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An Intelligent Helmet for Wireless Sensor Network

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Abstract:
The main aim of the system is to develop a smart helmet for mining industry workers. The problem addressed in this project was the improvement of a mining helmet in order to ensure more safety awareness between miners. When working with noisy equipment, being aware of one's surroundings can sometimes be challenging. In the mining trade miners tend to get rid of their safety gear because the gear is too significant, heat or uncomfortable to work with. So this system is developed to intimate the authorities in critical conditions.

To overcome the above problem, we are developing a smart helmet for mining industry workers. Firstly to identify the worker, each worker will be having different tag. Once the tag is identified, person's data will be sent to the PC through ZIGBEE. In order to check whether the worker has been using the helmet or not, IR sensors are used to check the helmet presence. The surrounding hazardous gases will be detected by the gas sensor present in the helmet. When gas is detected voice notification will be given through speaker. By the use of MEMS sensor, the head injuries occurrence will be identified. All the data related to sensors will be posted into the PC through ZIGBEE transceiver.

Keywords: ***Raspberry Pi3 Board (ARM11), ZIGBEE Module, GAS Detector, IR Sensor, MEMS sensor, IoT Environment, Speaker, Raspbian OS (Linux) QT Creator.***

1. INTRODUCTION

Wireless sensor Network has been employed to collect data about physical phenomena in various applications such as habitat monitoring, and ocean monitoring, and surveillance. As an emerging technology brought about rapid advances in modern wireless telecommunication, zigbee has attracted a lot of attention and is expected to bring benefits to numerous application areas including industrial WSN systems, and healthcare systems manufacturing. WSN systems are well-suited for long-term industrial. Environmental data acquisition for representation. Sensor interface device is essential for detecting various kinds of sensor data of industrial WSN environments. It enables us to acquire sensor data. Thus, we can better understand the outside environment information.

However, in order to meet the requirements of long-term industrial environmental data acquisition, the acquisition interface device can collect multiple sensor data at the same time, so that more accurate and diverse data information can be collected from industrial WSN.

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With rapid development major manufacturers are dedicated to the research of multisensory acquisition interface equipment. There are a lot of data acquisition multiple-interface equipments with mature technologies on the market. But these interface devices are very specialized in working style, so they are not individually adaptable to the changing IoT environment. Meanwhile, these universal data acquisition interfaces are often restricted in physical properties of sensors (the connect number, sampling rate, and signal types).

Now, micro control unit (MCU) is used as the core controller in mainstream data acquisition interface device. MCU has the advantage of low price and low power consumption, which makes it relatively easy to implement. But, it performs a task by way of interrupt, which makes these multisensory acquisition interfaces not really parallel in collecting multisensory data.

On the other hand, ARM family has unique hardware logic control, real-time performance, and synchronicity which enable it to achieve parallel acquisition of multi sensor data and greatly improve real-time performance of the system. Raspberri Pi board has currently becomes more popular than MCU in multi sensor data acquisition in IoT environment.

However, in IoT environment, different industrial WSNs involve a lot of complex and diverse sensors. At the same time, each sensor has its own requirements for readout and different users have their own applications that require different types of sensors. It leads to the necessity of writing complex and cumbersome sensor driver code and data collection procedures for every sensor newly connected to interface device, which brings many challenges to the researches.

The rest of this paper is organized as follows. The architecture is presented in Section II, and detailed hardware and software implementations are described in Section III. Project Implementation methodology in Section IV. Finally, we conclude our work with results in Section V.

