An Intelligent Device for Hazardous Event Detection for Mining Industry - Smart Helmet

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Abstract— Coal mining assumes essential part in the vast majority of the creating nations to meet the vitality requests. Be that as it may, a similar time mining industry is confronting numerous issues which primarily incorporate the excavator's wellbeing. Particularly the underground mine condition is exceptionally mind boggling. The emanations of harmful gasses like methane and carbon monoxide dependably happen in coal mine. The convergence of these gasses above security limit level makes chance about digger's wellbeing and life. Subsequently a persistent checking of such esteems is vital. A savvy framework is being proposed here, that can distinguish and assess air quality (Toxic gasses) and Hazardous occasions in the underground mining industry. It gives another technique for dissecting risky occasions occurring in the mining, for example, Methane, Propane, Butane, Benzene, Carbon monoxide and other lethal gasses. This proposed framework is given detail depiction of a framework to assess the centralization of dangerous gasses. This framework is produced with Raspberry pi separated from this the proposed framework will show the cap position on the individual and in addition any outer contribution on the protective cap and . To quantify these occasions appropriate sensors will be utilized and interfaced to Raspberry pi with wi-fi. The framework model created has many preferred standpoint that makes it helpful to work in brutal condition of underground mine, observing the grouping of dangerous gasses in its climate alongside Fire, Pressure, IR sensor.

Keywords— Air Quality; mining; safety; wireless sensor networks.

I. INTRODUCTION

A mine is thought to be a plant that produces helpful mineral with a given rate of metal and given amount, while the cost of mining is relied upon to be least cost. Land states of any mine are controlled by nature. They are capricious [1]. The different natural parameters of mine framework, for example, methane, carbon monoxide, temperature, oxygen et cetera, are right now utilizing the customary link transmission. Therefore really mine methane, carbon monoxide gas gathering zone motorized mining face, for example, the dead gob link security parameters can not be checked, so they can not anticipate the caution [2]. Mining venture movement is liable to high dangers due to its size, vulnerability, unpredictability, high expenses and excavator's wellbeing [3]. The discharge of lethal gasses from coal crease thus prompts air contamination in mine territory. It extremely influences excavator's wellbeing [4]. The more profound a mine is, the more terrible and more hazardous diggers' work is and the more costly excavators' work is. The high temperature of the Earth's middle raises the temperature of the underground mine and it will be difficult to work. Fig.1 demonstrates a case of underground metal mining where work is done in various divisions.
Challenges in underground environment

In coal mines, the significant emanation is of methane. The methane discharged amid and in the wake of mining operations is called Coal mine methane (CMM). Lately, there have been numerous fatalities in underground coal mine blasts in which methane was a contributing element. Additionally methane is 21 times more intense for ozone depleting substance outflows. The centralization of methane if went through a range in the vicinity of 5% and 15%, it might prompt blast. This scope of methane is known as the dangerous range. Methane can be touched off effectively in this range with the nearness of a start source to make a vicious methane blast that may spread within the sight of flammable coal clean [5]. Further, catching and using this gas won't just diminishing ozone depleting substance discharges, however can be utilized as extra vitality source in not so distant future that generally will be lost.

Managers are considered in charge of all wounds maintained under their watch, and ought to in this manner know about possibly hazardous circumstances [6]. The issue tended to in this paper was the change of a mining protective cap keeping in mind the end goal to guarantee more security mindfulness between diggers. When working with uproarious hardware, monitoring one's environment can once in a while be testing [7]. In the mining business diggers tend to evacuate some of their wellbeing gear in light of the fact that the apparatus is too overwhelming, warm or awkward to work with. In any case, mineworkers by and large don't evacuate their protective caps. By and by mining security caps just have the reason for ensuring the excavator’s head against potential unsafe knocks. The security head protectors don't have any innovation added to it to tell diggers when a kindred mineworker has experienced an unsafe occasion. Thrusly the motivation behind the proposed framework portrayed here was to alter a current mining security cap to make the protective cap even more secure by including a remote sensor hub arrange. The assignment was stretched out to outlining the framework sufficiently little to fit into the security cap and keep going sufficiently long while running on battery control. A further test was to alter the protective cap without changing its physical structure. The additional weight must be kept to a base. A mining protective cap should be changed to enhance digger security by adding insight to the head protector. At the point when a mineworker expels his cap he should be cautioned. On the off chance that a question falls on an excavator notwithstanding when wearing his head protector he can wind up plainly oblivious or fixed. The framework must decide if a mineworker has supported an existence undermining damage. These two occasions are characterized as dangerous occasions. Thirdly, hazardous gasses should be identified and reported. In the region of mining innovation, constant screen and control of mine peril are more unpredictable. Mine wellbeing modules are designed to impart to ground control or a focal station. A genuine basic issue in mines is perilous gasses.

