these developing fields. This is referred to as Healthcare 4.0. This Healthcare four.0 encapsulates the idea of a paradigm change in design thinking around sensing, knowledge fusion, and data analysis. It is highly reliant on constant monitoring of human circumstances and verbal communication among systems. This concept provides a situation in which bodily Homecare mechanisms collide with Cyber Homecare networks. This includes IoT, big data, and cloud computing.

When it comes to sensing, it's critical to remember that sensors must have properties such as bendability, stretch ability, and ultra-sensitivity. Describe an IoT-primarily based system for remote patient control. These papers typically outline an IoT device layout based on three-layer modeling: a hardware module made up of some important sign sensors, a gateway layer in charge of gathering data, storing it, and making it accessible to the higher level, that is the software layer. Hassen, Ayati, and Hamdi [32] suggested a domestic hospitalization computer method. IOT, CLOUD, and FOG Computing are used in this framework. If you need to deal with relational database issues like truth heterogeneity, a NoSQL database may help. The authors anticipate a complete interface substitute based on this thought.

This undermines the case for a low-cost computer, as it might be less expensive than a system that supplements an already installed monitoring device. Among others who have contributed to this work are Ding et al. [33] Formalized paraphrase The paper's findings are divided into three major categories: I using wearable devices to detect population risk; ii) patient tracking through unobtrusive sensing; and iii) telehealth technology for remote monitoring. Outside of a hospital environment, the authors discuss the use of touch tracing era to achieve consistent virus transmission outcomes. This is also critical for remote physiological monitoring outside of hospitals for patients under quarantine at their homes. Ordinarily, this paper condenses various wearable unobtrusive detection solutions and provides a road map for multi parameter physiological surveillance using wearable and unobtrusive sensors for COVID-19 and other feasible pandemics. Stojanovi [34] developed a headset-like interface that can be used in conjunction with masks. This method will show the cost of breathing and warn consumers and scientific groups of staff about unsafe levels. Other works [35, 36] concentrate on monitoring using smart watches and provide information about location and signs and symptoms to assist not only diagnose but also measure the degree of infection. Finally, to the best of our knowledge, we couldn't find any other articles that review related research on the expansion, development, and implementation of IoT technologies in far-flung patient surveillance following surgical procedures.

II. PROPOSING AN IOT-BASED HEALTHCARE PLATFORM

This section describes the IoT-based medical care level, including the theory that influenced its evolution, the strategy and prerequisites angles, entertainers, and use cases. It also clarifies the engineering of the stage in terms of its components, their relationships, divisions, and conventions.

2.1 Methodology

The following phases were used to build this project: Cutting Edge, Requirement Analysis, Software Innovation Strategy, Software Advancement, Software Testing, and Implementation.

Over the course of the state-of-the-workmanship review, we conducted and refreshed an audit in order to comprehend the current state and potential trends for IoT-based medical services applications and identify areas for additional inspections. It was possible to determine the fundamental characteristics, utilitarian prerequisites, efficiency credits, and nonfunctional prerequisites, difficulties, and chances of these applications using this review.

The first is the Cutting edge analysis: It was difficult for us to incorporate it in vast quantities, so we then found a few cutting-edge architectures in order to do better. Furthermore, we identified which systems to use that fulfill the prerequisites of our model in the reference architecture for IoT-based Health Care Applications (RAH) [13, 14]. The second is the requirement analysis: The audit findings are presented in Section II. We created a prerequisites record containing realistic and nonfunctional specifications of our model during the Requirement investigation phase.

In the Software design phase, we considers various layout and languages to use. In the Software development process, we coded the product primarily in Java and XML and based on the expected programming engineering. We conducted programming testing using white and black box, regression, and unit tests during the Software testing process. The overall working methodology of the proposed project are displayed using figure 1.

