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MDPI

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Smart Helmet 5.0 for Industrial Internet of Things Using Artificial Intelligence

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Abstract: Information and communication technologies (ICTs) have contributed to advances in Occupational Health and Safety, improving the security of workers. The use of Personal Protective Equipment (PPE) based on ICTs reduces the risk of accidents in the workplace, thanks to the capacity of the equipment to make decisions on the basis of environmental factors. Paradigms such as the Industrial Internet of Things (IIoT) and Artificial Intelligence (AI) make it possible to generate PPE models feasibly and create devices with more advanced characteristics such as monitoring, sensing the environment and risk detection between others. The working environment is monitored continuously by these models and they notify the employees and their supervisors of any anomalies and threats. This paper presents a smart helmet prototype that monitors the conditions in the workers' environment and performs a near real-time evaluation of risks. The data collected by sensors is sent to an AI-driven platform for analysis. The training dataset consisted of 11,755 samples and 12 different scenarios. As part of this research, a comparative study of the state-of-the-art models of supervised learning is carried out. Moreover, the use of a Deep Convolutional Neural Network (ConvNet/CNN) is proposed for the detection of possible occupational risks. The data are processed to make them suitable for the CNN and the results are compared against a Static Neural Network (NN), Naive Bayes Classifier (NB) and Support Vector Machine (SVM), where the CNN had an accuracy of 92.05% in cross-validation.

Keywords: PPE; OHS; risk detection; naive Bayes; support vector machine; convolutional neural network; deep learning; microcontroller

1. Introduction

Industrial security is achieved when adequate measures and procedures are applied to obtain access to, handle or generate classified information during the execution of a classified contract or program. Industrial safety is the set of rules and activities aimed at preventing and limiting the potential risks associated with an industry, including both transient and permanent risks [1,2].

Many safety protocols have been proposed to improve the quality of life of workers using different techniques [3,4]. Several studies have examined how the availability of artificial intelligence (AI) techniques could affect the industrial organization of both AI service providers and industries adopting AI technology [5]. Above all, the impact of AI on industry 4.0 and its possible applications in other fields have been studied in depth [6].

In recent years, research has also been conducted on the applications of AI in the manufacturing industry [7–11]. The system architecture described in the article integrates technology together with communication systems and permits analyzing intelligent manufacturing. The provided information shows an overview of the possible applications of AI in all industrial areas.

AI allows to maximize decision making in simple or very complex situations. The AI boom that has taken place in the last decades has led to the development of countless AI applications in numerous areas. At present, increasingly better solutions are available to protect the lives of workers when they are exposed to high-risk conditions. That is why, in industry, AI is combined with security measures in order to create an environment that offers better conditions for industrial development.

The objective of the proposed device is to improve occupational health and safety (OHS); increasing employee performance by reducing the probability of illness, injury, absence or death [12]. Another objective is to contribute to the third wave, as proposed by Niu et al. [13,14], through the implementation of intelligent systems for early risk detection in the working environment.

Different studies have been conducted in creation of devices for occupational safety and health (OSH), which indicate the need to implement increasingly innovative solutions for workers in high-risk areas. For example, in 2014 [15] a study was conducted among 209 welders in India and it was found that all of them had more than 2 injuries and 44% (92) of them had more than 10 injuries. Furthermore, in 2020 [16] an analysis of workplace-related injuries in major industries such as agriculture, construction, manufacturing and health care has been carried out. The data for this analysis have been obtained from a Bureau of Labor Statistics and it was found that from 1992 to 2018, the number amounted to 4,471,340 injuries in the upper extremities, 3,296,547 in the lower extremities, and 5,889,940 in the trunk ($p < 0.05$). Therefore, the motivation behind this research is to propose an innovative helmet with different sensors such as temperature, humidity and atmospheric pressure, the force exerted between the helmet and the head of the user, the variations in axes, air quality and luminosity, through specialized IoT modules being able to have a faster reaction time to an accident in a work team. All the research papers that address the problem of occupational safety and health (OSH) are summarised in Table 1 with the purpose of comparing the improvements and advantages of similar research.

The information coming from the sensors is analyzed through a platform known as ThingsBoard. Independent alarms are configured using this information. Likewise, the data coming from the sensors are adapted to classify them in a Convolutional Neural Network, whose accuracy is of 92.05% in cross-validation compared to 3 other supervised learning models.

The remaining part of this work is organized as follows: Section 2 gives an overview of the related literature. Section 3 describes the system design. A multisensory helmet with communication in IIoT and AI-based information analysis is presented in Section 4. Finally, the last section describes future lines of research.

Table 1. OSH-related proposals.

