WIRELESS COMMUNICATION ENABLED COAL MINE SAFETY, TRACKING AND MONITORING SYSTEM

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ABSTRACT:
A surveillance facility as we know is the backbone of any safety and security system. This concept is very much applicable to the mining industry as well. In our paper, we have proposed an idea to implement a system which will help improve the safety of workers in a mining facility. It facilitates wireless communication between the workstation and the server. The main focus of this idea is to make error detection much easier and to speed up the evacuation process. We have achieved this using concept of Electronics, IoT and wireless communication. The idea directly targets on improving the holes present in the current surveillance in the mining systems.

Keywords*: Wireless Communication, IOT, Safety, Mining system.*

1. INTRODUCTION

Accidents are uncertainty in any field of work, it occurs due to various reasons, carelessness or just in case of general bad-luck. The impact of these are very high in the case of mining, the loss of personal and property is very high and to add to this the rebuilding process is very tedious and difficult.[1] Alerting miners in a mine can be a difficult process bearing in mind the everyday working conditions that are encountered in a mine. Underground mines are very dark places and therefore the miners use safety helmets with attachable mining lights. The equipment used in underground mines can create a lot of noise and vibrations, which are compounded by the cramped conditions in the underground tunnels. The problem associated with the noise is that warning a miner with a speaker, alarm, vibration unit and LED system when a fellow miner is experiencing a hazardous event would most probably be in vain as the miner would not hear the alarm.[7] Arranging of IoT structures in Mines for Safety and Efficient Monitoring relies upon remote sensor framework can be sensible and adequately redirect dynamic condition of workers in the underground locales to data servers and can be watched reliably using web applications and servlets in a PC system. The mutt underpass radio multiplication exhibit including the free space spread and the changed waveguide causing is proposed. In any case, using conspicuous radio correspondence inside underground mines has a couple of impediments. Regardless of the way that radio signs are transmitted, tightening, diffraction, multi-way and disseminating are routinely serious

We know that the tunnels are dark, filled with poisonous gaseous, low levels of oxygen this pose as a threat to not only one but multiple workers and equipment. Providing these tunnels with a surveillance system would act as a viable solution. Adding a camera would not be feasible since the light is very less and manually wiring that many cameras would be a herculean task for anyone. Integrating the worker safety system with this surveillance system would provide advanced facilities, which will enable easy evacuation and prevention of fatal accidents. Essentially this is a very easy set-up and requires a very limited amount of power for operation. Obtaining the results of the surveillance are very instantaneous and time-efficient, therefore, arranging of backup is pretty easy.

2. EXISTING MODELS

There are existing coal mine alert systems that are built using sensors and WSN [2]. The coal mine intelligent monitoring system, through the minefield of ZigBee nodes, to collect a variety of wireless data, through the switch to downhole monitoring sites which adopts a ring network connection that can communicate conveniently. In addition, the system sets up a backup underground control and monitoring stations. The data is transmitted using an Ethernet connection. It includes wireless data acquisition subsystem based on ZigBee network, industrial Ethernet transmission subsystem and remote monitoring system. [5]We will use zig-bee software and three sensors such as temperature, humidity and gas sensor. Three sensors will detect the change in parameters of the environment and will give the information to the microcontroller. Then the microcontroller can check these values up to date, if any of the value exceeds the approved value, it will warn the person through the buzzer. This information is passed through the ZigBee module to the base station. Then the base station department must take safety measures to safeguard the people who work in coal mining.

3. PROPOSED MODEL

There are various models present, which mainly focus on reducing the fatality of the worker in case of any breakdown. We have integrated the worker monitor system into an overall monitoring system. To add to this we have modified the worker monitor system into a wearable device, which is easier to use.

4. SYSTEM MODEL AND APPROACH:

The system approach for this paper has been inspired by previous projects such as miner safety helmets and other devices. Considering the fact that there are workers who are not present at the blasting site and hence do not necessarily wear helmets, it would make more sense to have a wearable device. This will be attached to the worker. This is essentially the first block of the entire system, it will monitor the vitals of the workers using various biomedical sensors. It is also fitted with an alarm which sets off if the pulse of the worker is abnormally low. Via the microcontroller the vitals are displayed on an LCD display on the device itself, to add this the data from the microcontroller are transmitted to the main server using an RF transmitter module.