Frameworks utilized as a part of a mine can make extreme vibrations and increment the level of unsafe gasses, for example, CO, SO2, NO2 and particulate issue. The working conditions can be extremely loud and excavators don't observe each other always. Diggers tend to remain in gatherings and will be close to 5 meters (m) from each other. A notice framework should be consolidated that will caution diggers inside a 5 m sweep that an excavator is encountering a risky occasion. This framework needs to prepare and transmit the occasion inside 1 second (s). These frameworks measure nature around the excavator with gas sensors and are then used to actualize clearings. These don't ready the mineworker at all or just alarm the digger in a capable of being heard way. These frameworks caution diggers, yet when a mineworker is discouraged or harmed, an outside info is required from ground control [8]-[10]. Lately, reaping innovation has assumed a critical part in the range of mine applications. The writing on mines innovation is accessible yet exceptionally constrained. Nutter, et al. proposed an approach for distinguishing
wellbeing perils inborn in underground observing and control. They likewise planned potential wellbeing peril gear. They created techniques in view of systematic gadgets and PC based equipment/programming frameworks [16]. The Internet-of-Things, where all gadgets are brilliant and interconnected, are progressively being utilized as a part of more modern applications [12],[15], and it is in this manner likewise a rule that can have any kind of effect in mining wellbeing with more quick witted gear. The writing additionally demonstrates that in spite of some alluring arrangements; not very many have been actualized and tried in this present reality, recognizing the presence of a hole amongst hypothesis and certifiable application at deductively acknowledged level. In this paper savvy protective cap in consistence with IEEE 21451 benchmarks is displayed. It has different propelled elements, for example, quick reaction time low, versatility, and minimal effort with accurately worthy precision.

II. OBJECTIVE

1) Monitoring: To monitor the parameters like carbon monoxide, temperature and water level detection.

2) Communication: Monitored data will transmit toward pc side (receiver unit) through zigbee wireless communication. ZigbeeCC2500 can be used inside mines at routers.

3) Rescue: At whatever point the sensor information surpasses the predefined edge (preset) estimation of temperature, carbon monoxide and water level, the Wi-Fi module at remote checking site will transmit ready flag to nearby site by blowing ringer ceaselessly and any of the „G, L, C“ letter sets will be shown on LED fragment as per the developing circumstance (G for gas, L for expanding water level, C for temperature). If observing unit needs to call desperately to any worker, at that point signal will ring twice and the representative number will be shown on LED show. For instance in financial balance counter.

4) Protection: Because of this remote correspondence framework, representatives will be ready prior as contrast with display underground framework. So quick move will be made by protect group. So the odds of mischances will be diminished because of the underground mines ecological variables.

III. SYSTEM OVERVIEW

Tackling the issue of excavators evacuating their wellbeing hardware was a test, taken that any new security gear that is not lightweight and non-diverting, will simply be expelled, similar to the various wellbeing gear. As the head protector is the main security adapt excavators tend to continue, this is the place the new wellbeing hardware was included to. Three sensors were utilized, an accelerometer, air quality and an Infra-red (IR) sensor. These were utilized either to identify if a digger has encountered a knock to the head or evacuated his protective cap and encompassing air quality. The three sensors were associated with a ZigBee module. This module does all the preparing and furthermore controls the remote correspondence between isolated caps through the Contiki working framework (OS). The entire framework was dissected all through the plan procedure with a specific end goal to keep the power utilization to a base as the framework is running on battery control. Distinctive sensors were considered for each different part with a specific end goal to keep the power level as low as could be allowed. Keeping in mind the end goal to clarify the whole framework and the choices of every segment, the framework will be clarified segment by segment. The framework comprises of six segments, protective cap expel sensor, crash sensor, air quality sensor, information preparing unit, remote transmission and alarming unit. Figure 1 speaks to the piece graph of the savvy protective cap for mining security. The created model mining security display is appeared in Figure 2. The advancement of the model agrees to the IEEE 21451 standard

Fig2: Functional block diagram

A. Gas Sensor
For detection of methane and carbon monoxide which are the major toxic gases in underground coal mines, MQ-7 gas sensor is used.

