INDUSTRIAL WORKERS HEALTH AND SAFETY SYSTEM BASED ON IOT

A PROJECT

Submitted by

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Project Report Format

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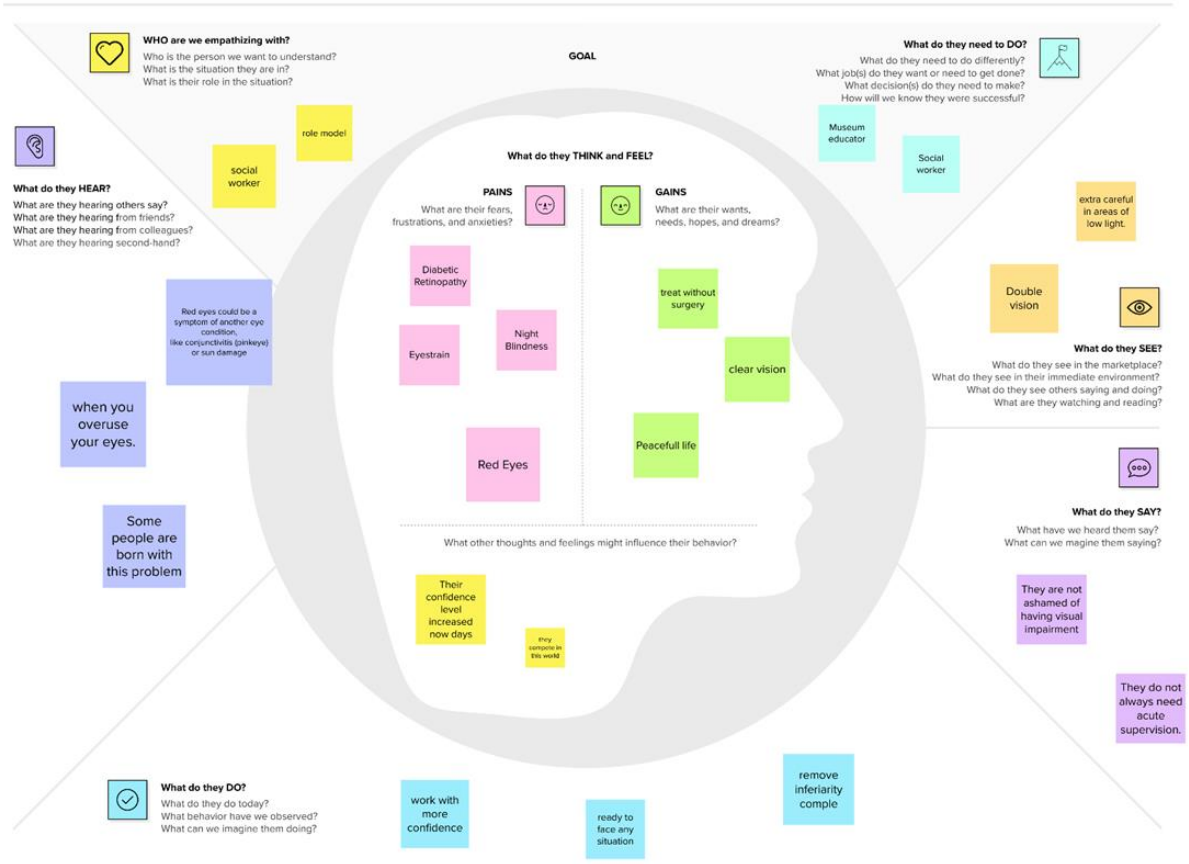
ABSTRACT

This paper presents a hybrid wearable sensor network system towards the Internet of Things (IoT) connected safety and health monitoring applications. The system is aimed at improving safety in the outdoor workplace. The proposed system consists of a wearable body area network(WBAN) to collect user data and a low-power wide-area network (LPWAN) to connect the WBAN with the Internet. The wearable sensors in the WBAN are exerted to measure the environmental conditions around the subject using a Safe Node and monitor the vital signs of the subject using a Health Node. A standalone local server (gateway), which can process the raw sensor signals, display the environmental and physiological data, and trigger an alert if any emergency circumstanceis detected, is designed within the proposed network. To connect the gateway with the Internet, an IoT cloud server is implemented to provide more functionalities, such as web monitoring and mobile applications