The second block of the system is present at each tunnel. Termed as a substation, at each substation the temperature, humidity, gas levels and a water sensor is present. It works in a similar manner to the wearable device. It obtains the data from the sensors and passes it onto the microcontroller. The data are presented on an LCD screen. And through an RF transmitter are transmitted to the RF receiver at the main server. There are also two alarms, one of which goes off when there is no transmission from the RF transmitter. The second alarm buzzes when the entire power to the system goes off. In case of a situation where there is no power supply to the system, it indicates to the personnel. The final block of the facility is the main server, it consists of three parts, the RF receiver, and microcontroller and Wi-Fi module. The function of this block is that it receives the information from the worker wearable device and the substitution and process the data in the microcontroller and using the Wi-Fi module it uploads the information to the website. And from the website, it can be accessed by the administrative personnel who can then call for and emergency if something goes wrong.

5. METHODOLOGY

As we mentioned before the objective of the paper is to present a model which provides an entire surveillance system. The efficiency and maximum utility are obtained when all the three units are put together.

- The wearable device
- The substation block
- The server block

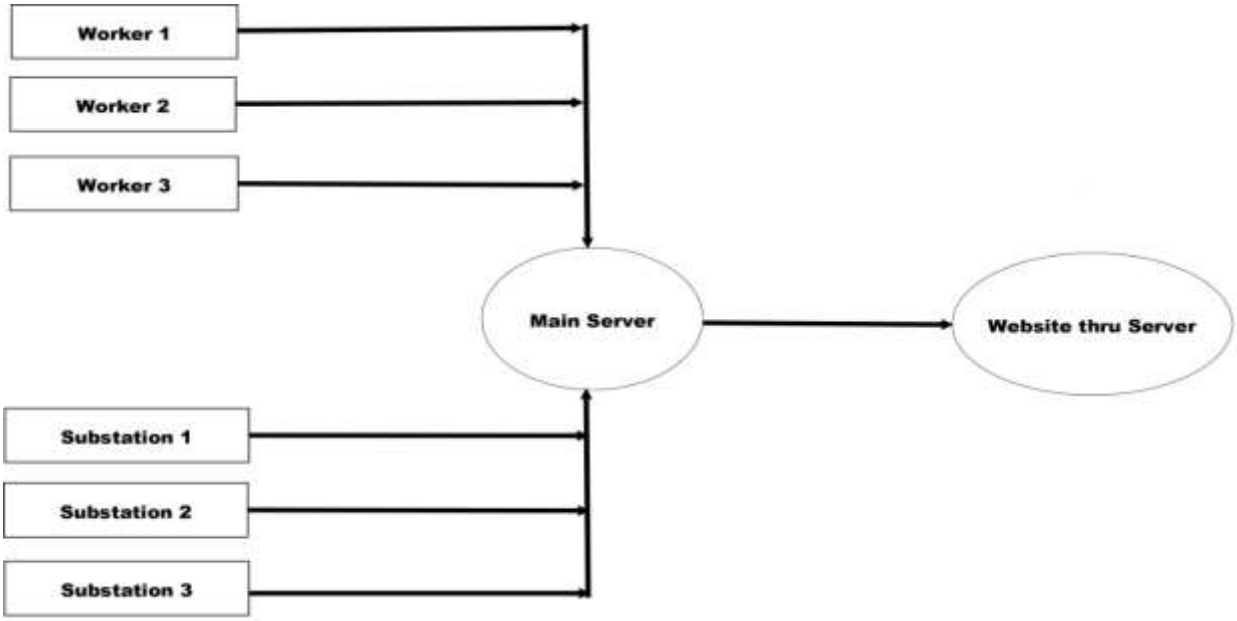

Figure 1: represents the flow diagram of the final surveillance system

5.1. WEARABLE DEVICE

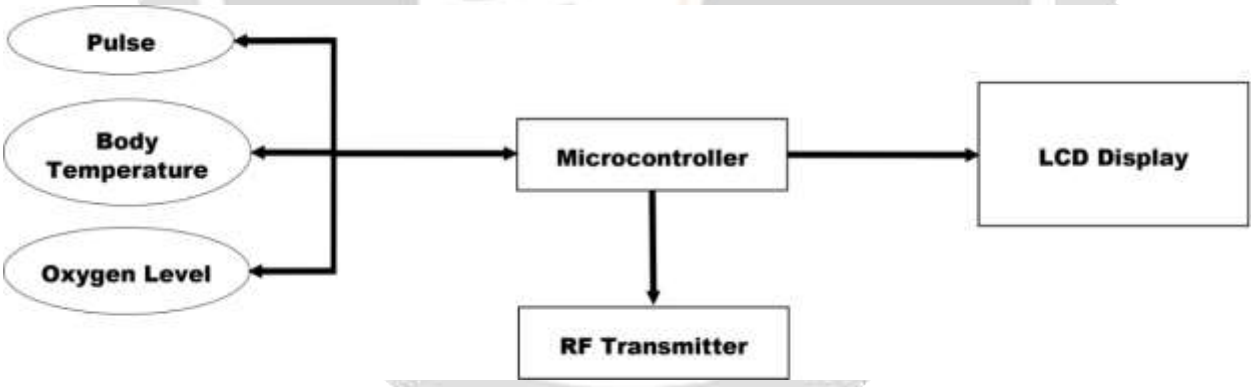

FIGURE 2: Represents the block diagram of the wearable device