Sensor made by smaller scale AL2O3 clay tube, Tin Dioxide (SnO2) delicate layer, measuring anode and radiator are settled into an outside made by plastic and stainless steel net. The radiator gives vital work conditions to work of touchy parts. The encompassed MQ-7 has 6 pins, 4 of them are utilized to get signals, and other 2 are utilized for giving warming current.

B. Air Quality Sensor

Air contamination from coal mines is basically because of emanations of particulate issue and gasses incorporate methane (CH4), sulfur dioxide (SO2), and oxides of nitrogen (NO2), and carbon monoxide (CO). From various examinations, it is outstanding that when individual comes in contact these chemicals/contaminations it could have antagonistic impact on their wellbeing. These uneven proportions of air contamination gasses, for example, suspended particulate issue, increment respiratory ailments, for example, asthma, interminable bronchitis, and cardiovascular issues [13].In this article we have measured the CO, SO2, and NO2, watched, at that point a flag is transmitted through in assembled wifi module to the alarming unit of the head protector.

C. Buzzer

In mining, the diverse sensors gather information identified with condition of underground mine. In the event that the qualities from these sensors surpass certain edge level, at that point there ought to be aware message of all the diggers to leave that place. Thus we have interfaced a basic signal to raspberry pi. Raspberry pi is modified to such edge esteem that the excavator can work with wellbeing and great wellbeing.

D. Helmet Removal sensor (IR sensor)

For identifying the evacuation of the cap a couple of various methodologies will be thinking about. For this investigation, in this framework the IR pillar based cap expel sensor system is viewed as better among the other accessible method, for example, a switch, Analog Distance sensor, Ultrasonic separation sensor and advanced separation sensor. The IR shaft can be intended to utilize the low measure of energy and its cost is less. an off-the-rack IR computerized indicator is utilizing for this application. The IR sensor was intended to send a consistent flag from the one side of the head protector to another agree with the circuit.

E. Flame sensor

Fire sensor is the most delicate to standard light that is the reason its response is for the most part utilized as fire alert purposes. This module can recognize fire or wavelength in 760 nm to 1100 nm scope of light source. Little plate yield interface can and single chip can be specifically associated with the microcomputer IO port. The sensor and fire should keep a specific separation to stay away from high temperature harm to the sensor.
F. Raindrop sensor

The rain sensor module is a simple device for rain discovery. It can be utilized as a switch when raindrop falls through the sprinkling board and furthermore to measure precipitation power. The module highlights, a rain board and the control board that is separate for more accommodation, control marker LED and a flexible affectability however a potentiometer. The simple yield is utilized as a part of identification of drops in the measure of precipitation. Associated with 5V control supply, the LED will turn on when acceptance board has no rain drop, and DO yield is high. While dropping a little sum water, DO yield is low, the switch pointer will turn on. Forget about the water beads, and when reestablished to the underlying state, yields abnormal state.

Fig 5: Rain drop sensor

e. Raspberry Pi

The Raspberry Pi is little pocket estimate PC used to do little figuring and systems administration operations. It is the principle component in the field of web of things. It gives access to the web and thus the association of mechanization framework with remote area controlling gadget ends up noticeably conceivable. Raspberry Pi is accessible in different adaptations. Here, demonstrate Pi 3 show B is utilized and it has quad-center ARM Cortex-A53 CPU of 900 MHz, and RAM of 1GB, it additionally has: 40 GPIO pins, Full HDMI port, 4 USB ports, Ethernet port, 3.5mm sound jack, camcorder interface (CSI), the Display interface (DSI), and Micro SD card opening.

f. Raspbian Operating System

Raspbian working framework is the free and open source working framework which Debian based and improved for Raspberry Pi. It gives the fundamental arrangement of projects and utilities for working Raspberry Pi. It accompanies around 35,000 bundles which are pre-accumulated programming's that are packaged in a pleasant configuration for hustle free establishment on Raspberry Pi. It has great group of designers which runs the exchange shapes and gives answers for some pertinent issues. Be that as it may, Raspbian OS is still under reliable improvement with a primary concentrate on enhancing the execution and the security of however many Debian bundles as could be expected under the circumstances.