II.SYSTEM ARCHITECTURE

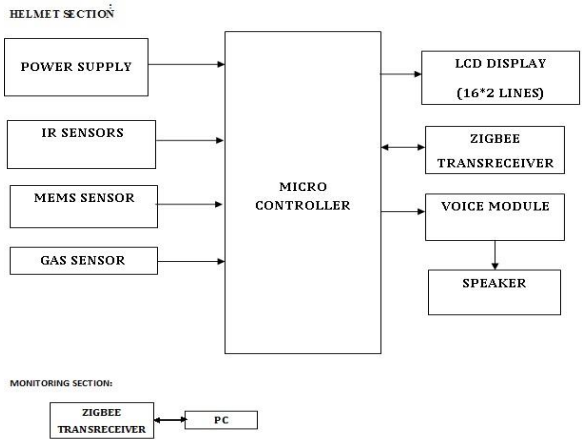

Figure.1 System block diagram

Firstly to identify the worker, each worker will be having different tag. Once the tag is identified, person's data will be sent to the PC through ZIGBEE. In order to check whether the worker has been using the helmet or not, IR sensors are used to check the helmet presence. The surrounding hazardous gases will be detected by the gas sensor present in the helmet. When gas is detected voice notification will be given through speaker. By the use of MEMS sensor, the head injuries occurrence will be identified. All the data related to sensors will be posted into the PC through ZIGBEE transceiver.

III.HARDWARE IMPLEMENTATION

3.1. Raspberry Pi Board

Figure 2: Raspberry Pi3 Board

Raspberry Pi is a credit-card-sized single board computer developed in the UK by Raspberry Pi foundation with the intention of stimulating the teaching of basic computer science in schools. It has two models;

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Model A has 25 6Mb RAM, one USB port and no network connection. Model B has 5 12Mb RAM, 2 USB ports and an Ethernet port. It has a Broadcom BCM2835 system on a chip which includes an ARMl176JZF -S 700 MHz processor, Video Core IV GPU, and an SD card. The GPU is capable of Blu-ray quality playback, using H.264 at 40MBits/s. It has a fast 3D core accessed using the supplied OpenGL ES2.0 and Open VG libraries. The chip specifically provides HDMI and there is no VGA support. The foundation provides Debian and Arch Linux ARM distributions and also Python as the main programming language, with the support for BBC BASIC, C and Perl, detailed description of Raspberry Pi board has been given in Fig. 2 (Raspberry Pi user guide). Python was chosen as the main programming language, as it is generally accepted to be both easy to learn and a fully fledged , programming language suitable for real world applications. With the addition of NumPy, SciPy, Matplotlib, IPython, and PyLab, Python can be used for computational mathematics as well as for the analysis of experimental data or control systems.

PCM/I2S AUDIO:

The PCM audio interface is involved in a computerized medical peripheral health center providing the input and output of quality serial or telecommunication audio streams for the Prime Minister. It supports many classic PCM formats along with I2S.

3.2. ZIGBEE Technology

ZigBee modules feature a UART interface, which allows any microcontroller or microprocessor to immediately use the services of the Zigbee protocol. All a Zigbee hardware designer has to do in this is ensure that the host's serial port logic levels are compatible with the XBee's 2.8- to 3.4-V logic levels. The logic level conversion can be performed using either a standard MAX-232 is directly connected to the XBee UART. Tarang modules are designed with low to medium transmit power and for high reliability wireless networks. The modules require minimal power and provide reliable delivery of data between devices. The interfaces provided with the module help to directly fit into many industrial applications.

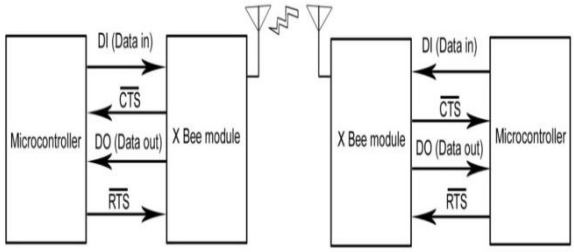

Fig 3. ZIGBEE Receiver Block Diagram

3.3 IOT Application Gateway

The ARM11 is connected to a router with a wired serial connection. The router runs open source embedded Linux software, providing networking functionality to connect the internet. This essentially provides internet access to the ARM11 board. Router acts as an IoT application gateway and interconnects. A private IPv6 network using a Virtual Private Network (VPN) is used for connecting the IoT application gateway to the server.

