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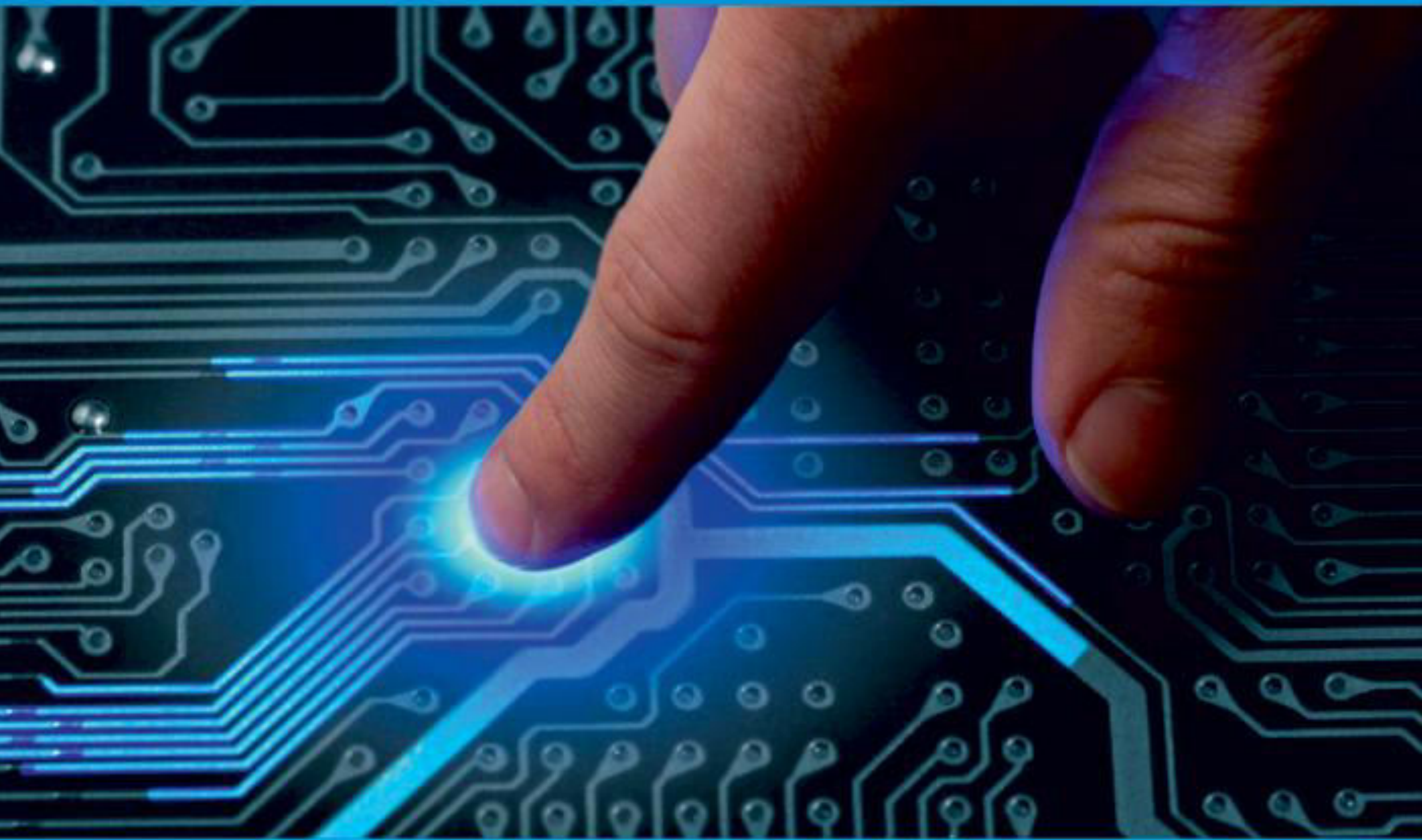

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Monitoring both Physiological and Environmental Data using Wearable Sensors in Industries