This is the wearable device that is worn by the worker. The reference papers [1], [3] and [6] act as the inspiration to this model. An operating coal mine is a very large operation, and it has thousands of workers, necessarily not all the workers are wearing safety gear and helmets. But it would be easy for them to wear a simple device like a bracelet or watch. It has sensors that are in contact with the human skin at a particular location where is the vitals are easily readable. The obtained data is then processed in the microcontroller and then displayed on the LCD display and simultaneously, the RF transmitter sends the values to the main server.

5.2. SUBSTATION BLOCK

It is very much similar to the previous part of the system, but the importance of this block is much more than that of the previous one. The involvement of heavy machinery under extreme pressure and heat, this by itself calls for high levels of risk. The presence of hazardous gases makes this environment very dangerous to work in. In this block, we have added the necessary sensors for the detection of various parameters. Temperature, water, CO2, CO, O2, and humidity, these are the physical parameters that we measure. The results shown for these parameters are obtained using ZigBee with CAN bus [17], which is as same as the one what is achieved here by this device. This device is planted inside of the tunnel, it constantly retrieves the data from the surroundings and sends it to the microcontroller. The controller has two functions, one it displays the data on the LCD device and two it passes on the data to the RF transmitter from which the data is sent to the main server. There is a high chance that either the power supply or any component in the device might not work, In that case, there are inbuilt alarm systems. The alarm system 1 goes off when any component in the device is fried off or not working properly, the alarm system 2 is connected to the power supply, so when the power supply is cut. The alarm system goes off which is supplied by an external battery independent of the main supply.