The server collects sensor data forwarded by the application gateway and store in a database for further processing and then to be viewed via a website. Data can be viewed in terms of previous day, week, and month time periods graphically. In the present setup, heterogeneous sensing units are designed and developed indigenously for intelligent home monitoring systems to integrate with IoT networks.

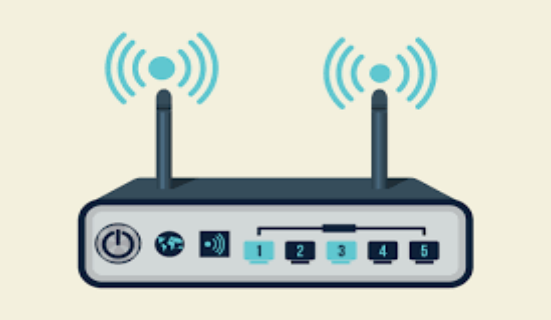

Figure 4: Internet Router

The Linux-Open WRT software provides the networking architecture to participate in many types of networks. These networks are abstracted into devices, which generalizes management and configuration. This abstraction requires device drivers which operate in the

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kernel space, making development difficult. A TUN/TAP device driver acts as a virtual network device with its output directed to a user space program instead of a physical device. This simplifies the development of a network device, as a user space program is easier to develop

3.4 GAS SENSOR

Gas detectors can be used to detect flammable and toxic gases, oxygen depletion. This type of device is used widely in industry and can be found in locations, such as on oil rigs, to monitor manufacture processes and emerging technologies such as photovoltaic. They may be used in fire fighting. Gas leak detection is the process of identifying potentially hazardous gas leaks by sensors. These sensors usually employ an audible alarm to alert people when a dangerous gas has been detected. Common sensors include infrared point sensors, ultrasonic sensors, electrochemical gas sensors, and semiconductor sensors. More recently, infrared imaging sensors have come into use. All of these sensors are used for a wide range of applications and can be found in industrial plants, refineries, waste-water treatment facilities, vehicles, and homes.

Figure 5: GAS sensor

IR SENSOR:

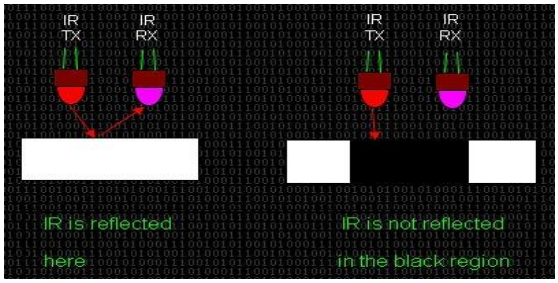

Figure 6: Schematic Diagram for Infrared Transmitter and Receiver

An infrared emitter is an LED made from gallium arsenide, which emits near-infrared energy at about880nm. The infrared phototransistor acts as a transistor with the base voltage determined by the amount of light hitting the transistor. Hence it acts as a variable current source. Greater amount of IR light cause greater currents to flow through the collector-emitter leads. As shown in the diagram below, the phototransistor is wired in a similar configuration to the voltage divider.

IR reflectance sensors contain a matched infrared transmitter and infrared receiver pair. These devices work by measuring the amount of light that is reflected into the receiver.

Because the receiver also responds to ambient light, the device works best when well shielded from ambient light, and when the distance between the sensor and the reflective surface is small(lessthan5mm). IR reflectance sensors are often used to detect white and black surfaces. White surfaces generally reflect well, while black surfaces reflect poorly.

MEMS:

Micro electro mechanical systems (MEMS) are small integrated devices or systems that combine electrical and mechanical components. Their size range from the sub micrometer (or sub micron) level to the millimeter level and there can be any number, from a few to millions, in a particular system. MEMS extend the fabrication techniques developed for the integrated circuit industry to add mechanical elements such as beams, gears, diaphragms, and springs to devices.