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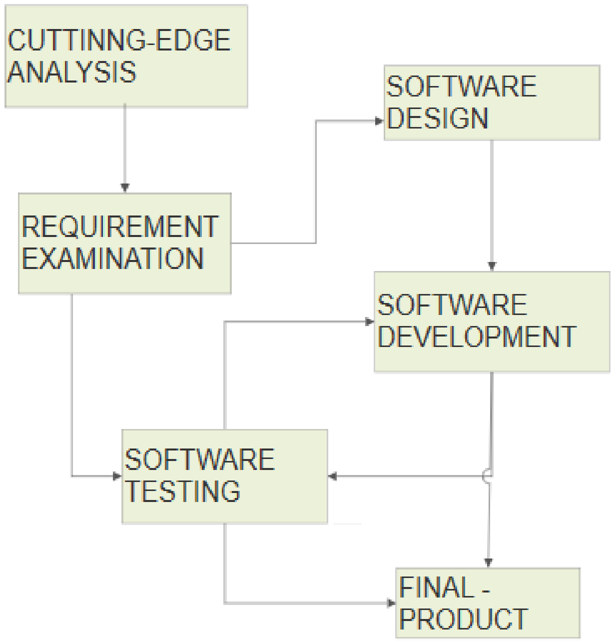

Fig. 1. Overall working methodology of the proposed project

2.2 Design Issues and Requirements

Our primary goal is to design an IoT-Based Remote Monitoring Medical Care System (IoT-MCS) is to monitor the patients after surgery during the pandemic. This IoT-MCS includes patients and doctors to advance improved consideration and quick preventive and sensitive pressing practices. It addresses issues such as interoperability, security, overall efficiency, and availability. In terms of specifications, this software has remote affected individual and environment control, as well as emergency and crisis response.

Monitoring a remote infected individual and their environment entails collecting sensor data connected to the patient's body at their respective homes. The data collected is invaluable for nurses to keep an eye on things at their door, as well as for doctors to make fast decisions during emergency situations. As a result, the electrodes attached to the patient's body provide data on heartbeat, blood pressure, and temperature. In extreme cases, we have attached another temperature sensor to monitor ambient conditions, as this is often needed. As a result, since the patient in critical condition is at home and not in a hospital, which is a more controlled environment, this ambient statistics is more important for powerful healthcare and enhances the remote surveillance offered by this platform.

Finally, emergency response addresses details concerning the patient's health status and the facilities that must be notified in the event of an emergency involving a controlled affected individual in a critical state of affairs. Given that this patient is at home and not in a hospital, the effectiveness of a quick response in an emergency situation can be the difference between life and death. When the sensor values reach a certain level, a warning is sent to the doctor. In exchange, the operations to be performed will be sent to the patients as a standard text message. The overall working of IoT-Based Remote Monitoring Medical Care System (IoT-MCS) is displayed using figure 2.

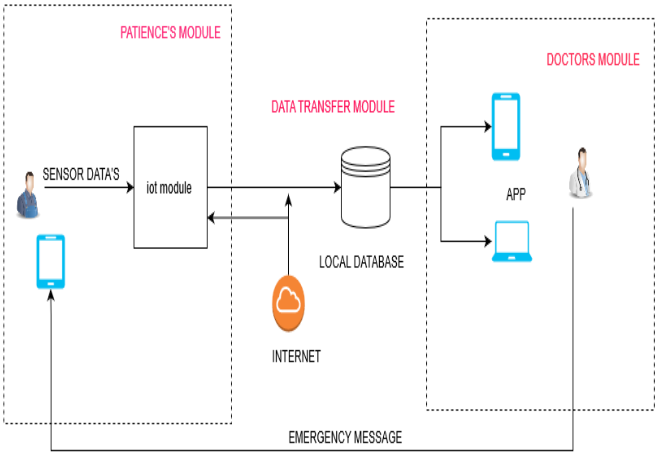

Fig. 2. IoT-Based Remote Monitoring Medical Care System (IoT-MCS)

III. IOT-MCS MODULE OVERVIEW

As seen in Figure 2, the IoT-MCS is divided into three sections: the affected patient module, data transfer module and the doctor module. These components address the solution's technical requirements and collaborate to achieve distant monitoring and efficient healthcare for patients after surgery. The staying power module contains electrodes that can be connected to the patient's body for continuous monitoring of their surgical operation. The sensors have information on their pulse, temperature, oxygen level, and blood pressure. The sensors will be altered based on the men and women's physical state and the surgical operation they've undergone. It also defines the basic security and critical efficiency of medical electric device scientific electric systems to be used in the home healthcare setting. This whole module is linked to the internet for data switch.