Bibliography	Keywords	Novelty of the Proposal
Vaughn Jr, Rayford B. et al. (2002)	Security-engineering, Risk assessment	The state of security-engineering practices by three information security practitioners with different perspectives.
Choudhry, R. M., and Fang, D. (2008)		This work discusses empirical research aimed at why construction workers engage in unsafe behavior.
Niu, Yuhan, et al. (2019)		This research seeks to develop a smart construction object enabled OHS management system.
Champoux, D., and Brun, J. P. (2003)	Occupational health and safety (OHS), Construction safety, Artificial Inteligence (AI)	This exploratory study based on telephone interviews with the owner-managers of small manufacturing enterprises gives an overview of the most characteristic OHS representations and practices in small firms.
Podgorski, Daniel, et al. (2017)		A proposed framework based on a new paradigm of OSH risk management consisting of real-time risk assessment and risk level detection of every worker individually.
Barata, Joao et al. (2019)		Viable System Model (VSM) to design smart products that adhere to the organization strategy in disruptive transformations
Sun, Shengjing, et al. (2020)		A unified architecture to support the integration of different enabling technologies
Hasle, P., and Limborg, H. J. (2006)	Occupational health and safety, Accident Prevention	The scientific literature regarding preventive occupational health and safety activities in small enterprise.
Hasle, P., et al. (2011)	Occupational health and safety, Accident prevention	The investigation applied qualitative methods and theoretical approaches to CSR, small and medium-sized enterprises (SMEs), and occupational health and safety.
Abdelhamid, T. S., Everett, J. G. (2000)	Occupational safety, Construction safety, Accidents prevention	Accident root causes tracing model (ARCTM) tailored to the needs of the construction industry.
Chi, S., Han, S. (2013)		This study incorporates the systems theory into Heinrich's domino theory to explore the interrelationships of risks and break the chain of accident causation.
Cambraia, F. B., et al. (2010)	Incident reporting systems, Safety management	Guidelines for identifying, analyzing and disseminating information on near misses in construction sites.
Chevalier, Yannick, et al. (2004)	Network security, Cryptographic protocols	High level protocol specification language for the modelling of security-sensitive cryptographic protocols.

2. Related Works

Protective equipment is of obligatory use in cases where the safety of the worker is at risk. However, detecting hazardous situations in a timely manner is not always possible, leading to the occurrence of accidents. Such events call the worker's health and safety into question; the confidence of the worker in the company for which they work decreases [17–19]. For effective prevention of injuries or fatal accidents in the working environment, the integration of electronic components is crucial given their ability for early risk detection. The research of Henley, E.J. and Kumamoto, H [20] proposed a quantitative approach for the optimal design of safety systems which focused on information links (human and computer), sensors, and control systems. In 2003, Condition Monitoring (CM) was addressed in the research of Y. Han and Y. H. Song [21] including a review of popular CM methods, as well as the research status of CM transformer, generator, and induction motor, respectively. In December 2001, the factor structure of a safety climate within a road construction organization was determined by A.I Glendon and D.K Litherland [22]; a modified version of the safety climate questionnaire (SCQ). They also investigated the relationship between safety climate and safety performance. In March 2011, Intelligent Internet of Things for Equipment Maintenance (IITEM) was presented by Xu Xiaoli et al. [23]. The static and dynamic information on electrical and mechanical equipment is collected by IITEM from all kinds of sensors, and the different types of information are standardized, facilitating Internet of Things information transmission [24,25]. The investigations that address motion monitoring and sensor networks have been compiled in Table 2.

Table 2. Proposals related to sensor networks.

Bibliography	Keywords	Novelty of the Proposal
Zhou, Yinghui, et al. (2012)	Internet of Things, Wearable Computing, Robot sensing systems, Acceleration Feature analysis Human-computer interaction	Wearable device based on a tri-axis accelerometer, which can detect acceleration change of human body based on the position of the device being set.
Zhu, C., and Sheng, W. (2009)		A human daily activity recognition method by fusing the data from two wearable inertial sensors attached on one foot and the waist of the subject.
Lindeman, Robert W., et al. (2006)		A development history of a wearable, scalable vibrotactile stimulus delivery system.
Kim, Sung Hun, et al. (2018)		Experiments were performed in which the sensing data were classified whether the safety helmet was being worn properly, not worn, or worn improperly during construction workers' activities.
Nithya, T., et al. (2018)	Head motion recognition, Hazardous gas, Temperature measurement, Sensor System, IMU, Electroencephealography (EEG)	Smart helmet able to detect hazardous events in the mining industry and design a mine safety system using wireless sensor networks.
Li, Ping, et al. (2014)		Smart Safety Helmet (SSH) in order to tack the head gestures and the brain activity of the worker to recognize anomalous behavior.
Fang, Y., et al. (2016)	Crane safety, Human errorReal-time, Crane motion capturing	A prototype system was developed based on the framework and deployed on a mobile crane.
Cao, Teng, et al. (2014)	Steady-state visual evoked potential (SSCEP), Brain-computer interfaces (BCIs)	Propose a method for the real-time evaluation of fatigue in SSVEP-based BCIs.

Moreover, an Accident Root Causes Tracing Model (ARCTM), tailored to the needs of the construction industry, has been presented by Tariq S. Abdelhamid and John G. Everett [26]. In January 2010, guidelines for identifying, analyzing and disseminating information on near misses at construction sites were defined by Fabricio BorgesCambraia et al. [27]. In September 2013, three case studies were presented by Tao Cheng and Jochen Teizer [28] which employed methods for recording data and visualizing information on construction activities at a (1) simulated virtual construction site, (2) outdoor construction setting, and (3) worker training environment. Furthermore, systems theory has been incorporated in Heinrich's domino theory by Seokho Chia and Sangwon Han [29] to explore the interrelationships between risks and to break the chain of accident causation. In April 2008, the reasons for which construction workers engage in unsafe behavior were discussed in the empirical research of Rafiq M. Choudhry and Dongping Fang [30]. Interviews were conducted in Hong Kong with workers who had been accident victims. In addition, Daniel Fitton et al. [31] applied augmented technology with sensing and communication technologies which can measure use in order to enable new pay-per-use payment models for equipment hire. The areas in which it is necessary to create a safer working environment are listed in Table 3. This can be achieved through the use of sensors for the monitoring environmental parameters and capturing motion.

