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Design of a Telehealth System for Covid-19 Patients Using Internet of Things

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Abstract: IoT-based health monitoring systems lower frequent visits to hospitals and meetings between doctors and patients. However, patients suffering from chronic diseases require regular health observation by clinical staff. In this proposed work, I have taken advantage of the IoT technology to make patients' lives better for prior determination of disease and treatment. A smart vital monitoring system is being designed using Internet of Things (IoT) technology which can observe the pulse rate, oxygen level, blood pressure, and temperature of a patient. This framework is useful for country regions where close by clinics can be in contact with city medical clinics about their patient's health conditions. If any changes happen in a patient's health in view of standard qualities, the IoT framework will alarm the doctor or specialist accordingly. This patient's vital monitoring framework with the use of IoT assists medical specialists to gather patient's health information continuously. The accessibility of fast internet permits the framework to screen patients' vitals at regular intervals. This framework would also help in identifying and early treatment of COVID-19 patients. If the patient's heart rate or body temperature or body oxygen levels falls below standard values, then the IoT framework will alarm the doctor or specialist accordingly.

Keywords: Telehealth, Internet of Things (IoT), Remote Patient Monitoring, and E-Health

I. INTRODUCTION

The concept of telehealth emerged as a result of digitalization across the medical care industries with the utilization of mainly the Internet of Things (IoT), Artificial Intelligence (AI), data analytics, and accessibility of personalized health services. Internet of Things (IoT) is a rapid development technology that has the capability to use cloud computing and the ability to trade information to make quick decisions for the system requirements within a huge, connected network. The spread of the COVID-19 pandemic all over the planet has changed the regular routine of people to a great extent. Observing the health of COVID-19 infected patients in the wards is of big concern for healthcare providers. The diagnosis and anticipation of COVID-19 could be made with the backing of sensor technology combination with IoT with an AI algorithm for processing of health information of patients.

Challenges of COVID-19 can be minimized by using the Internet of things (IoT) based smart health monitoring framework. This might be wearable like smartwatches or could be smart sensors attached to the COVID-19 patients. A patient's vital signs can provide the status of a patient's health condition, this information could be analysed, and important inferences could be identified out of observation. The various vital signs that could be detected to identify COVID-19 include oxygen level, pulse rate, blood pressure, body temperature, and so forth. AI algorithms could be used to distinguish the COVID-19 patients out of a lot of information by comparing the health parameters, storing it on the cloud server, and providing secured access to this data to caregivers. An automated health monitoring system also can be developed that responds to or makes an alert in a critical situation for the patient.

II. RELATED WORK

The benefits given by Internet technologies have spread over numerous areas of the modern world. Bluetooth-enabled sensors and RFID labels allow us to make remote observation systems using wireless networks. With the rapid increase of research in smart wearable technologies, another innovation called the Internet of Medical Things (IoMT) has arisen. A few applications related to this innovation are remote patient observation, motion disorder detection, sleep monitoring, assessment of sickness level of a clinical risk level, and implantable sensors.

The existing framework in the industry comes with data acquisition and primary processing of physiologic boundaries. It additionally provides interfaces for remote and local patient information access. An outline of this model is introduced in Fig. 1

A patient observation system implements essentially ECG, temperature, Blood Pressure, and respiratory functionality. Normally, a ward patient needn't bother with all four vitals observed, which may cause an extra burden on resources (for

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example a patient conceded for a minor disease could require just temperature observation to recognize risk level). Subsequently, the monitoring system should be designed considering two main objectives - necessary vitals identification and flexibility.

These objectives are achieved by utilizing two sorts of devices: smart sensors and a gateway. A smart sensor screens a vital sign and patients can be attached with more than one sensor, as per their requirements (for example one pulse sensor and oximeter). The Gateway accumulates the information from these sensors and makes it accessible, through REST API services to the clinical staff. This model guarantees consistence with the IoT standards.

