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IOT Based Smart Helmet for Construction Workers

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***Abstract*- Day by day the death rate of the construction workers at the construction site is increasing. But still there are no such remedies to reduce this fatality rate. To provide continuous monitoring of the workers and to prevent them from any health hazards during working, this system proposes a smart flexible helmet for the construction workers to provide security and rescue measures in case of any emergency conditions. The proposed system describes a smart inexpensive helmet for the construction workers made up of chromium embedded with Accelerometer and Gyroscope sensor.**

I. INTRODUCTION

Construction is one of the most vital industries in global infrastructure development, but it is also one of the most dangerous. Workers in this field are frequently exposed to risks such as falling objects, exposure to harmful gases, extreme environmental conditions, and various mechanical and electrical hazards. According to global safety reports, a significant number of workplace injuries and fatalities occur in the construction sector. While personal protective equipment (PPE) like helmets, gloves, and vests are mandated, traditional safety gear often lacks the intelligence to prevent or mitigate accidents in real time.

With the rapid advancement of technology, especially in the field of the Internet of Things (IoT), there is an increasing opportunity to enhance workplace safety through smart and connected solutions. IoT refers to a network of interconnected devices that can collect and exchange data using embedded sensors, processors, and communication hardware. By integrating IoT technology into construction safety equipment, it becomes possible to create smart systems capable of monitoring conditions, detecting hazards, and sending alerts or data in real time.

This project proposes the development of an **IoT-based smart helmet** designed specifically for construction workers. The primary aim of this smart helmet is to provide enhanced safety by monitoring various parameters such as the presence of toxic gases (e.g., methane or carbon monoxide), ambient temperature, the impact force on the helmet, and the worker's location. These features are made possible by incorporating sensors like gas sensors, temperature sensors, accelerometers, and GPS modules, all connected via microcontrollers and communication modules such as Wi-Fi or GSM.

Beyond safety, the smart helmet can also contribute to productivity and compliance. For instance, data collected over time can help project managers analyze worksite conditions, monitor workers' safety behavior, and ensure compliance with occupational safety regulations. It also builds a culture of proactive safety management rather than reactive damage control.

provide security and rescue measures in case of any emergency conditions.

II. LITERATURE SURVEY

Kishor Shrestha et all proposed the "Hard Hat Detection for Construction Safety Visualization". They used image processing techniques to check whether the worker is wearing the helmet or not. This system is used to detect whether the worker is wearing the hat during working. But it does not provide any safety measures to overcome in case of any emergency conditions.

S. Nandhini et all proposed "IOT based Smart Helmet for ensuring Safety in Industries". This system uses sensors to monitor the workplaces. This system is particularly used for detecting safety at workplaces but not for the workers.

S.R .Deokar et all proposed "Smart Helmet for Coal Mines Safety Monitoring and Alerting" system. This system seems to be very efficient as it ensures safety for both the workers and the workplace using wireless sensor networks. It also includes fall detection, toxic gases emission from industry, etc.

Shruthi et all proposed "Smart Helmet for Coal Miners using Zigbee Technology". This system devises a smart helmet using Zigbee technology for monitoring the emission of hazardous gases, abnormal temperature conditions, humidity levels etc. This system ensures safety for workers at the mining area but this helmet is not purposely provided for the safety of the workers.

III. PROPOSED SYSTEM

The smart helmet is embedded with Arduino Uno kit to which the sensors like Heartbeat sensor, Accelerometer and Gyroscope sensor are connected. The helmet is also provided with a panic button to alarm others in case of any disaster. All these smart helmets are worn by the construction workers at the time of working. The civil engineer or the contractor receives all the information about the worker provided by the helmet with the use of the GSM module involved in it. Through this GSM module, alert message are sent through SMS. DCDC converter is used to regulate a flow of current. The contractor or the civil engineer monitors functions of all the workers provided by the helmet with the use of a mobile application specially designed to serve this purpose.

A. Methodology

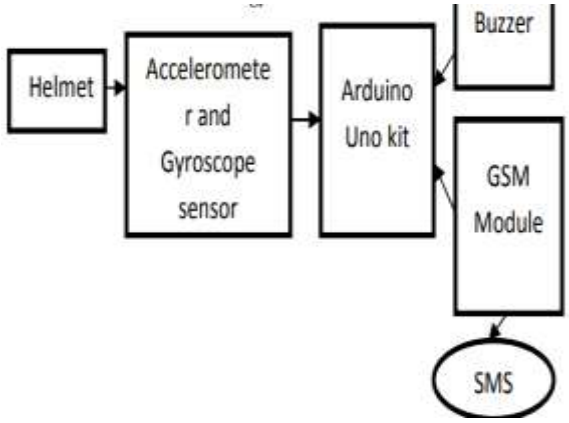

Fig. 1 System architecture.