In December 2008, the underlying biomechanical elements required to understand and study human movement were identified by A. Godfrey et al. [32]. A method for investigating the kinematics and dynamics of locomotion without any laboratory-related limitations has been developed by Yasuaki Ohtaki et al. [33]. In April 2012, the usage of the Unscented Kalman Filter (UKF) as the integration algorithm for the inertial measurements was proposed by Francisco Zampella et al. [34]. Furthermore, in 2012, a micro wearable device based on a tri-axis accelerometer was introduced by Yinghui Zhou et al. [35]. It can detect change in the acceleration of the human body on the basis of the position of the device. In 2009, a method for the recognition of daily human activities was developed by Chun Zhu and Weihua Sheng [36]. This method involved fusing the data from two wearable inertial sensors attached to the foot and the waist of the subject. In October 2012, Martin J.-D. Otis and Bob-Antoine J. Menelas [37] reported an ongoing project whose objective was to create intelligent clothes for fall prevention in the work environment. In 2007, a signal transform method, called Common Spatial

Pattern, was introduced by Hong Yu et al. [38] for Electroencephalographic (EEG) data processing. In March 2006, the development history of a wearable, called the scalable vibrotactile stimulus delivery system, was presented by Robert W. Lindeman et al. [39]. In 2014, an objective and real-time approach based on EEG spectral analysis for the evaluation of fatigue in SSVEP-based BCIs was proposed by Teng Cao et al. [40].

Table 3. Proposals related to safety environment and motion recognition.

Bibliography	Keywords	Novelty of the Proposal
Fernández-Muñiz, B., et al. (2012)	Safety climate, Employee perceptions, Safety performance	The current work aims to analyse the safety climate in diverse sectors, identify its dimensions, and propose to test a structural equation model that will help determine the antecedents and consequences of employees' safety behaviour.
Glendon, A. I., Litherland, D. K. (2001)		A behavioral observation measure of safety performance and a road construction organization using a modified version of the safety climate questionnaire (SCQ).
Han, Y., and Song, Y. H. (2003)	IMU, Magnetometers, Gyroscopes, Accelerometer, Human motion	After introducing the concepts and functions of CM, this paper describes the popular monitoring methods and research status of CM on transformer, generator, and induction motor, respectively.
Godfrey, A. C. R. M. D. O. G., et al. (2008)		The underlying biomechanical elements necessary to understand and study human movement.
Ohtaki, Y., et al. (2001)		A new method is proposed to investigate kinematics and dynamics of locomotion without any limitation of laboratory conditions.
Zampella, Francisco, et al. (2012)		The usage of the Unscented Kalman Filter (UKF) as the integration algorithm for the inertial measurements.
Cheng, T., and Teizer, J. (2013)	Body sensor network (BSN), Vision Algorithms, Augmented reality (AR) Virtual Reality (VR), Location tracking,	A novel framework is presented that explains the method of streaming data from real-time positioning sensors to a real-time data visualization platform.
Bleser, Gabriele, et al. (2015)		Assistance system based in the last advances in hardware, software and system level.
Fitton, Daniel, et al. (2008)		Investigation into how physical objects augmented with sensing and communication technologies can measure use in order to enable new pay-per-use payment models for equipment hire.
Yu, H., et al. (2007)	Measuring vigilance, Sensor network, Intelligent sensors	Signal transform method, Common Spatial Pattern, to process the EEG data.
Qiang, Cheng, et al. (2009)		A cost effective ZigBee-based wireless mine supervising system

Thanks to the implementation of communication technologies, it is possible to notify both the managing staff and the workers about the hazards encountered in a particular working area. A helmet that implements Zigbee transmission technologies for the analysis of variables such as humidity, temperature and methane in mines has been developed by Qiang et al. (2009) [41]. This helmet helps decrease the risk of suffering an accident during the coal extraction process. An intelligent helmet for the detection of anomalies in mining environments was also proposed by Nithya et al. (2018) [42]. This research points to the possibility of integrating components in the PPE that would alert the worker of the presence of danger. Moreover, the vital signs of the worker are monitored by their helmet, making it possible to monitor their state of health. An emergency button on the helmet is used for the transmission of alerts via Zigbee technologies to the personnel nearest to the working environment. Accelerometers have been integrated in safety helmets by Kim et al. (2018) [43], with the purpose of detecting if the safety helmet is being worn properly, improperly or not worn at all while the worker performs their tasks. In December 2016, a framework for real-time pro-active safety assistance was developed by Yihai Fang et al. [44] for mobile crane lifting operations.

Ensuring the physical well-being of workers is the responsibility of employers. Better protection is offered to today's workers thanks to PPE helmets by protecting the worker from blows to the head. However, monitoring other aspects for the worker's security is important in some cases. Li et al. (2014) [45] developed a helmet which, by means of sensors, measures the impact of blows to the worker's head. Sensors for brain activity detection are also implemented in the helmet. In terms of movement, identifying the position of the worker is essential in order to detect falls that result in physical injury or fatal accidents.