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ABSTRACT: In this paper, we develop a wearable sensor network system for IoT- connected safety and health applications. The safety and health of workers are important for the industrial workplace, therefore, an IoT network system that can monitor both environmental and physiological can greatly improve safety in the workplace.
Monitoring of environmental conditions has become increasingly crucial because poor environments can lead to severe health issues. The wearable sensor network can monitor the surrounding temperature, humidity, and LoRA network. The proposed network system incorporates multiple wearable sensors to monitor environmental and physiological parameters. The wearable sensors on different subjects can communicate with each other and transmit the data to a gateway via a wi-fi network.
Once the harmful environments are detected, the sensor node will provide effective notification and warming mechanisms for the users. The data from the sensors can be processed, analyzed, and stored in the cloud and all the data is transferred with the help of wi-fi.

KEYWORDS: wearable sensor network, wi-fi, wearable body area network (WBAN).

I. INTRODUCTION

Internet of Things (IoT) describes the network of physical objects – "things" that are embedded with sensors, software, and other technologies to connect and exchange data with other devices and systems over the Internet. Wearable sensor nods are generally deployed in chemical environments to monitor both physiological and environmental from the environment and the human body. The physiological parameters any of a set of instruments that convey precise information about an individual's bodily functions, such as heart rate, skin temperature.

The environmental parameters are any data collection activity or investigation involving the assessment of chemical, physical, or biological factors in the environment in which affect human health or the quantity of life. Environmental parameters are like temperature and construction weather conditions. To transmit over a short distance to a gateway via the wireless network. In addition to medical applications, wearable technologies can be used in safety monitoring. Because these wearable devices are worn on the body they need to be low-powered and can detect multiple environmental conditions.

A wearable sensor network for environmental monitoring safety application is presented in the work. The system is based on a wearable sensor node using low-power wireless communication. A wearable environmental monitoring sensor network is based on a wi-fi network and can even monitor more than one environmental parameter and physiological parameter. The battery life of the wearable device is limited and the device requires a regular charge. A wearable sensor is used to gather physiological and environmental data. Thus enabling patient status monitoring. The wearable sensors just as the name implies are integrated into wearable objects or directly with the body to help monitor health and/or provide clinically relevant data for care.

Collected environmental data and physiological data need to be transmitted to the cloud via wi-fi. Bluetooth is widely used in wearable body area networks for medical applications to transfer the data from the health node to the safe node, but we directly connect the safe node to the server via wi-fi, and the data is transmitted directly to the server from both the nodes. For example, a wrist-worn wearable system for photo-plethysmogram [PPG] monitoring [5] [7], a WBAN with motion and electrocardiogram [ECG} sensors for rehabilitation [12], and an edge-based WBAN health care monitoring system with heart rate monitoring [1]. Apart from healthcare applications like monitoring body temperature, humidity, heart rate WBAN's have also been used to monitor environmental conditions. For instance, the work [2] monitors the temperature, humidity, ultraviolet [UV], and also the flame for safety application.

Safety is very important for industrial workplaces, especially for workers constantly switching working environments between indoor and outdoor. To prevent workers from being exposed to any risky hazardous situations are some physiological parameters of the workers should also be monitored, body temperature and heart rate are the most studied parameters in WBAN-based medical monitoring works. Among different wearable environmental monitoring applications.

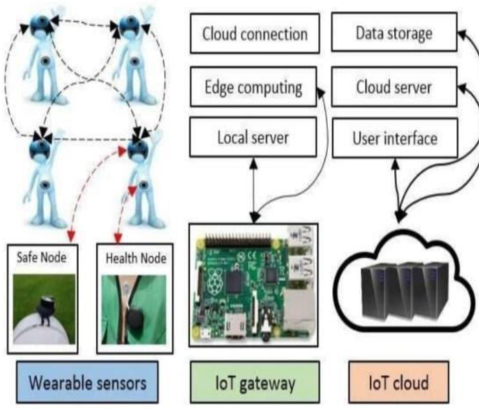

Fig. 1: The architecture of the WBAN

In addition to UV, carbon dioxide [CO2], smoke, CO, and volatile organic compound [VOC] are some indoor pollutants [13]. VOC is an organic chemical that has a high vapor pressure at room temperature. Symptoms of CO2 toxicity, such as drowsiness, disorientation, shortness of breath, and mild headache, may happen to some occupants when the CO2 level is high.