Introduction

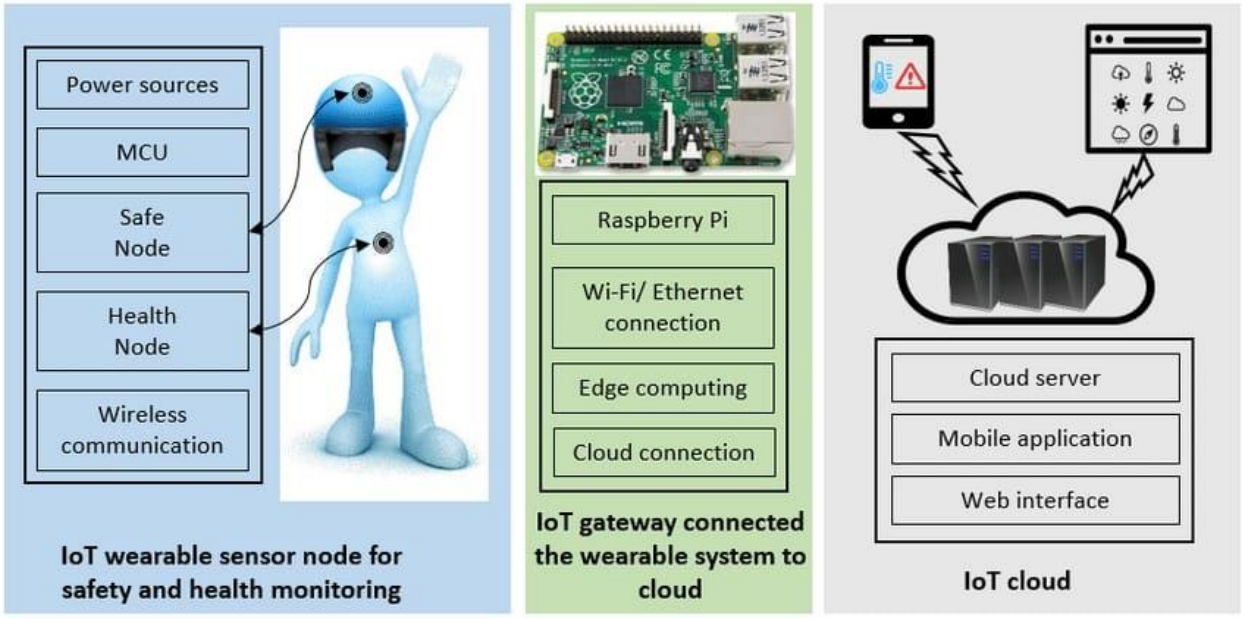
The Internet of Things (IoT) has become one of the most powerful communication para diagrams and attracted many research interests in the 21st century [1,2]. It can connect numerous objects, such as sensors, vehicles, houses, and appliances, together to the Internet, which allows users to share information, data and resources. The emergence of IoT has made it a key component in the environmental monitoring and health-care applications. For example, wireless sensors can be deployed in various locations to monitor environmental conditions [3], and wearable sensors can be attached to the subjects' body to measure physiological status [2]. Those data can be transmitted to a cloud infrastructure and presented to the targeted users. However, the existing works mainly focus eitheron environmental or health-care monitoring applications. There is a lack of such a system which can measure both of them and provide invaluable information about environmental and physiological data at the same time. Wearable sensor nodes are generally deployed inside a wearable body area network (WBAN) to monitor physiological signals, such as the heart rate (HR), respiration rate (RR), electrocardiography(ECG), body temperature, body position, and blood pressure (BP) [2,4–6]. In addition to medical applications, WBAN can also be used to monitor environmental conditions around people [7,8]. Such applications can provide useful information for users to gain a deeper understanding of their surroundings, especially for safety-related applications. For instance, in a construction site, workers' safety and health are always a major concern in the industry