The data transmission module, which collects sensor data and sends it to the next stage of this module when it accumulates. Where data values are stored and sorted before being sent to the hospital module. The data transfer includes a view state, which is our interface. The software gathers all of the data from our online archive, sorts it, and displays it on our admin page, which in this case is a doctor's module. The data is organized and presented as discrete units over time.

The doctor's module is now accessible, allowing doctors to check on the condition of their patients. An occurrence occurs where there is a deviation in the values. The case sends a notification/alert to the doctor, telling him or her of the situation. Doctors can first determine the patient's health and, if necessary, write medications. The sent letter is sent as an SMS message to the patient's attendant's phone. Phone numbers and sensor positions may be listed during the initialization process. Figure 3 represents the module's data flow and overall operation.

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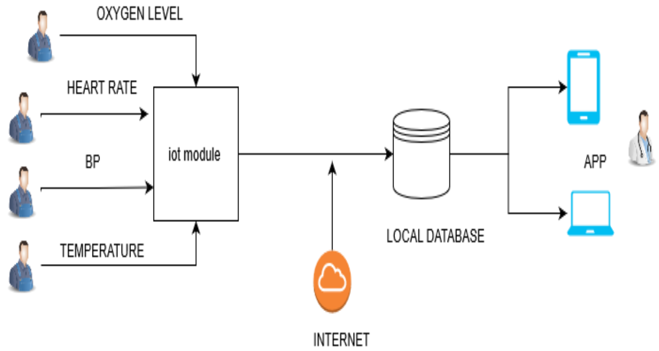

Fig.3 Module's data flow and overall operation.

IV. IMPLEMENTATION AND RESULT

As mentioned in the previous chapter, there are three modules, and the implantation specifics for each module are given below. Firstly, the patience's module, in which the sensors are connected to the patience's frame. As previously said, there are four sensors that can be considered. Figure 4 depicts the pin configuration for the whole rig. Four sensors are taken into account: spO2, heartbeat, blood pressure, and temperature. This module also has a wireless module for transferring statistics. The wireless module design may be completed at any point during the setup of the whole model in the environment.

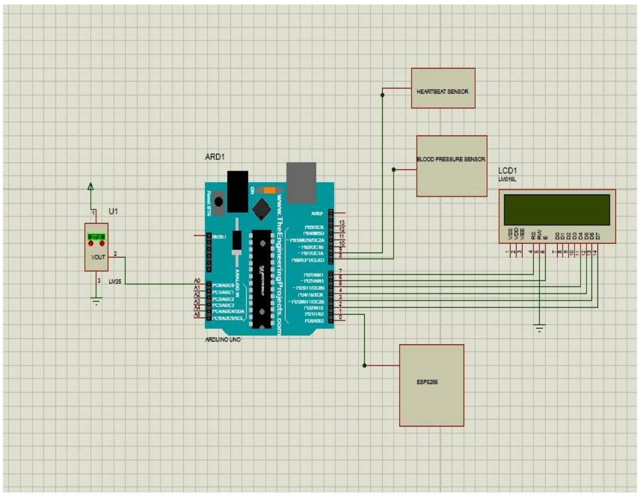

Fig. 4 Pin Configuration of IoT-MCS

The second module is the doctor's module, which is where the app comes in. This app connects to our web database and retrieves the values from there. Now, let's have a look at our software. The first configuration is the user login, which allows doctors to enter the app using their login credentials. The second layout is the data values; since it was only introduced on one patient, the data would be shown alongside the dates. In the third layout, a doctor will administer medicine to a patient in an emergency. The login credentials and value entered in the developed application is displayed using figure 5.