So, it is essential to have a WSN system to monitor both UV and gas for the industrial workplace. The goal of wearable communication is to provide prompt safety warning messages to all workers. The results obtained from the sensors are represented in the form of graphs which include humidity, temperature, heartbeat rate, etc. The remainder of this paper is organized as hardware and software implementation.

II. LITERATURE REVIEW

The small technological device capable of storing and processing data that can be worn on the body is wearable computers. There is no specific definition for wearable computers, but they can be defined by their perceptible characteristics [9]. Rhodes in 1997 and Hendrik Witt in 2008 explained wearable computers by describing many of their properties, for instance, portability, limited capability, context awareness, operational constancy, and hands-free or limited use of hands [10].

In 2014, Genaro Motti et al. gave a sample definition of wearable sensors as body-worn devices, such as clothing and accessories, that integrate computational capabilities to provide specific features to users [9]. The term wearable, as well as the terms wearable technology and wearable devices, is indicative of consumers electronics technology that is embedded computer hardware that is built into products that are worn on the outside of one’s body [6].

The first report on the wearable computer was written by Thad Starner in 1995 and was called “The Cyborgs are Coming". His perturbation was with wearable computer interfaces, and he recognized two main characteristics: persistence and constancy [9]. Endurance describes the permanent availability of wearable computers and the ability to use them while simultaneously performing other tasks. Reliability describes how one wearable computer can be used in every situation.

In 1998, Professor Kevin Warwick implemented a sensor embedded in the median nerves of his left arm [8]. This task has been applied to control a wheelchair and an artificial hand by measuring transmitted signals and creating artificial sensors through electrodes on the arm.

III. METHODOLOGY

The wearable sensor network is based on the wi-fi network. Each safe node can communicate with the other via wi-fi. Wi-fi network is based on a star topology, which means data is transmitted from point to point. If the data is not

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addressed and encrypted, it can be received and seen by all the wi-fi nodes in the same region with the same specification. To improve the security and privacy of the network, data encryption is embedded before each packet transmission. If all the workers are working in a particular region rather than giving each worker a safe node, we can give a single safe node for that particular region in that way the industry can save money. The safe node can be directly updated on the server through the internet. And also the Health node data can be uploaded directly to the server with the help of the internet.

I] Safe Node

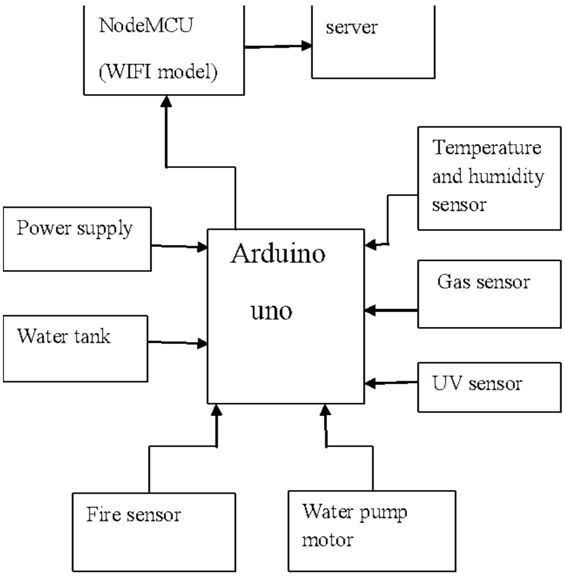

Fig.2 (a) Safe Node

The block diagram of the Safe Node is shown in Fig. 2 (a). Each Safe Node has a power management unit, one MCU, and Six environmental sensors. The Safe Node is powered by a rechargeable battery and a voltage regulate (MCP1810) will regulate the battery voltage to a constant voltage (3.3 V). The MCU is connected with the wi-fi function. five environmental sensors selected are temperature and humidity (DHT11), UV (SI1145) and carbon dioxide (CO_2, GC0012), fire(LM393), water pump motor(). These sensors are selected due to their high performance, high accuracy, and low power consumption.