A. Accelerometer
B. Overview

The proposed system is divided into three phases:

1) Monitoring phase
2) Detecting phase
3) Fall Sensing phase

1) The Monitoring phase:

It is used to measure the angular velocity of the object and the acceleration or motion of the human body. Continuously Monitor the Physical Condition of the Workers the accelerometer and the gyroscope are embedded inside a single chip.

This chip is attached with Helmet to detect the Acceleration, Axis and gravity of the Helmet. Both these sensors are used for fall detection that may result from drowsiness, fatigue, etc. 2) Fall sensing phase:

Fall sensing phase is once the person can fall alert message are sent through the contractor. Check The Workers Orientation And Motion. Once Trigger Is Activated.

3) Location Tracking and Alert Message

GSM modem is a unique type of wireless modem accepts a SIM card. It operates similar to mobile phone with its own specific mobile number.

C. Arduino Uno

The Arduino Uno is designed with 14 digital input/output pins and 6 analogy input pins.

This kit in this system is used as a microcontroller for controlling all the activities of all the modules involved in the process. The sensors are connected to this Arduino board. This kit is embedded inside the smart helmet during the manufacturing process.

Fig. 2 Arduino Uno

D. Accelerometer and Gyroscope sensor

The gyroscope sensor is used to measure the angular velocity of the object. The 3 axis gyroscope sensor can find the orientation and rotation of the person in all three directions with respect to gravity. This provides an angle value ɵ which is then used to indicate the position of the person during fall. An accelerometer sensor is used to measure the acceleration or motion of the human body. A tri axial accelerometer measures the acceleration in all 3 axes x, y and z respectively. The accelerometer sensor provides a parameter value for measuring the person motion. Both these sensors are used for Fall detection.

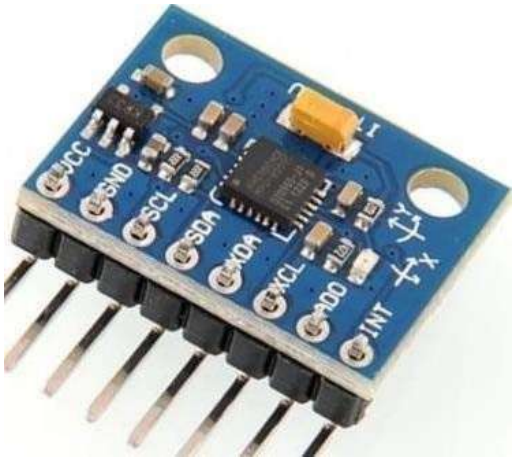

Fig. 3 Accelerometer and gyroscope

E. Fall Detection Algorithm (example)

(1) if the parameter > threshold value of the parameter then

(2) if ɵ> threshold value of ɵ then

(3) return fall detection

(4) return no fall detection

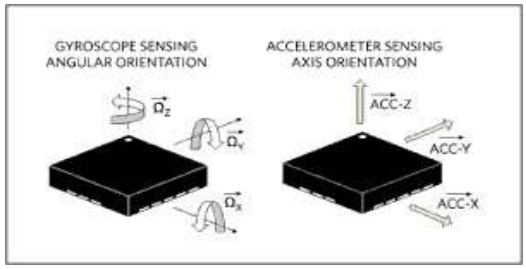

Fig. 4 axis and angular orientation

F. GSM Module and the Mobile App

It is used to describe the protocols for second-generation (2G) digital cellular networks used by mobile devices such as mobile phones and tablets. Alert message are sent through GSM Module. All other details can also be viewed in the mobile application. . The contractor monitors and receives all the information about the worker with use of this GSM facility.

G. Buzzer

The helmet is also designed with panic button. This button is used to alarm other working at various floors of the large building in case of any disaster or emergency situations.

It is designed primarily to intimate every other workers involved in the construction process instantly to avoid large disaster. It is an audio signalling device.

Fig. 5 GSM module and mobile app

Fig.6 Buzzer

IV. EXPERIMENTAL RESULT

The smart helmet consists of accelerometer and gyroscope sensor, dc-dc controller (step down), pulse sensor, buzzer, Arduino Uno and a GSM module.

A. Hardware design

The project hardware setup is shown in figure 1. The helmet made with the Arduino Uno board, accelerometer and gyroscope sensor, GSM module, Buzzer and Dc-Dc step down converter.