IV. DEPICTION OF THE SYSTEM

The information from different sensors sent to the raspberry pi. At whatever point the sensor information surpasses the predetermined limit (preset) esteem, the wi-fi module at remote observing site transmits ready flag to nearby site by blowing signal ceaselessly. Alarming excavators in a mine can be a troublesome procedure remembering the ordinary working conditions that are experienced in a mine. Underground mines are extremely dull spots and in this way the diggers utilize wellbeing caps with worked in or connectable mining lights.

Fig 6: Block diagram
The hardware utilized as a part of underground mines can make a considerable measure of clamor and vibrations, which are intensified by the confined conditions in the underground passages. The issue related with the clamor is that notice a digger with a speaker or an alert framework when a kindred excavator is encountering an unsafe occasion would most likely be futile as the mineworker would not hear the caution. A moment choice was considered with the utilization of a vibrating unit inside the mining protective cap. Cautioning a mineworker with a vibrating cap would work. However when a mineworker is working with one or near hardware that makes a considerable measure of vibration, the excavator most presumably would feel or misconstrue the vibration as a component of the vibration made by the gear. This will enable the framework to just work in particular conditions. The point would be for the framework to work under all conditions. Utilizing light-emanating diodes (LED’s) put on the top of the mining protective cap was additionally considered as it would be a visual method for alarming the excavator. It was then chosen that adding LED’s to a mining head protector that is as of now outfitted with a major light associated with the cap would mean not utilizing the accessible assets. It was thusly chosen to actualize a framework that will caution the digger by glimmering the mining light a couple of times. Utilizing this notice technique has the additional advantage of utilizing the mining protective cap light of the mineworker who is encountering the dangerous occasion. Blazing the light continually at the same time demonstrate who is encountering the issue and in addition show the area of the mineworker.

V. RESULT AND DISCUSSION

The critical levels of the hazardous gases such as CO, SO2, and NO2 in the mines industry has been indicated through alerting unit. The helmet removal test was done successfully with an off the-shelf IR distance sensor. The IR sensor designed from first principles was working device. It was discovered, after the system was integrated, that the transmitted IR signals reflects off the dummy head and kept reflecting off the helmet’s surface until it reached the receiver. The signal at the receiver side was close to the same amplitude as the signal received when the helmet was removed from the head.

A shrewd mining head protector was produced that can recognize three sorts of risky occasions, for example, threat level of unsafe gasses, excavator cap expelling, and crash or effect (mineworkers are struck by an object). The conventional mine security framework can be successfully supplanted by the observation and wellbeing framework proposed in the paper. This paper gives a framework identified with wellbeing and security of underground mines. The framework is dependable, reliable, continuous, practical and easy to use. A bigger range and more profundity inside risky underground mines are currently can be secured and mishaps can be controlled viably. The framework consolidated the low power, minimal effort Wi-Fi based high recurrence remote information transmission innovation. The sensor and Wi-Fi module can be ideally introduced in mines (routers). Proper checking and correspondence is conceivable between the representatives and the observing site which can take proper activities all the more quickly and shrewdly.

Future Scope

1. It will improve scalability of underground environment and extend accurate position of miners.

2. In future, with the help of Wi-Fi module and GUI (software part), it is possible can avoid railways accidents, road accidents, submarine accidents etc.

3. With use of sophisticated sensors, the system can work with more accuracy in real time. It can be modified in industrial monitoring as well.

4. The system can be enhanced by adding extra measuring equipment to check the worker’s heart rate and blood pressure.

VI. CONCLUSION

REFERENCES