Empathy Map

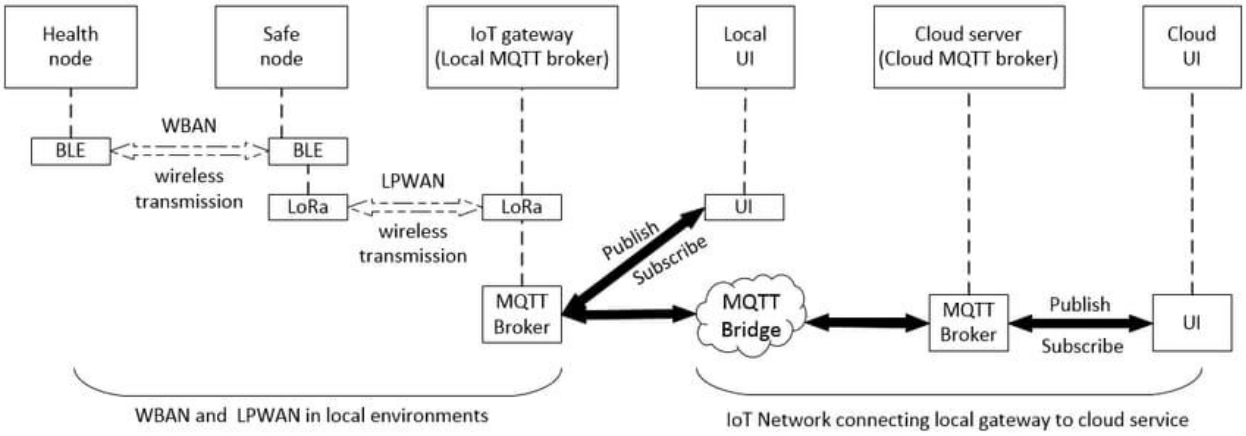


Block Diagram

The system's structure is depicted in Figure 1. Here, patients will measure their pulse rate and SpO2 using the max30100 sensor and body temperature using the Lm35 sensor, and patients can see measurement data in the mobile app and LCD display. The data will be shown in the mobile app with the help of a Bluetooth module that will receive data from the Arduino and save it in the cloud. From there, the data will be transferred into the mobile application, and the patients can view the measurement of the health parameters. After measuring the physiological vital data of the human body, it will be sent to the Arduino UNO, which will process the analog data into digital. After that, the data via Bluetooth module will appear on the mobile application. Measured data from the human body can be seen on the LCD display as well.



System architecture

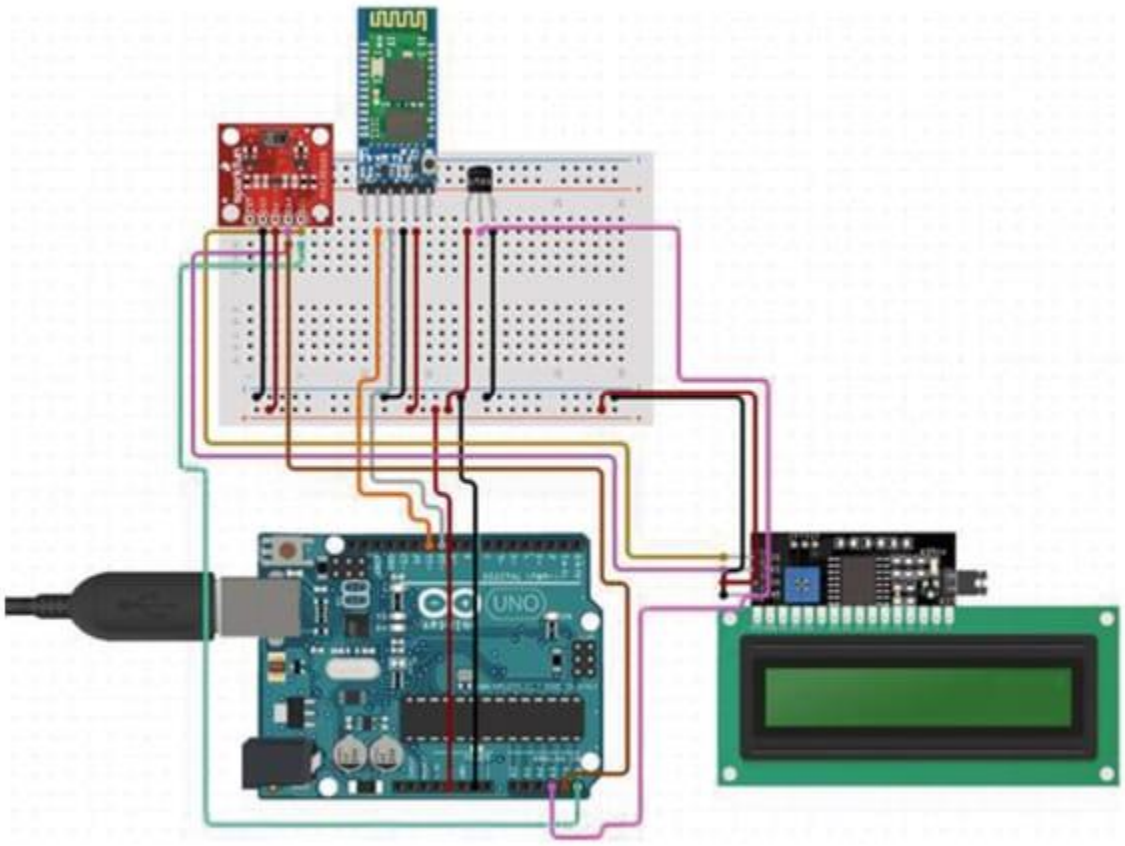


Network implementation

Hardware Design

This health monitoring system consists of sensors and a microcontroller. We used the Arduino Uno as the

microcontroller, and the sensors are MAX30100 (pulse rate and SPo2 measurement sensor) and LM35 (body temperature measurement sensor). And there are more components we are using, such as an HC-05 (Bluetooth module), to connect the Arduino with the mobile application and LCD display.



Arduino microcontroller

Advantages of IoT in Healthcare

The overall importance of healthcare software solutions is difficult to overestimate as technology promises to make healthcare services more effective and alleviate the burden placed on healthcare providers. This is critical in the context of the aging population and the increase in the number of chronic diseases.