Fig. 7 Helmet design

B. Mobile application

The mobile application is used by all workers as well as the contractor. It consists of admin and employee page. The admin page shows complete details about the workers and the site. The employee page shows the corresponding employee's name, ID, location and designation.

Fig. 8 mobile application

C. Arduino output

The output image of the Arduino Uno which is used to identify the person condition. If the person condition is critical and the trigger is activated through person fall. It shows the figure 3.

```
9
8
9
12
19
5
1
TRIGGER 1 ACTIVATED
15
TRIGGER 2 ACTIVATED
24
53
53
TRIGGER 3 ACTIVATED
7
9
10
10
10
10
9
9
9
7
7
FALL DETECTED
```

Fig. 9 Arduino Output

D. Alert Message

The alert message is sent to the contractor, if the contractor receives any SMS about the workers condition he/she receive the worker easily.

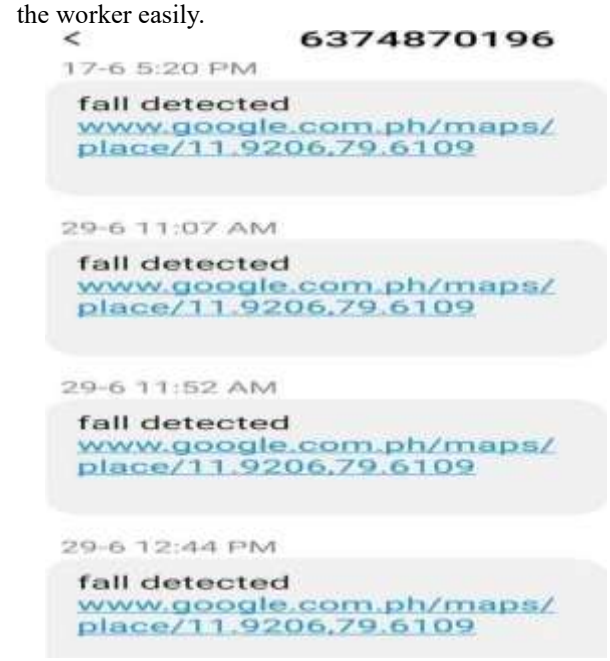

Fig. 10 Alert message

E. Location Tracking

Figure 11 shows the location of the particular worker in the construction place.

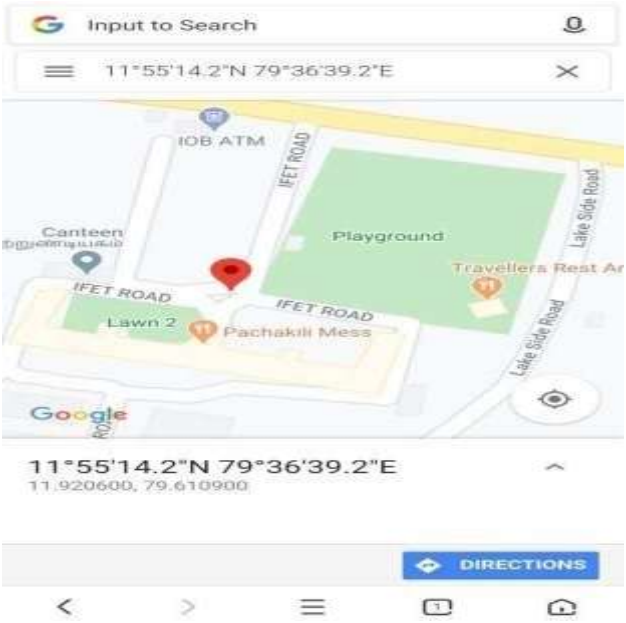

Fig.11 location tracking

Advantages of Proposed System

- Monitoring of workers health condition at the construction site.
- Fall detection of the workers due to fatigue, drowsiness, etc.
- Alarming system provided in case of any natural calamity.
- Prior intimation and notification of the workers condition to the contractor.
- Reduction in death rate of construction workers.
- Quick location identification of the construction workers in case of any emergency situation.
- Enhanced security to the workers working at some highest floors for a large building.
- Inexpensive user-friendly hardest shield that could save the workers from all type of hazards.

V. CONCLUSION

If this proposed system is implemented to ensure the complete safety of the workers at the construction site. Through this smart helmet, the contractor can continuously monitor the entire workers involved in construction process and can also get notification about the workers' physical condition and can immediately save the workers from any serious issues in case of emergency. Hence we can reduce the death rate of the construction workers and provides increased security to them.

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