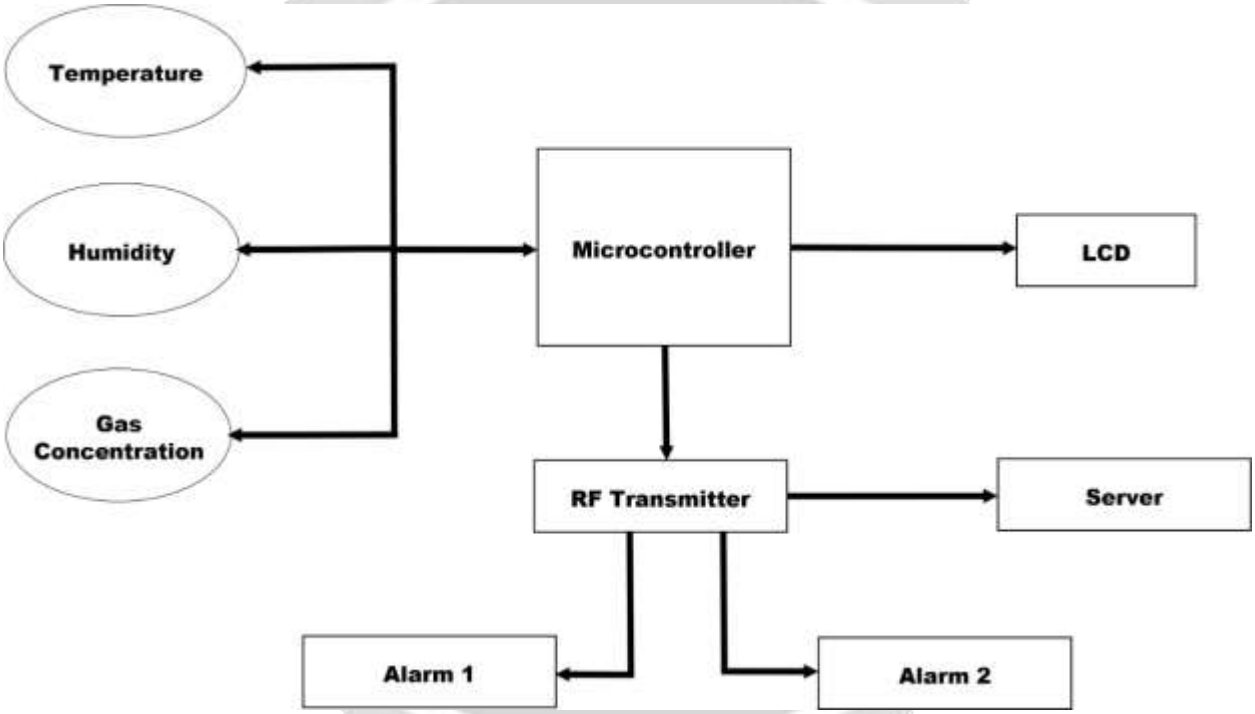

FIGURE 3: Represents the block diagram of substation block

5.3. MAIN SERVER

This is the final block of the system. This block consists of an RF receiver, Microcontroller and a Wi-Fi module. The RF receiver accepts the incoming data from the worker's wearable device and the individual substations. The receiver collects the data and sends it to the microcontroller. From the microcontroller, it is sent to the website and also updated in the mobile application. This mains server is present directly above the workers and the substation to avoid losing data which might be crucial.

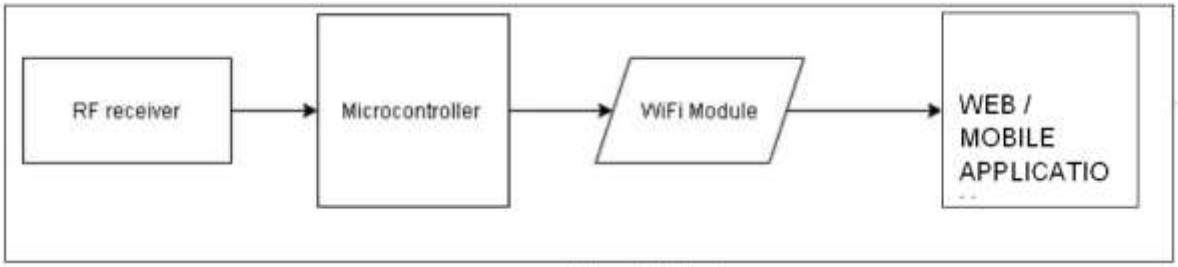

FIGURE 4: Represents the block diagram of the main server

6. RESULT

Figure 5: shows readings take at various times. [17]

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Date & Time	Xbee Address	Tempereture	Carbon Monoxide
2/23/2015 2:32	0013A20040B90913	34.83871	0
2/23/2015 2:33	0013A20040B90913	36.59824	0
2/23/2015 2:33	0013A20040B90913	36.24633	0
2/23/2015 2:33	0013A20040B90913	36.24633	0
2/23/2015 2:34	0013A20040B90913	36.12903	0
2/23/2015 2:34	0013A20040B90913	36.01173	0
2/23/2015 2:34	0013A20040B90913	34.60411	0
2/23/2015 2:34	0013A20040B90913	34.72141	0
2/23/2015 2:35	0013A20040B90913	34.83871	0
2/23/2015 2:35	0013A20040B90913	34.83871	0
2/23/2015 2:35	0013A20040B90913	34.95601	0
2/23/2015 2:35	0013A20040B90913	34.95601	0
2/23/2015 2:36	0013A20040B90913	34.95601	0
2/23/2015 2:36	0013A20040B90913	35.19062	0
2/23/2015 2:36	0013A20040B90913	34.60411	0
2/23/2015 2:36	0013A20040B90913	33.66569	0
2/23/2015 2:37	0013A20040B90913	34.1349	0
2/23/2015 2:37	0013A20040B90913	34.0176	0
2/23/2015 2:37	0013A20040B90913	34.1349	0
2/23/2015 2:37	0013A20040B90913	34.3695	0
2/23/2015 2:38	0013A20040B90913	34.4868	0
2/23/2015 2:38	0013A20040B90913	34.3695	0
2/23/2015 2:38	0013A20040B90913	34.3695	0

Figure 6: shows the reading of the temperature. [16]

Figure 7: shows the graphical representation of the physical parameter over time. [16]

7. CONCLUSION

In this paper, we have devised an idea which focuses on an easier method for danger detection. The advantages of this method are that it uses less to zero human intervention in monitoring the parameters, also to add to this the data is being constantly updated. This enables us to detect any change and prevent any severe damage. It is highly cost-effective and sustainable

8. REFERENCE

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