In 2019, Machine Learning (ML) algorithms for the prediction and classification of motorcycle crash severity were employed in a research by Wahab, L., and Jiang, H. [46]. Machine-learning-based techniques are non-parametric models without any presumption of the relationships between endogenous and exogenous variables. Another objective of this paper was to evaluate and compare different approaches to modeling motorcycle crash severity as well as investigating the risk factors involved and the effects of motorcycle crashes. In 2015, a scalable concept and an integrated system demonstrator was designed by Bleser, G. et al. [47]. The basic idea is to learn workflows from observing multiple expert operators and then transferring the learned workflow models to demonstrate the severity of motorcycle crashes. In 2019, an intelligent video surveillance system which detected motorcycles automatically was developed by Yogameena, B., Menaka, K., and Perumaal, S. S. [48]. Its purpose was to identify whether motorcyclists were wearing safety helmets or not. If the motorcyclists were found without the helmet, their License Plate (LP) number was recognised and legal action was taken against them by the traffic police and the legal authority, such as assigning penalty points on the motorcyclists' vehicle license and Aadhar Number (Applicable to Indian Scenario). In 2017, a comparison of four statistical and ML methods was presented by Iranitalab, A., and Khattak [49], including Multinomial Logit (MNL), Nearest Neighbor Classification (NNC), Support Vector Machines (SVM) and Random Forests (RF), in relation to their ability to predict traffic crash severity. A crash costs-based approach was developed to compare crash severity prediction methods, and to investigate the effects of data clustering methods—K-means Clustering (KC) and Latent Class Clustering (LCC)—on the performance of crash severity prediction models. These novel proposals are compiled in Table 4. They employ artificial intelligence and machine learning, and suppose a significant improvement in different scenarios.

In 2005, the results obtained with the random forest classifier were presented in the research of M. Pal [50] and its performance was compared with that of the support vector machines (SVMs) in terms of classification accuracy, training time and user defined parameters. In January 2012, the performance of the RF classifier for land cover classification of a complex area was explored by V. F. Rodriguez-Galiano et al. [51]; the evaluation was based on several criteria: mapping accuracy, sensitivity to data set size and noise. Furthermore, in February 2014, a random forest classifier (RF) approach was proposed by Ahmad Taher Aza et al. [52] for the diagnosis of lymph diseases. In April 2016, the use of the RF classifier in remote sensing was reviewed by Mariana Belgiua and Lucian Drăguţ [53]. Besides, in 2015, machine learning approaches including k-nearest neighbor (k-NN), a rules-based classifier (JRip), and random forest, were investigated by Esrafil Jedari et al. [54] to estimate the indoor location of a user or an object using RSSI based fingerprinting method. Finally, in July 2011, a method utilizing Healthcare Cost and Utilization Project (HCUP) dataset was presented by Mohammed Khalilia et al. [55] for predicting disease risk in individuals on the basis of their medical history.

With regard to CNN in 2020, an automated system for the identification of motorcyclists without helmets from real-time traffic surveillance videos was presented by Shine L. and Jiji, C. V. [56]. A two-stage sorter was used to detect motorcycles in surveillance videos. The detected motorcycles were fed in a helmet identification stage based on a CNN. Moreover, in July 2019, the same approach to detecting the absence of helmets on motorcyclists with or without helmets was presented by Yogameena B. et al. [48]; it was different in that it combined a CNN with a Gaussian Mixture Model (GMM) [57]. Furthermore, in 2020, a system that uses image processing and CNN networks was developed by Raj K. C. et al. [58] for the identification of the motorcyclists who violate helmet laws.

The system includes motorcycle detection, helmet vs. helmetless classification and motorcycle license plate recognition. As can be observed, CNNs have been used mainly for real-time image processing. However, the use of CNN for linear data evaluation is proposed in this paper. Here, CNN is integrated (input–output) in a rules model for the classification of different problems in working environments. The presented papers are examples and inspired the given research as a support for this paper. A diagram of the most represented technologies in the state of the art is given in Figure 1. These technologies are the main basis of the proposal.

Table 4. Proposals related to Smart manufacturing and Machine Learning.