Examples of MEMS device applications include inkjet-printer cartridges, accelerometers, miniature robots, micro engines, locks, inertial sensors, micro transmissions, micro mirrors, micro actuators, optical scanners, fluid pumps, transducers and chemical, pressure and flow sensors. Many new applications are emerging as the existing technology is applied to the miniaturization and integration of conventional devices.

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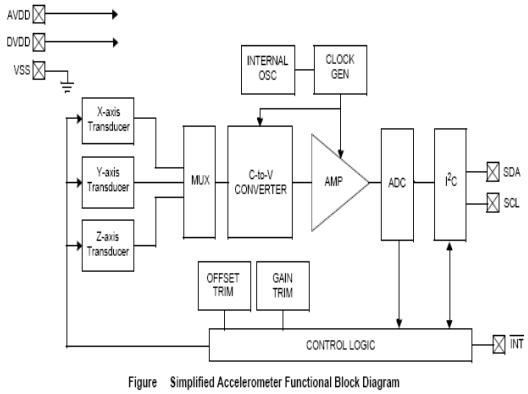

Figure Simplified Accelerometer Functional Block Diagram

IV IMPLEMENTATION METHODOLY

This miniature model is recognized that on the basis of the Board High-Performance Circuit Board (ARM11-Raspberry Pi-3 Model B). In this system, helmets have sensors, gas masks, and sensors to monitor infrared in the coal industry. Any accident situation in the mine, helmets provided to a monitoring station through zigbee transmission and control stations will warn coal miners using zigbee to get the last seconds in a helmet, so the miners have a chance to save lives from the danger of mining.

V.EXPERIMENTAL RESULTS

The developed system is tested by installing the Smart sensing units and setting up an IOT based system. Interconnecting IPv6 network is performed by connecting and configuring the modified router (IoT application gateway) as discussed in section III. Integrated system was continuously used and updated real-time sensing information to the server over an IOT environment.

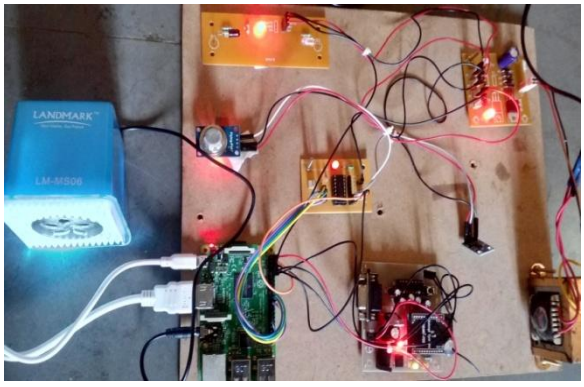

Figure 7: Transmitter section

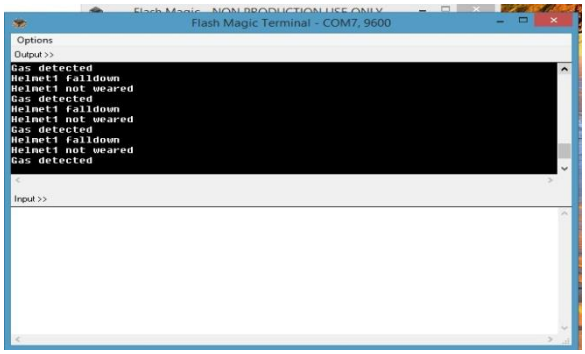

Fig 8: Sensor values shown at the receiver section pc

VI.CONCLUSION

Integration of the features of all used hardware has been developed. The presence of each module is encouraged and put carefully, thus contributing to the best performance of the device. Secondly, the abuse has eventually improved IC, and with the help of growing technology, the project is being successfully implemented.

Due to the need for system requirements and components to be easily developed, this project can be easily implemented. It will provide security to coal miners and will change how they are working as a system covering changes in the mining environment. The original design of the ZigBee Wireless Sensor with less power has been shown. This is a reliable system with quick and easy setup. The system can be easily expanded. Using the ZigBee Wireless Positioning Tool will improve the system's quantitative measurements and extend the exact location of your underground miners in the future.

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