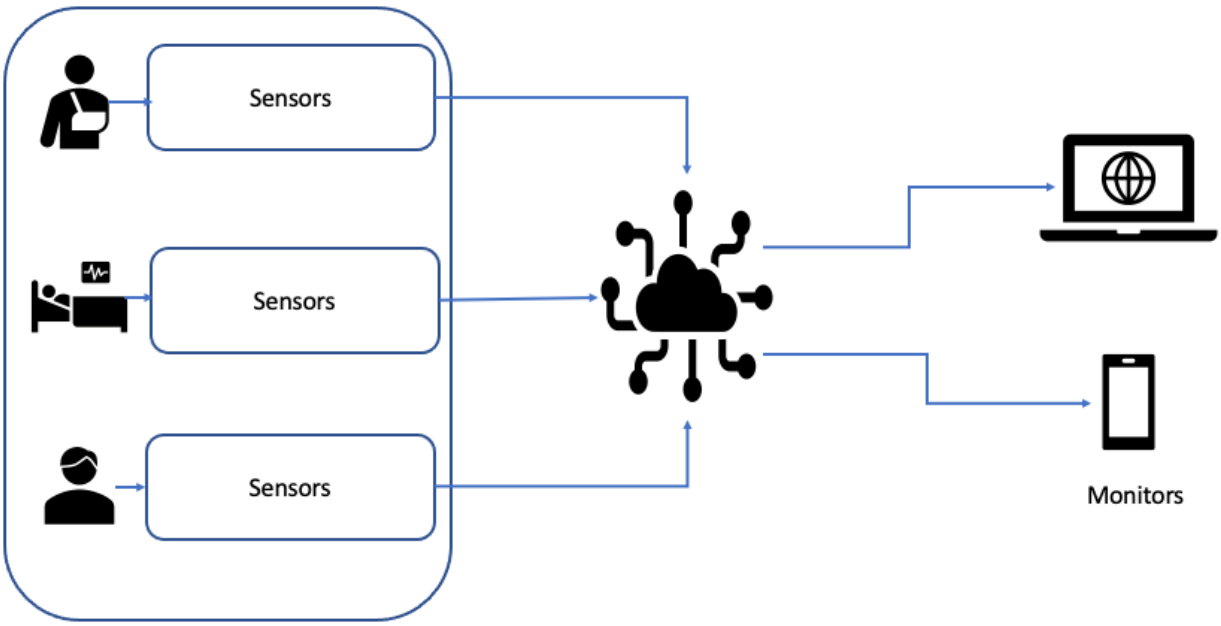

Fig. 1 General architecture of Patient Observation System

III. PROPOSED MODEL

The system comprises hardware components that are needed for the design of the prototype. These incorporate the IoT development kit with a built-in Analog to Digital converter (Azure MXChip IoT DevKit), temperature sensor, oximeter, heartbeat sensor, and blood pressure sensor. The COVID-19 disease initially enters through the nostrils and mouth and moves toward the respiratory system of a person. The Blood Pressure (BP) was viewed as high on account of COVID-19 patients, so monitoring of BP is one of the important vitals in detecting COVID. The oxygen level and temperature of COVID patients should be observed, which assists in monitoring the health status of COVID-19 patients. The oxygen level in COVID-contaminated people was viewed as decreased, so an oximeter is utilized to quantify the oxygen level in the people. Every one of the sensors is to relate to the microcontroller (Azure MXChip IoT DevKit), to record the information and convey it to the cloud for storing, processing, and distributing data to caregivers.

1. MXChip AZ3166 IoT DevKit:

The Microsoft Azure Certified IoT DevKit (IOT-AZ3166) is an all-in-one board enhanced for prototyping and creating Internet of Things (IoT) applications utilizing Microsoft Azure services. It comes up with an Arduino compatible board with rich peripherals, for example, sensors, OLED display, debugging chip (ST-Link), and security(encryption/description) chip. It can utilize Visual Studio Code with Arduino Extension to develop an IoT application that incorporates various services like Azure IoT Hub, cloud, and Cognitive Services.

2. Blood Pressure Sensor:

The Blood Pressure sensor is wrapped around the arm of the patient, and it generates three different vital information for the IoT board. These values are systolic, diastolic, and pulse rate and are fed to the IoT-AZ3166.

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3. Temperature Sensor: The MLX90614 is a contactless Infrared (IR) digital temperature sensor it is placed near the patient body and it detects the body temperature values and sends them to the IoT board. The MLX90614 comes up with 17-bit ADC, low noise amplifier, and a powerful DSP unit thus generating high accuracy of the thermometer.

4. Pulse Oximeter:

The MAX30102 is an integrated chip that comes up with oximetry and heart rate sensor modules. It incorporates a photograph detector, optimized optics, two LEDs, and a low-noise processor to identify heart rate and oxygen level signals.