Bibliography	Keywords	Novelty of the Proposal
Lee, Jay, et al. (2018)	Artificial Inteligent Smart manufacturing, Failt diagnosis	State of AI technologies and the eco-system required to harness the power of AI in industrial applications.
Henley, E. J., and Kumamoto, H. (1985)		Provides a quantitative treatment of the optimal design of safety systems focusing on information links (human and computer), sensors, and control systems.
Li, Bo-hu, et al. (2017)		Based on research into the applications of artificial intelligence (AI) technology in the manufacturing industry in recent years.
Xiaoli, X. et al. (2011)		A presentation of Intelligent internet of things for equipment maintenance (IITEM) which we can make intelligent processing of device information.
Varian, Hal. (2018)		Summary of some of the forces at work and to describe some possible areas for future research.
Wahab, L., and Jiang, H. (2019)	Machine Learning (ML), Decision Tree Classifier (DTC), Random Forest (RF), Multinomial logic model (MNLM), Support vector machine (SVMs), Receiver operating characteristic (ROS)	Traffic crash analysis using machine learning techniques.
Azar, A. T., et al. (2014)		A random forest classifier (RFC) approach is proposed to diagnose lymph diseases.
Belgiu, M., and Drăguţ, L. (2016)		This review has revealed that RF classifier can successfully handle high data dimensionality and multicolinearity, being both fast and insensitive to overfitting.
Khalilia, M., et al.		Method for predicting disease risk of individuals using random forest.
Jedari, E., et al. (2015)		Machine learning approaches including k-nearest neighbor (k-NN), a rules-based classifier (JRip), and random forest have been investigated to estimate the indoor location of a user or an object using RSSI based fingerprinting method.
Iranitalab, A., and Khattak, A. (2017)		This paper had three main objectives: comparison of the performance of four statistical and machine learning methods including Multinomial Logit (MNL), Nearest Neighbor Classification (NNC), Support Vector Machines (SVM) and Random Forests (RF), in predicting traffic crash severity.
Pal, M. (2005)		To present the results obtained with the random forest classifier and to compare its performance with the support vector machines (SVMs) in terms of classification accuracy, training time and user defined parameters.
Rodriguez-Galiano, V. F., et al. (2012)		The performance of the RF classifier for land cover classification of a complex area is explored.
Yogameena, B., et al. (2019)	Complex software system, Mixture models, Convolutional neural networks	Intelligent video surveillance system for automatically detecting the motorcyclists with and without safety helmets.
Cockburn, D. (1996)		The benefit of taking a holistic perspective to developing complex software systems.

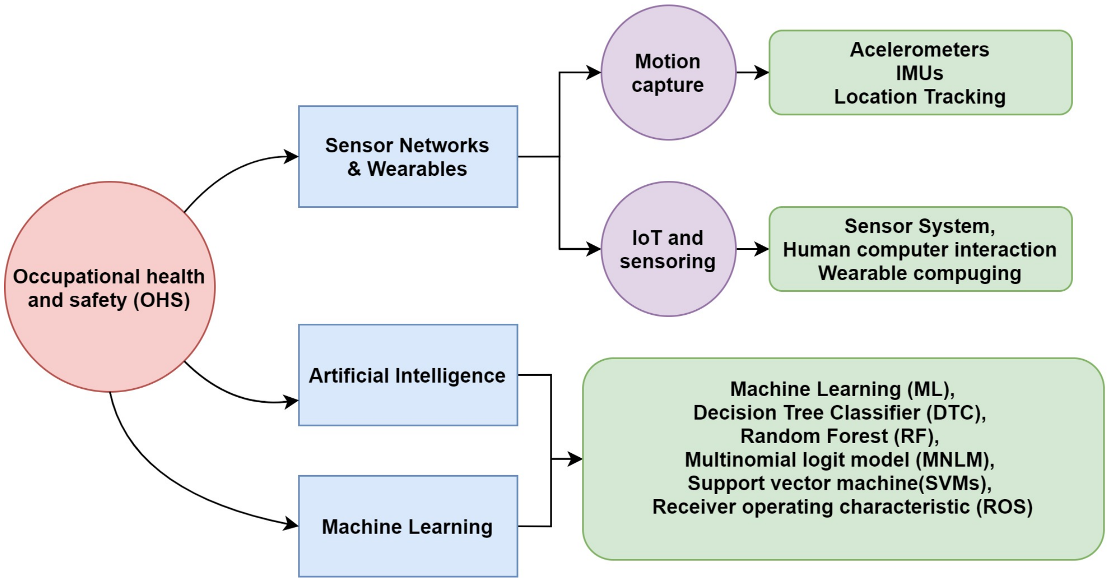

Figure 1. A block diagram of the devices.

3. Smart Helmet 5.0 Platform

There are different methodologies for carrying out research on electronics and system design. Thus, in this section, a description of the hardware and software used for the development of the fifth version of the smart helmet will be presented, and the procedure followed for its subsequent validation through the AI model will be detailed. The four previous helmets included less sensorisation and conectivity, which is why we developed a new version with all the improvements.

3.1. Hardware Platform

The structure followed in the development of the proposed helmet are the steps involved in the prototype development methodology, identifying the parameters to be monitored in the environment. A Job Safety Analysis (JSA) was performed, identifying the risk factors that lead to injuries and accidents in the worker [59]. The deficiencies that have been observed are presented in Table 5 for work places such us mines, construction places and electrical work areas. They are related to aspects such as lighting, detection of blows to the worker's helmet (PPE detection), dangerous temperature levels for human activityand poor air quality in the environment. Other parameters that could be interesting such as, noise, rate pulse and body temperature are implemented in other devices for better ergonomics.

Table 5. Identification of common risk situations in the worker's environment.

Risk Factors	Associated Hazards
Lack of Adequate Lighting	- The inability of the worker to see their environment clearly leads to accidental hits, slips, trips and falls. - The worker is unaware of the events occurring in their environment.
Temperature	- Extreme temperature changes leading to a heat stroke
Air Quality	- Harmful air in the environment
Operator Movement	-Slips, trips and falls -Blows to the worker's head

Given the above, a series of specialized sensors are proposed to counteract the difficulties that usually occur in a high-risk work environment [1], see Table 6. As seen in the literature review, agriculture and industrial activities involve high risk, among others.

