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DEVELOPING A DEVICE FOR HEALTH MONITORING AND HUMAN TRACKING IN COAL MINE CALAMITIES

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ABSTRACT

Coal is an important fossil fuel used for the generation of electricity and other industrial activities. Basic menace in mining process is due to frequently occurring underground accidents. The mining industries are dynamic in nature because of continuously changing environment of underground mines, hence accidents occur in the process of mining and thousands of casualties occur every year. The accidents can occur because of electrical failure, entrapment, exploding vessels under pressure, fire, falling of roof, handling material, etc. The topographical constraints make the situation worse. The interactive communication between different types of systems becomes difficult. The equipment interconnection and power supply are more susceptible that may damage due to accidents hence the entire system becomes weak and inactive. It becomes difficult to track the location of the mine workers during roof fall accidents as the mines get dumped with huge pile of rocks and dust. Tracking the workers, dead or alive becomes critical for the mine authorities. This study was carried out with an intention to design a device which will enable tracking the location of the mine worker along with pulse rate detection. By wearing this device, it is possible to continuously monitor the location and the vital signs of the human body in case of accidents. The device will also sense the pulse rate and help in providing immediate medical help to the mine worker in case of fainting or drop of blood pressure due scarcity of oxygen. This prototype design is such that it is easily wearable and does not hamper activities of mine worker. The designed prototype will continuously monitor pulse rate as well as location of the mine worker and send the information to the base station. In case of any emergency, the last location of the mine worker can be easily tracked and rescue can be provided effectively. The comparative study of the existing system and the designed prototype has been carried out.

KEYWORDS: Coal mines, RFID, Wi-Fi Technology, Pulse Sensor.

The underground coal mines face a major problem due to recurrent occurrence of accidents. The mining industry is extremely active in terms of adverse topographic conditions as compared to other industries. The accidents in mines cause thousands of casualties of human life and at the same time lot of monetary losses are faced. The underground tunnels in the mines are several meters long and are very narrow in width. The mine workers have to cover long distances in these tunnels and there are no such systems to accurately locate the mineworkers.

Many mines use manual tracking systems to keep a record of tentative location of the mine workers. In case the mine worker forgets to notify his location to the foreman, there will be no recent track record of that worker and his location will not be traced during the accidents like roof falls. Due to the adverse environmental conditions in coal mines the mine workers are prone to hazardous gases and inadequate oxygen supply which calls for immediate medical attention. After the occurrence of accident in coal mine, a rescue operation is conducted to search for the mine workers. Since the wired connections get disrupted due to accidents, effective help does not reach the workers and some of them succumb to their injuries. To overcome the above problems a system has been designed using wireless communication technique.

SYSTEM DESIGN ANDOPERATION

The basic device is Arduino Uno. Arduino has 14 digital input/output pins. Since the RFID (Radio frequency identification) reader works on digital data it is interfaced with the digital pins of the microcontroller. Arduino is connected with the RFID reader at pins 9, 8. The Arduino is programmed such that it can read the RFID tags. The basic programming required for interfacing RFID reader is done using Arduino Software. The Wi-Fi module is placed over Arduino kit to so as to establish LAN (Local Area Network). The pulse sensor is connected to the Arduino pins A0, 5V, GND.

The system is wireless, battery operated and the overall maintenance required is cheap. The technology used here has better advantages over other techniques like Zigbee, Bluetooth, or GPS (Global Positioning System). The tracking system is based on RFID technique. RFID technology makes use of electromagnetic field to automatically identify the tags. Electronic information is stored in these tags. RFID technology has been implemented in industries, libraries, schools and universities for tracking purpose. In this prototype, RFID technology is used for tracking the location of the coalmine worker in the underground mines. RFID reader is fixed on the helmet of the mine worker and the tags are fixed at a specific distance in

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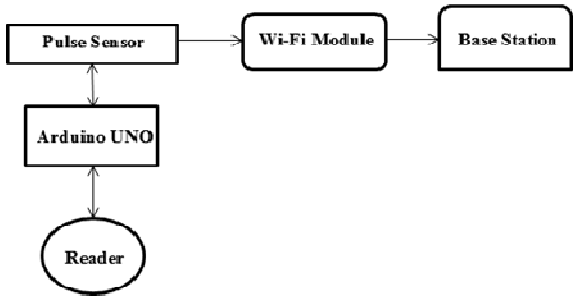
each underground lane. The tags contain information of the lane location. As the mine worker passes through the lane the reader will read the information stored in the tag. For example, if the information stored in the tag reads "Lane 1", the location of the mine worker will at Lane 1. As per different lanes and areas the tags can be assigned with location specific information for tracking purpose. This information is further transmitted to a computer system wherein the mine authorities can keep a check on the location of the workers. Another important part of this prototype is health monitoring. A pulse sensor is used for monitoring the pulse rate of the mine worker. The pulse rate of the mine worker will be displayed on the computer at the base station. The pulse sensor can read the pulse from the ear lobe too. This makes it easy to use for this particular application since the rigorous activity of the mine worker is not hampered. The tracking and pulse sensing system is interfaced with a microcontroller. A simple Arduino Uno microcontroller is used for this purpose. The use of microcontroller helps to establish a single platform for location tracking and health monitoring. The tracking and monitoring information from the microcontroller is transmitted to the base station through Wireless Local Area Network i.e. WLAN. The complete system is connected to WiFi at the base station. A data base is generated on the main computer system which stores all the information received from the device and displays it on a webpage. The device can be easily mounted inside the helmet of the mine worker. The complete circuit works on a 9 volt rechargeable battery.