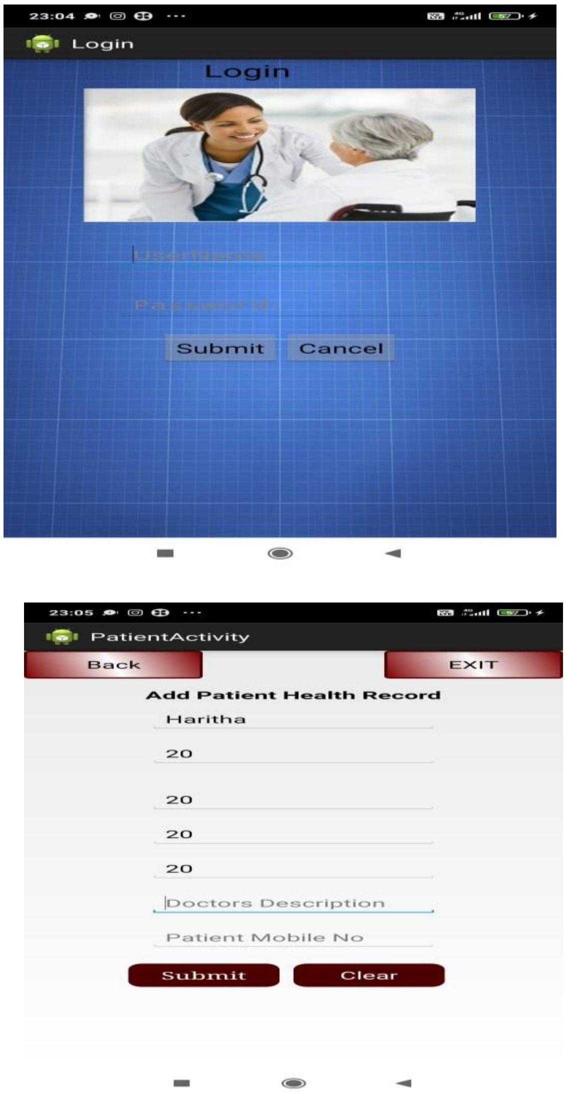

Fig. 5. Login Credentials and Value Entry in the Developed application

The third module is the records switch module, in which we store our values in an online archive. In this case, the net DB is called Go Daddy. The calculated data's are sent to the data base and stored in various id's the assistance of the Wi-Fi module. Figure 7 depicts the entire hardware installation.

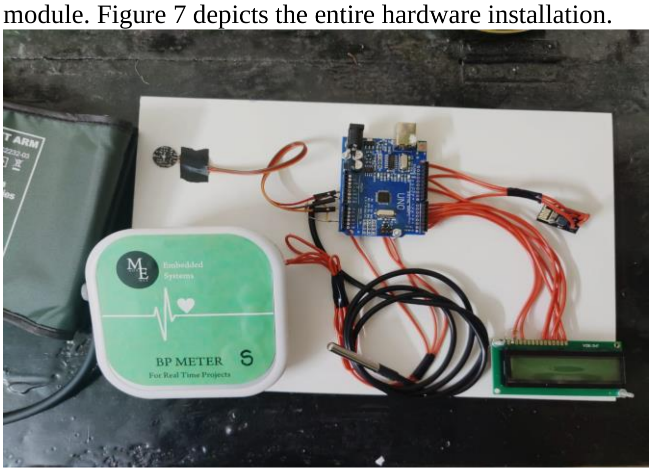

Fig. 7. Hardware Setup for IoT-MCS application

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As mentioned in previous modules, a few testing methods were also used to ensure that the whole model worked properly. Unit monitoring was performed to ensure that each component was operational. We checked to see if each layout in our app was running as planned, and we also installed an LCD on the hardware side to see if the sensors were working. Regression checking was carried out several times to ensure that it was in working order. Table 1 contains the values measured over time. Figure 8 depicts a schematic depiction of the values over time.