Table 6. Identification of electronic components for the prevention of risks in the worker's environment.

Risk Factors	Solution
Lack of Adequate Lighting	- Implementation of a brightness sensor in the helmet - Inclusion of torches as one of the tools of worker
Temperature	- Implementation of temperature sensors in the devices of the worker or environment
Air Quality	-Moisture and gas sensors.
Operator Movement	- The use of wearable devices with accelerometers capable of detecting falls. - Integration of sensitive force resistors in the helmet of the operator.

In terms of the transmission of information from sensors, the use of Wi-Fi technologies has been selected due to their ability to transmit the information in Local Area Networks (LAN) to a web server responsible for collecting, processing and transmitting anomaly warnings to the worker or administrative personnel. The following describes the system design and the interaction of the components.

The elements used in the smart helmet and the risks it seeks to prevent or detect are detailed below. The operation of the Smart PPE and the distribution of the circuits will also be discussed. In addition, the architecture and technologies are explained, as well as the operating rules of the different sensors and actuators that make up the system. Finally, their communication system is considered, as well as the technology used for both the management of the data and for its visualization and treatment once obtained.

The aim of this Smart PPE is to protect the operator from possible impacts, while monitoring variables in their environment such as the amount of light, humidity, temperature, atmospheric pressure, presence of gases and air quality. At the same time, the Smart PPE is to be bright enough to be seen by other workers, and the light source will provide extra vision to the operator. All these alerts will be transmitted to the operator by means of sound beeps. The sensors described below were selected as part of the set of electronic devices to be implemented:

- Temperature, gas and pressure sensor;
- Brightness sensor;
- Shock sensor;
- Accelerometer.

In the process of the visualization of environmental data, a LED strip is deployed on the helmet as a means of notifying the worker of anomalies through color codes presented in the environment. The block diagram shown in Figure 2 is a representation of the electronic system integrated in the helmet.

The specifications of the sensors and the microcontroller used to monitor the environment are defined as follows:

The component used to supervise the parameters of gas, pressure, temperature and humidity is the low power environmental sensor DFRobot BME680. It is a MEMS (Micro-Electromechanical System) multifunctional 4 in 1 environmental sensor that integrates a VOC (Volatile Organic Compounds) sensor, temperature sensor, humidity sensor and barometer. The environmental pressure is subject to many short-term changes caused by external disturbances. To suppress disturbances in the output data without causing additional interface traffic and processor work load, the BME680 features an internal IIR filter. The output of the subsequent measurement step is filtered using the following Equation (1):

$$x_{filt}[n] = \frac{x_{filt}[n-1] * (c-1) + x_{ADC}}{c} \quad (1)$$

where $x_{filt}[n-1]$ is the data coming from the current filter memory, and x_{ADC} the data coming from current ADC acquisition and where $x_{filt}[n]$ denotes the new value of filter memory and the value that will be sent to the output registers.

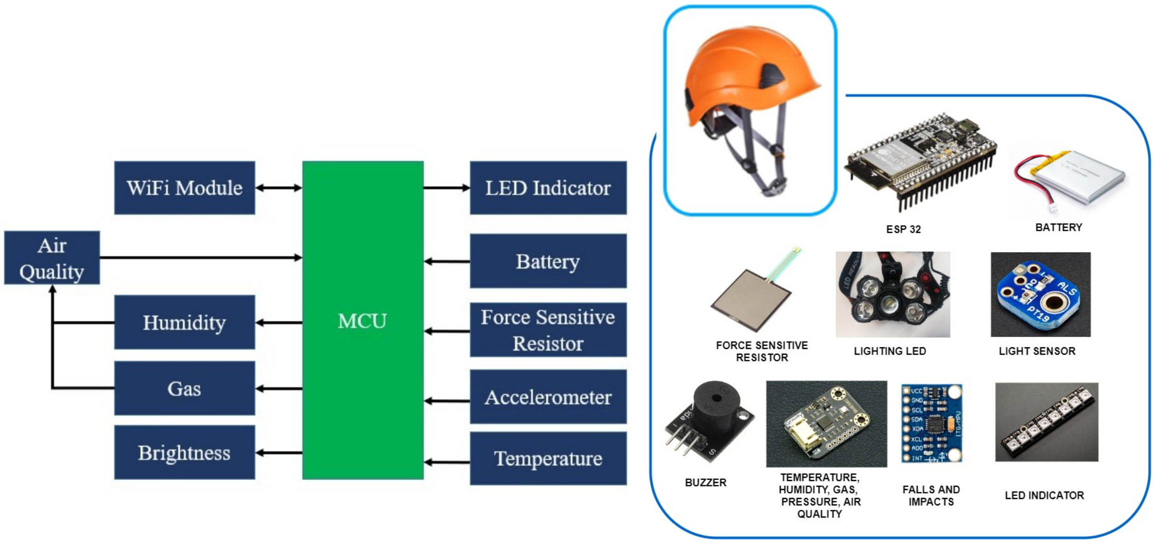

Figure 2. A block diagram of the devices.

The sensor implemented for the monitoring of the level of brightness is the ALS-PT19 ambient light sensor. Due to the high rejection ratio of infrared radiation, the spectral response of the ambient light sensor resembles that of the human eyes.