Figureure 1: Basic block diagram of the prototype

HARDWARE DESCRIPTION

Arduino Uno

Microcontroller used is based on ATmega328 called as Arduino Uno with 14 digital input/output pins, 6 analog inputs, 16 MHz ceramic resonator, USB connector, a power jack, ICSP header and a reset button. The board covers all the requirements of the microcontroller and it can be powered by simple AC-to-DC adapter.

RFID Reader and Tags

RFID readers are of different range depending on the application. UHF reader is used in this prototype. The UHF reader reads tags at 865 MHz. The reader radiates 865MHz frequency when a tag of 865 MHZ is brought near it and reads the electronic information stored in the tag. The reader is interfaced with the microcontroller. Passive RFID tags of ultra-high frequency are used.

Wi-Fi Module

ESP8266 Wi-Fi Module is used for accessing Wi-Fi network as it contains integrated TCP/IP protocol stack. This makes the module accessible to any microcontroller. ESP8266 is can either host an application or it can take connections from other Wi-Fi networks. The module can be integrated with sensors due to its powerful storage capacity and fast processing. It requires minimal external circuitry and it takes minimum space.

Pulse Sensor

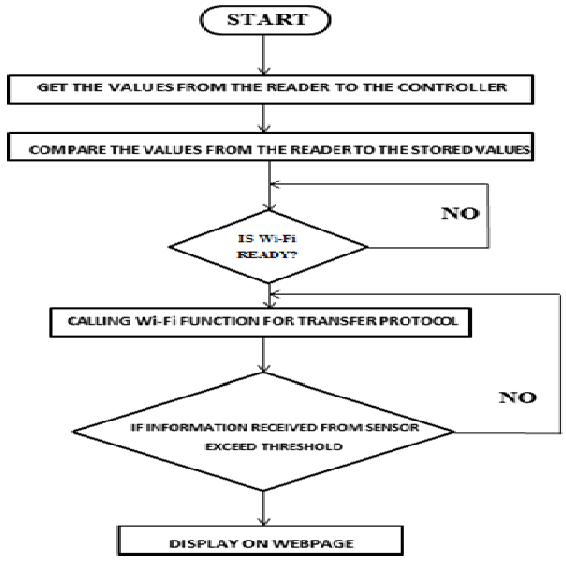
A plug-and-play heart-rate sensor is used for pulse detection. It is easily compatible with Arduino Uno microcontroller. Pulse Sensor is used to incorporate live heart rate data. The pulse sensor has a jumper cable and can be clipped to fingertip or earlobe. At the back of the sensor is an LED light which shines as the pulses get recorded. The back portion of the sensor makes contact with the skin.

SOFTWARE DESCRIPTION

Arduino Uno can be programmed using Arduino software which is open source; the coding is easy since the software uses basic programming languages like C, C++. Arduino makes transformations to make sure that the code is correct and then this code is processed by the compiler. The compiler makes the code outputs human readable. The program is loaded on Arduino board to perform required operation.

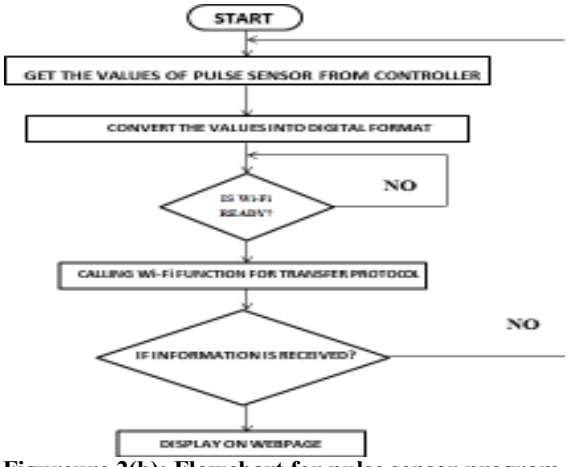
In this application, the Arduino has to be programmed such that the information from RFID reader and pulse sensor should be displayed on the webpage. While programming for the RFID reader, the tag numbers are stored. Each tag is assigned some name as per the requirement. For example, tag 1 can be named as "Lane 1". When a tag gets read by the reader, the electronic information will get compared by with the information of the stored tags and the name will get displayed. Suppose the tag matches information of tag 1, the webpage will display Lane 1. The Wi-Fi module has to simply transfer the information to the main

server. The webpage display is programmed using simple HTML (Hypertext Markup Language) and CSS (Cascaded Styling Sheet). The Wi-Fi module helps to establish a LAN which serves the purpose of wireless information transfer. An instant server is initialized and the Wi-Fi module gets connected to the main Wi-Fi network. The ip (internet protocol) address of the module will be verified by the main network and a connection will be established. Once the Wi-Fi is conFigureured, the information from the device is displayed on the webpage of the main server. The data gets stored in the main server in the database. The program logic for RFID is explained in the flowchart shown in Figure 2(a).



Figureure 2(a): Flowchart for RFID program

In case of the pulse sensor program, the output from the sensor is converted from analog to digital. The digital output is then transmitted by the Wi-Fi module to the main server. The program logic is explained in the Figure 2(b) flowchart.



Figureure 2(b): Flowchart for pulse sensor program

RESULTS AND CONCLUSION

This wireless prototype has a lot of advantages over other existing systems and it will help in ensuring safety of the mine workers. The following are the advantages of the proposed system:

The device is very easy to implement and it is also very effective.

1. The information transfer is accurate.
2. In case of any damage to the system, it can be replaced at cheap cost.

The device was tried at mines of Western Coal Fields Limited and it was compared with the present existing system and it was observed that the time required for getting the information about the mine worker in case of calamity is comparatively less than the time required by existing traditional system.

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