RESEARCH ARTICLE

Smart Constructor Helmet

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ABSTRACT

Construction industry is one of the most booming industries in the whole world. This industry is mainly an urban based one which is concerned with preparation as well as construction of real estate properties. The repairing of any existing building or making certain alterations in the same also comes under Construction Industry. Large-scale construction requires collaboration across multiple disciplines and hence involves a large number of workers for faster construction processes. But Construction industry has a dangerous side to it which when exposed, shows the deaths of a large number of workers in this sector and the malpractices involved in this sector. Hence is the need of a smart helmet used by workers in the construction field which can be used for the following purposes; tracking of each worker's location by the manager, communication facilities, safety alert messages. The helmet also provides a provision of total working hour calculation and hence, providing attendance which would reduce the manager's workload. Hence, a better working environment in the construction field is provided. *Keywords:-* Smart Helmet

I. INTRODUCTION

Construction work has been increasing in developing and undeveloped countries over the past few years. In a developing country like India, it is a key factor for progression, say like the metro works currently taking place in the state of Kerala.

India's construction industry is the country's second largest employer and contributor to economic activity, after agriculture. According to government estimates, it grew by 80 per cent in the last four years, from \$78 billion in 2013 to approximately \$140 billion this year. The Construction industry of India is an important indicator of the development as it creates investment opportunities across various related sectors. The construction industry has contributed an estimated US\$ 308 billion to the national GDP in 2011-12 (a share of around 19%). The industry is fragmented, with a handful of major companies involved in the construction activities across all segments; medium-sized companies specializing in niche activities; and small and medium contractors who work on the subcontractor basis and carry out the work in the field. In 2011, there were slightly over 500 construction equipment manufacturing companies in all of India. The sector is labor-intensive and, including indirect jobs, provides employment to more than 35 million people.

But, Construction work is a hazardous land-based job and there is a darker side to this explosive growth. For all the big money involved, the sector has scant regard for the safety of those who work in its lowest rungs and every year, hundreds of the men and women workers face a painful death. Scandal towards workers including reduction in their wages and over working time is also becoming a common practice.

Hence, is the need of a Smart Construction Helmet, usable and wearable by all the workers during the working hours of their jobs respectively.

II. LITERATURE SURVEY

Smart helmets are available in different forms with a wide variety of features. Some of them are mentioned as follows. The Babaali construction helmet is a product which consist of Bluetooth technology for connectivity, Built in frond camera for video data collection and SD card storage, Real-time audio and video data delivering to background server etc. Construction helmet from Laing O' Rourke is one another important product in the market currently. Here an array of sensors mounted on a sweatband is retrofitted on to the helmet which then monitors the temperature and the heat rate of the workers, and alerts the workers if and when they may be suffering from heatstroke. Called the DAQRI Smart Helmet, which is a wearable, human-machine interface, DSH uses augmented reality to connect workers with information and their environments, helping to improve efficiency and productivity. It's purpose-built for a work environment. The ruggedness of the helmet, combined with a largest field of view from the see-through display helps users feel comfortable and safe in an industrial environment, indoor and out. And there's no need to struggle with goggles, a hard hat, headphones, and whatever else trying to fit under there. The eye protection, speakers, and microphone are built right in.. The headgear uses a combination of cameras and sensors to capture and record realtime information about the user's surroundings, from valve readings to thermal data. It can also show the wearer stored information like safety guidelines and worker instructions. The device could be integrated with building information modelling (BIM) software. This could allow the display to show users the insides of structural elements, such as the interior of a pipe.

III. METHODOLOGY

The Smart Construction Helmet, usable and wearable by all the workers during the working hours of their jobs respectively, has a variety of important key objectives which are: Location of the worker with respect to where they are located in the building, Communication from the manager to the workers, Alert message when an unexpected accident occurs, Calculation of total working hours and attendance with respect to each worker.

1. Location Tracking: The implementation key of Location tracking is Wi-Fi localization. Wi-Fi localization is a geolocation system that uses the characteristics of nearby Wi-Fi hotspots and other wireless access points to discover where a device is located. It is used where satellite navigation such as GPS is inadequate due to various causes including multipath and signal blockage indoors, or where acquiring a satellite fix would take too long. Such systems include indoor positioning systems. Wi-Fi positioning takes advantage of the rapid growth in the early 21st century of wireless access points in urban areas. Useful in case of indoor location tracking. The accuracy depends on the number of nearby access points whose positions have been entered into the database. Wi-Fi hotspots are placed in every corner of the room providing a signal strength of 100m each. The location of the worker is tracked based on the signal strength of corresponding hotspot in the respective room where the information (which is the id of the hotspot) is sent to the server which could be seen by the authority.