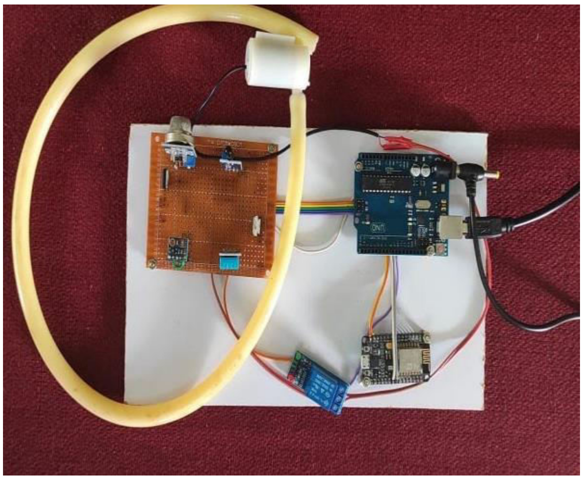

Fig: Safe node

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II] HEALTH NODE

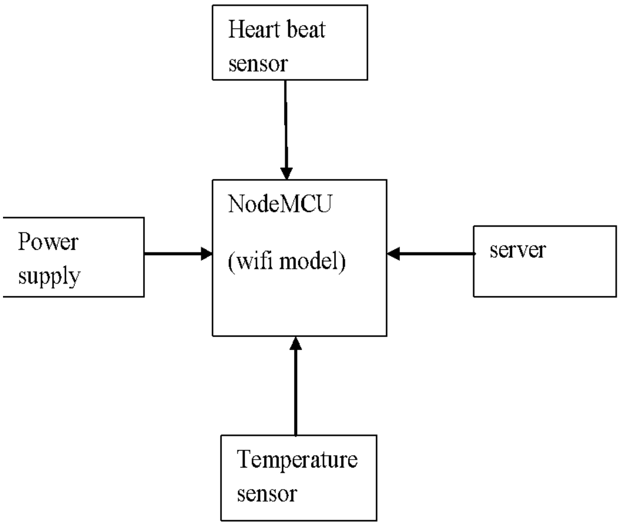

Fig.2 (b) Health Node

Fig. 2 (b) presents the block diagram of the Health Node. The Health Node comprises a power management unit, an MCU with wi-fi connectivity, and two physiological sensors. a health node is powered by a power bank. A low-power buck-boost converter (RT6150) is adopted to regulate the battery voltage at 3.3 V for the rest of the circuit. The body temperature sensor (LM35) and heart rate sensor (PPG) are connected to the MCU by flexible wires. Both of the health parameters will be directly transmitted to the server via wi-fi.

Fig: Health node

III] Cloud Implementation

Thing Speak is an IoT analytics platform service that allows you to collect, visualize and analyze live data streams in the cloud. Thing Speak provides abrupt visualizations of data posted by your devices to Thing Speak. With the ability to execute MATLAB code in Thing Speak we can perform online analysis and processing of the data as it comes in. Thing Speak is usually used for prototyping and proof of concept IoT systems that require analytics. Thing Speak provides access to MATLAB to help us make sense of data. We can: i) Convert, combine, and calculate new data. ii) Schedule calculations to run at certain times. iii) Visually understand relationships in data using built-in plotting functions. iv) Combine data from multiple channels to build a more sophisticated analysis.

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The Node MCU of the safe node is programmed to send the data to the Thing Speak channel where it allows to aggregate, visualize and analyze live data streams in the cloud. The transfer of data to the Thing Speak with the help of Wi-Fi.

IV. CONCLUSION

In this paper, we present an IoT network system for connected health and safety applications for industrial outdoor workplaces. The system can monitor both physiological and environmental data forming a network from wearable sensors attached to workers' bodies and provide invaluable information to the system operator and workers for safety and health monitoring. Aspects such as sensor node hardware and software design, gateway, and cloud implementation are discussed. In our future works, different environmental and physiological sensors can be of the health parameters will be transmitted to the safe Node via the wi-fi network. Integrated to the system to suit different workplaces. A smartphone-based IoT gateway can be developed to reduce the dependency of the fixed location

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