The sensor implemented for shock detection is a sensitive force resistor, the sensor emits shock alerts if the readings obtained in the environment exceed a threshold value.

The sensor responsible for the detection of falls suffered by the worker is the MPU6050 module, it is an electronic component that has six axes (three corresponding to the gyroscope system and three to the accelerometer) making it possible to obtain the values of positioning in the X, Y and Z axes.

The light source integrated in the helmet is a NeoPixel Adafruit LED strip, the component integrates a multicolor LED in each section of the strip. The algorithm implemented in the microcontroller is configured in such a way that it is possible to control the color of the LED strip.

The microcontroller used for processing, transmitting and displaying the information transmitted to the web platform is the dual-core ESP-WROOM-32 module of the DFRobot FireBeetle series, which supports communication through Wi-Fi and Bluetooth. The main controller supports two power methods: USB and 3.7 V external lithium battery.

The components are integrated in the microcontroller, which obtains and processes the information coming from the sensors. This information is then transmitted to the implemented web server by means of the Wi-Fi module. The designed electronic system is located in the backside of the helmet, as shown in Figure 3. It also integrates a lamp which is activated automatically if the brightness value of the sensor is below the threshold value established in the programming of the microcontroller. The information transmitted by the helmet can be viewed on a web platform.

This section describes the developed software and the interaction that takes place between the different components.

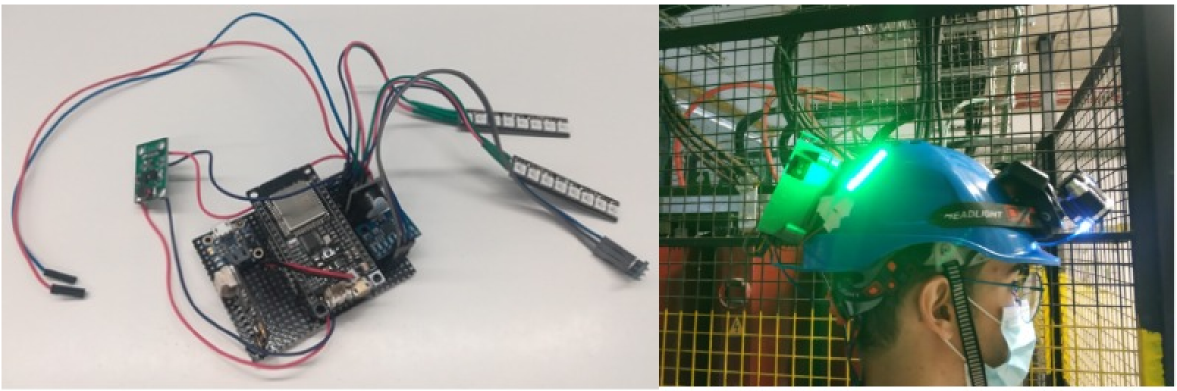

Figure 3. The electronic system of the helmet.

3.2. Intelligence Module

Firstly, the communication between the active sensors is enabled by Thingsboard. ThingsBoard is an open source IoT platform for data collection, processing, visualization and IoT device management. It is free for both personal and commercial use and can be implemented anywhere.

It enables device connectivity through industry-standard IoT protocols (MQTT, CoAP and HTTP) and supports both cloud and on-premise deployments. ThingsBoard combines scalability, fault tolerance and performance, ensuring that the users' data are never lost.

ESP32 is a series of low-power, low-consumption system-on-a-chip microcontrollers with integrated Wi-Fi and dual-mode Bluetooth, as mentioned in the previous section. The device is responsible for transmitting the information to the ThingsBoard platform and its subsequent processing by the intelligent model see Figure 4, to interact with the helmet.

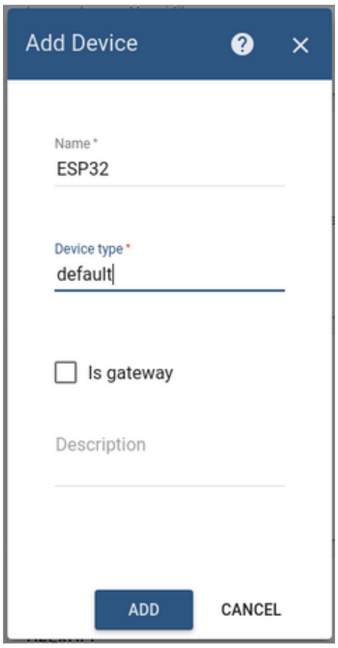

Figure 4. Setting up the ThingsBoard platform to operate according to the information received from ESP32, IoT module added to ThingsBoard and Multi-sensorial configuration.

Simple steps are required to link the devices to the platform:

- The automatically generated access token is copied from the Access token field.
- Go to Devices, locate ESP32 device, open the device details, and select the Latest telemetry tab.
- It is now possible to view the data regarding an asset.

The data obtained through ThingsBoard is later processed by an intelligent model, the model confirms or denies the existence of a real emergency. This is the reason why configuring the platform is very important.

An association must be created between the different values of the sensors and the corresponding response. Once these associations are created, it is possible to modify any value depending on the values to be tested empirically or in the alarms. Alarms are configured in the device settings so that the respective notifications appear on the panel. A rule chain must be added.