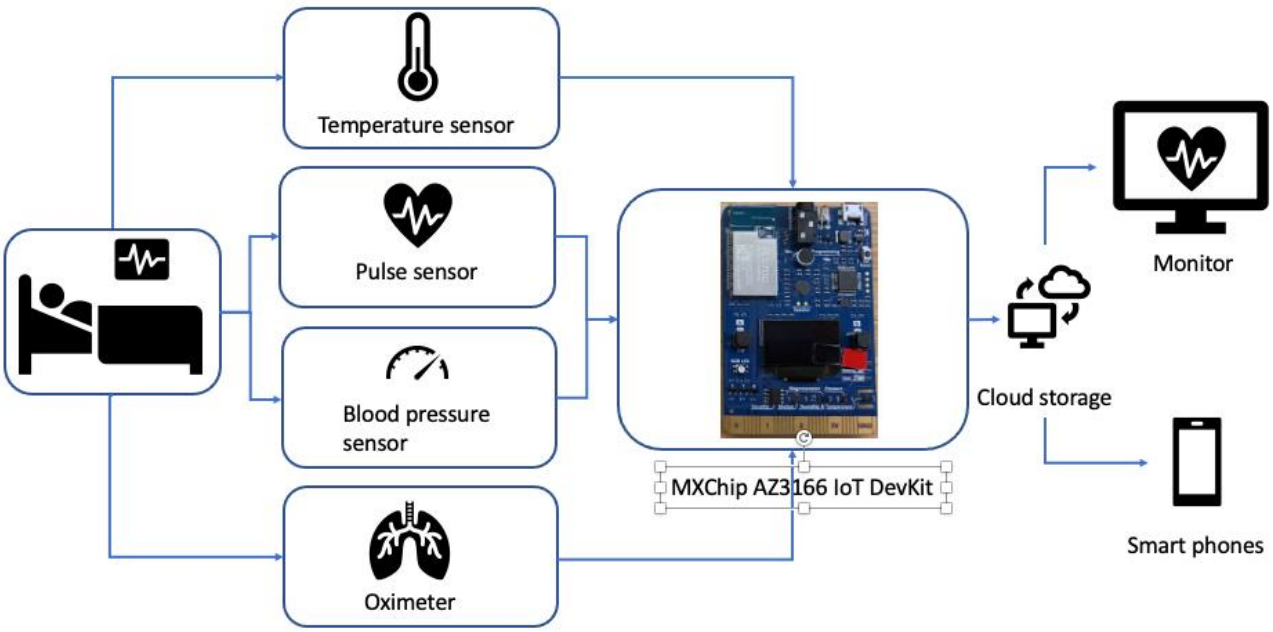

Fig. 2 Proposed design of IoT based Smart health monitoring system

IV. SYSTEM DESIGN

The proposed design consists of the three primary steps: vital data capturing, data processing followed by data storage, and sending patients' parameters to caregivers.

1. Data Capturing:

At first, the sensors which are to be used in our system relate to Microsoft Azure Certified IoT DevKit. The sensor outputs (i.e., Blood Pressure, Pulse rate, Oximeter, and temperature) are associated with the Input/Output pins of the IoT kit which have been configured as input information.

2. Data Processing and analyzation:

The output values of the sensors are received by the IoT kit, and it displays on the monitor and saves to the Azure cloud server for future records at the same time the required information will be sent to the caregivers for tracking the patient's health condition. The Artificial Intelligence (AI) algorithm that runs the IoT kit processes these values by comparing this data with standard parameters.

3. Alerting caregiver:

If any of the vital values exceeds the threshold value of the vital sign, an alert will be sent to the caregiver. The caregiver will access the patient vitals report and took a decision on further treatment.

V. CONCLUSION

The proposed IoT-based health monitoring design doesn't provide any solution for treatment or prevention of Covid-19, but it might give ease to the health providers to get the patients' vital data on their mobiles or tabs or monitors at their place. Medical specialists can identify the vital information of the specific patient regarding the standard values with the

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present one. Along with the information stored on the cloud, the Internet of things additionally gives potential chances to add advanced features like adding more biomedical sensors to this framework. Subsequently, the innovation of IoT makes this monitoring framework more adaptable and more updatable in the future. In this proposed work, I have taken advantage of innovation to make patients' lives more flexible for covid diagnosis and give the right treatment to patients by monitoring an individual's pulse, temperature, oxygen level, and Blood Pressure.

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