2. Communication from authority: If the manager wants to convey important messages immediately to the workers, he/she could type the required content which would be heard by the worker through the smart helmet. Communication with authority is done with help of TEXT-TO-SPEECH conversion. TEXT-TO-SPEECH is implemented with the help of GOOGLE API. Google APIs is a set of application programming interfaces (APIs) developed by Google which allow communication with Google Services and their integration to other services. Google Text-to-Speech converts text into human-like speech in more than 100 voices across 20+ languages and variants. It applies research in speech synthesis and Google's powerful neural networks to deliver high-fidelity audio. This API creates lifelike interactions with users that transform customer service, device interaction, and other applications.

3. Sudden fall alert message: Sudden fall alert message is implemented with the help of an accelerometer which is present on the helmet. Accelerometer detects magnitude and direction of the proper acceleration, as a vector quantity, and can be used to sense orientation (because direction of weight changes), coordinate acceleration, vibration, shock, and falling in a resistive medium. When a rapid transition occurs in the value of the accelerometer (which may occur when the worker falls unconscious or when he/she falls down) a timed conditional message will be provided. Worker could respond to this with a 'send help or not' option. If 'no' is selected, normal working is continued, else, the manager will be notified with a 'help' status in his server. Hence, emergency services can be provided.

4. Total Working hours calculation and attendance: The accelerometer is employed for this purpose. Initially, after the

worker has logged in, within 1 minute, he/she has to perform an action greater than a predefined threshold to start the working hours calculation. This is done so that the worker does not sit idle after logging in. As soon as the worker logs in, the attendance is marked for the respective day. The head movements are tracked and correspondingly stored on the database. When the head movements stop, idle time is also recorded that represents the rest taken by the workers. Based on this, the total working hours are calculated. On the basis of the number of hours worked, the corresponding salary is provided to the worker by the manager. Hence, salary is allotted to the worker in an hourly basis.



Figure 1: System Design

IV. IMPLEMENTATION

The software's used for the development of project are:

ANDROID STUDIO- Android Studio is the official integrated development environment (IDE) for Google's Android operating system, built on JetBrains' IntelliJ IDEA software and designed specifically for Android development. It is available for download on Windows, macOS and Linux based operating system. It is a replacement for the Eclips Android Development Tools (ADT) as the primary IDE for native Android application development.

XAMPP : Server Setting- XAMPP is a free and open-source cross-platform web server solution stack package developed by Apache Friends, consisting mainly of the Apache HTTP Server, MariaDB database, and interpreters for scripts written in the PHP and Perl programming languages.

DREAMWEAVER(Code typing)- Adobe Dreamweaver is a proprietary web development tool from Adobe Inc. It was created by Macromedia.

The hardware requirements are:

SERVER SPECIFICATION- Minimum 4GB RAM. 8GB RAM is recommended; plus 1 GB for the Android Emulator. 1280×800 minimum screen resolution. 2GB of available disk space minimum. Microsoft Windows 7/8/10 (32-bit or 64-bit), 64-bit required for native debugging macOS X 10.10 (Yosemite) or higher, up to 10.13 (macOS High Sierra) GNOME or KDE desktop Linux (64 bit capable of running 32-bit applications)(GNU C Library (glibc).

ANDROID OS PORTABLE DEVICE- Minimum 1 GB RAM, 500 MB of available space, Android 5.0 or above.

SERVER SIDE DESIGN:

The server which is used by the manager to monitor each worker's details is mainly implemented with the help of PHP, MySQL and XAMPP. Dreamweaver is used to execute the PHP commands which provides the overall layout and design of the server. MySQL were used to construct the tables and enter the values to the tables that were correspondingly stored in the database.

Admin				Lagout
0	SH Welcome to SMART HELMET	Short Summa	ary Monitoring Pane	2
Dashboard		FALL DETECTION		
Add Device		USER TIME	STATUS	
C Assign Helmet		ARJUN 2019-04-29 17:19:42	help	
Add New Employee				
Add Message				
<u>^</u>				

Figure 2: Server layout

PhpMyAdmin is a free software tool written in PHP, intended to handle the administration of MySQL over the Web. PhpMyAdmin supports a wide range of operations on MySQL and MariaDB. Frequently used operations (managing databases, tables, columns, relations, indexes, users, permissions, etc.) can be performed via the user interface. XAMPP is an open source software developed by Apache friends, consisting mainly of the Apache HTTP Server, MariaDB database. XAMPP software package contains Apache distributions for Apache server, PHP and Perl. And it is basically a local host or a local server. This local server works on your own desktop or laptop computer. The use of XAMPP is to test the clients or your website before uploading it to the remote web server. This XAMPP server software gives you the suitable environment for testing MYSQL, PHP, Apache and Perl projects on the local computer. The tables implemented using MySQL, taken in the XAMPP control panel is as shown beelow:

M Structure	SQL 🔍 Se	arch 间 Quer	y 🛃 Export	📑 Import	ß
Table 🔺	Action				
assign_helmet	Browse	🛃 Structure 👒 S	Search 👫 Insert	🚍 Empty 🤤	Drop
attendance	Browse	🥻 Structure 👒 S	Search 👫 Insert	层 Empty 🥥	Drop
device_registra	tion 🔲 Browse	📝 Structure 👒 S	Search 👫 Insert	🚍 Empty 🥥	Drop
🗆 fault	Browse	📝 Structure 👒 S	Search 👫 Insert	层 Empty 🥥	Drop
msg_values	Browse	📝 Structure 👒 S	Search 👫 Insert	🚍 Empty 🥥	Drop
payroll	Browse	🛃 Structure 👒 S	Search 👫 Insert	层 Empty 🥥	Drop
sensor_values	Browse	🛃 Structure 👒 S	Search 👫 Insert	🚍 Empty 🥥	Drop
user	Browse	📝 Structure 👒 S	Search 👫 Insert	🚍 Empty 🥥	Drop
user_registration	Browse	📝 Structure 👒 S	Search 👫 Insert	🚍 Empty 🤤	Drop
wifi_data	Browse	📝 Structure 👒 S	Search 👫 Insert	层 Empty 🥥	Drop
10 tables	Sum				

Figure 3: Server side tables

The table consists of the following parametres:

1. Assign_helmet : Can add details of employee name, ID, imei number and date.

2. Attendance: Shows the entry time, exit time, date according to imei number.

3. Device_registration: Register the device to database.

4. Msg_values: Displays the message to be sent by the manager along with the corresponding imei and a status. Status can be either 0 or 1. If it is 0, the existing messages will be sent.

5. Payroll: Shows the payment details.

6. Sensor_values: Shows the acceleration values (x,y,z) along with the calculated acceleration and time. A status option is also provided in which 'help' could be sent if necessary.

7. User: Provide username and password.

8. user_registration: Employee Registration details- Name, age, address, email-id, phone number, grade and password.

9. Wifi_data: Shows wifi_ssid (hotspot name), wifi signal, date and time.

APPLICATION DESIGN:

The application was designed in android stidio. It is the official integrated development environment (IDE) for Google's Android operating system, built on JetBrains' IntelliJ IDEA software and designed specifically for Android development.



Figure 4: Application Design

There are 3 main activities used here: Splash, Home and Alert activity.

1. Splash activity (Launcher activity): The first activity that gets executed when the application is launched. It is the window where the IP address is entered to connect to the server. The PHP files can be accessed using this IP address.

2.Alert activity: Provides the alert dialogue box in case of accidental alert message. Responds to the message 'Help'.

3.Home activity: The messages are always checked. The message sent from the authority is displayed here. Text to speech conversion is implemented here.

The services are:

1. Wi-Fi service: Scans the nearby available Wi-Fi hotspots and stores into an array called Wi-Fi list. Sorts the list in the descending order of signal strength using a class called Collection which is then later, inserted to database.

2. Sensor service: Obtains the x, y and z coordinates and sends them regularly to the server. If the 'status' field value gets updated to 1, executes Alert activity.

Permissions used are:

1. BaseActivity

2.PermissionResultActivity

3.PermissionUtils

Gives permission to access internet, locations, phone etc. It also checks for the result inorder to display messages like 'permission granted', 'permission denied' and 'never ask again'.

Utils: It has classes. Since java is an object oriented programming language, the utils consists of objects which can be used to access methods. These methods are created in utils and used in home, alert activity etc.

V. FUTURE WORK

Workplace safety is a key area that the helmet has been designed to address. Future work could be provided to replace the necessity to carry auxiliary tools like tablets, books, digital cameras, laptops etc. These types of hand-carried equipment can be dangerous when a worker is performing a task at high altitudes. By having access to this information in a visual space, workers can have their hands free to perform operations or maintain balance. We can update our current implementation technology with machine learning algorithms to obtain more accurate and precise readings. This would also result as a new approach to this project. The helmet could again be improved with addition of sensors that detects heart rate, skin temperature, blood oxygen level, and frontal lobe brain activity so that focus and cognitive states can be monitored. The combination of this set of sensors can serve as an early warning for a variety of potential health-related danger zones that the worker could be placing themselves in.

VI. CONCLUSION

The smart construction helmet combines the traditional safety structure of a hard hat with leading-edge technology to create a safer helmet that's brimming with features to boost productivity, efficiency and effectiveness. This smart helmet already has superior strength and construction and protects the smart technology housed inside as well as your head. Workplace safety is a key area that the helmet has been designed to address. Smart technology has never been wellsuited to worksite conditions with dust, debris and an array of hazards that quickly destroy many consumer-grade products. Wearables could increase the efficiency of technicians, engineers, and other workers in field service, maintenance, healthcare, and manufacturing roles. However, in a manufacturing setup where engineers are working with complex and heavy machinery, they should not feel uncomfortable with these. This product will be economically feasible due to the small amount of hardware used which makes it lightweight and easy to use. Considering India's current situation with accidental deaths at construction sites which is also increasing day by day, this Smart Construction Helmet would surely be a turnover and hence, enhance safer working environments for all equally.

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