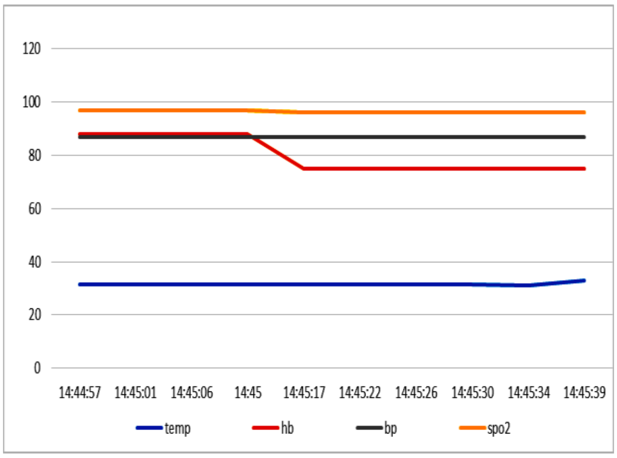

Fig. 8. Schematic depiction of the values over time.

Table 1. Monitored values over time

Time	**14:44:57**	**14:45:01**	**14:45:06**	**14:45:11**	**14:45:17**	**14:45:22**	**14:45:26**	**14:45:30**	**14:45:34**	**14:45:39**
Temp	31.56	31.5	31.44	31.37	31.37	31.37	31.31	31.31	**31.25**	**33**
HB	88	88	88	88	75	75	75	75	**75**	**75**
BP	87	87	87	87	87	87	87	87	**87**	**87**
SPO2	97	97	97	97	96	96	96	96	**96**	**96**

To determine the precision of the values calculated, a graph was drawn between the values measured by our model (IOT-MCS) and the values measured by a thermometer and a pulse oximeter. The data's where taken during different parts of the day (5 times). Figure 9 shows the graph marked between IOT-MCS and other devices to analyze the efficiency of our model with 95% correct.

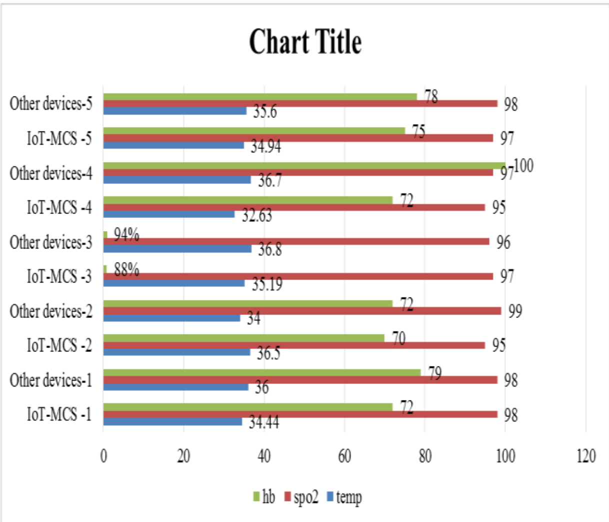

Fig. 9. Efficiency of the Proposed IoT-MCS model

	IOT-MCS-1	OTHER DEVICE-1	IOT-MCS-2	OTHER DEVICE-2	IOT-MCS-3	OTHER DEVICE-3	IOT-MCS-4	OTHER DEVICE-4	IOT-MCS-5	OTHER DEVICE-5
HB	72	79	70	72	88	94	72	100	75	78
SPO2	98	98	95	99	97	96	95	97	97	98
TEMP	34.44	36	36.5	34	35.19	36.8	32.63	36.7	34.94	35.6

V. CONCLUSION

This paper was expanded on previous studies on an IoT-based healthcare framework for monitoring patients in ICU beds during the pandemic outbreak. IoT-MCS solution is adequately adaptable to be used in situations including pervasive nonstop health surveillance with the assistance of unobtrusive gadgets this revel in provides a critical foundation for extending our strategy for various contexts including critical patient monitoring. We also have reported our experience in developing this project and also we would like to use this model in a real time environment. We hope that these findings will pique your interest in furthering research on this subject. As a result, we will progress toward filling the existing holes and shortcomings that are impeding the implementation of continuous health surveillance sponsored by unobtrusive sensors. Finally, in the future, we would like to add a machine learning algorithm to forecast solutions during emergency scenarios, as well as a cloud-based setup to make it more accurate.

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