The main advantages of IoT implementation in healthcare:

Remote monitoring: Real-time remote monitoring via connected IoT devices and smart alerts can diagnose illnesses, treat diseases, and save lives in case of a medical emergency.

Prevention: Smart sensors analyze health conditions, lifestyle choices, and the environment and recommend preventative measures, which will reduce the occurrence of diseases and acute states.

Reduction of healthcare costs: IoT reduces costly visits to doctors and hospital admissions and makes testing more affordable.

Medical data accessibility: Accessibility of electronic medical records allow patients to receive quality care and help healthcare providers make the right medical decisions and prevent complications.

Improved treatment management: IoT devices help track the administration of drugs and the response to the treatment and reduce medical errors.

Improved healthcare management: Using IoT devices, healthcare authorities can get valuable information about equipment and staff effectiveness and use it to suggest innovations.

Research: Since IoT devices are can collect and analyze a massive amount of data, they have a high potential for medical research purposes.

Disadvantages:

Security and privacy. Keeping the data gathered and transmitted by IoT devices safe is challenging, as they evolve and expand in use. ...

Technical complexity. ...

Connectivity and power dependence. ..

Integration. ...

Higher costs (time and money)

Result:

The system created for this research study is shown in this section, along with the results obtained by the system. The completed system consists of the pulse rate and SpO2 sensors and the body temperature sensor connected to an Arduino Uno. The Arduino is connected to a device with the help of a USB, which will

help power up the system. When we upload data to the Arduino, the system starts working, and the measurement data will be shown in the serial monitor of the Arduino Integrated Development Environment (IDE) and the Liquid Crystal Display (LCD) display, and the data will also be shown in a mobile application with the help of a Bluetooth module.

The full system diagram is shown in Figure 5, including the measurements of the pulse rate, SpO2, and body temperature, shown in the serial monitor of the Arduino IDE and in the mobile application. Figure 6 shows the data of the measurements of all the parameters in the serial monitor of the Arduino IDE. The data value is taken from the sensors MAX30100 and LM35.

Conclusions and Future Works:

This paper presents the implementation of a hybrid wearable sensor network system for anIoT-based industrial safety monitoring applications. It comprises a WBAN for short-range wirelesscommunication and an LPWAN for long-distance data transmission. Two sensor nodes, the Safe Nodeand Health Node, are deployed in the WBAN to collect the environmental and physiological data ofthe subject respectively, which will be further sent to an IoT gateway via the LPWAN infrastructure.The gateway (local server) is configured to perform the edge computing function, including receivingsensor signals, processing raw data, real-time display, emergency notification, as well as sending datato the Internet cloud server. The cloud will provide the IoT applications of the system, such as datastorage, website display, and mobile user interface. The proposed IoT enabled wearable sensor systemcan be used in the industrial safety monitoring applications, such as the construction workplace, whereboth the environmental condition and the health status of the workers are important to ensure safety.Table 4summaries some recent wearable environmental and physiological monitoring applications.Table 4. Comparisons of wearable environmental and physiological monitoring applications.Parameters [32] [35] [36] [53] This workMCU - Cortex-M3 CC2540 CC2541 Cortex-M0Wirelesstechnologies BLE 6LoWPANRFID BLE BLE BLE and LoRaRange Short Short Short Short Short to LongPhysiologicalparametersECG, respiration,heart rate,bodytemperature,blood oxygenMotion,ECGPPG,hydrationPPG, motion,Skin impedance,ECG, VOC,ozone,respiratory rateBody temperature,heart rateEnvironmentalparameterstemperature,humidity,noise,air qualityTemperature,barometricpressure,ambient lightpressure,gas, VOCAmbienttemperature,relativehumidityAmbienttemperature,relative humidity,UV, CO2IoT realization Yes Yes - - YesSensor nodelocation Cloth - Wrist Chest,wrist,handholdTop of helmet,chestPowerrequirementsRechargeablebattery3-VrechargeablebatterySolar with20 mAhrechargeablebatteryRechargeablebattery3.6-VrechargeablebatteryApplication

HealthcareHealthcaresystemfor hospitalHealthcareHealthcarefor ChronicRespiratoryDiseaseSafety and healthmonitoring forindustrial workplaceIn our future work, a smart IoT gateway that can cope with multiple wireless technologies andperform faster edge computing will be deployed. The edge computing can reduce the latency andimprove the efficiency of the network system. A robust smartphone-based gateway can be furtherdeveloped to reduce the dependency on the Raspberry Pi and best use the BLE function of thesmartphone. Since the data security is very important for personal health data, security algorithm onboth edge computing and cloud services will be developed to improve the privacy and security levelof the entire system.