A selection of the attributes placed on the server and on the device's threshold panel must be carried out. The names of the attributes on the server must correspond with those on the panel so that when the data are dynamically configured, they will be recognized correctly and will appear on the diagram generated by the platform, Figure 5.

Subsequently, in the script block, it is verified that the information coming from the device does not exceed the established threshold value. If the script is positive, an alarm is configured and the information to be displayed is defined.

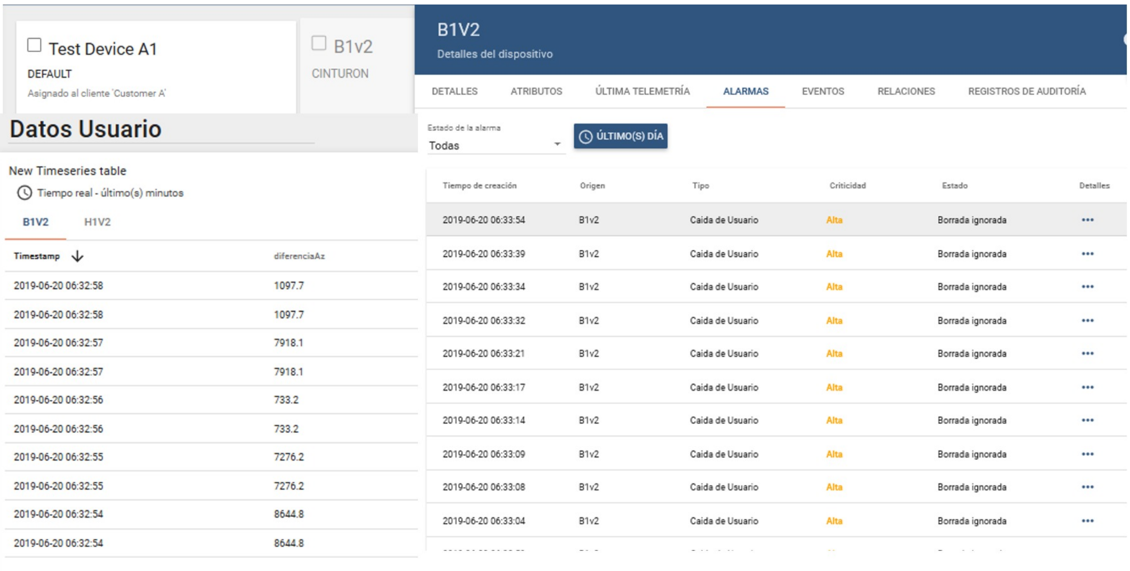

Figure 5. Alarm configuration on ThingsBoard, Block alarm creation method and Connecting alarms with sensors.

Moreover, the root string, which is in charge of obtaining and processing the information coming from the devices, has been modified. In this case, an originator type section has been added, where the devices that transmit the information are identified. Likewise, code strings have been generated to implement the customized code blocks in the panels. Finally, the information on the data panel may be visualized.

In cases where it is not necessary to perform this procedure, it is possible to view the notifications generated by the different devices. To this end, it is necessary to enter the Device section. Select one of the devices for which an alarm has been configured and go to the alarms tab, see Figure 6, where the notifications generated by that device are displayed.

Once the alarms have been configured on the platform, validation is carried out through the explanation of the AI [60].

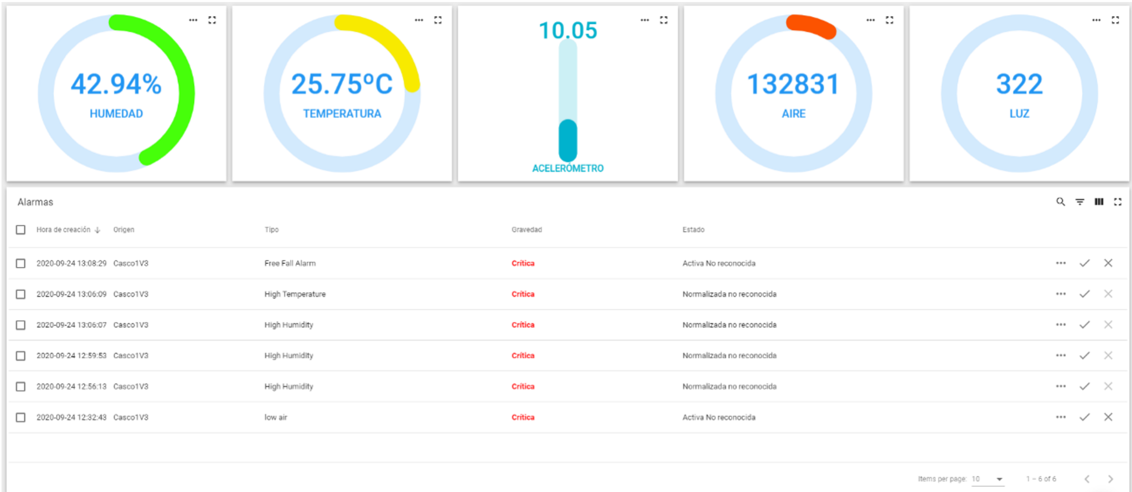

Figure 6. Final configuration of ThingsBoard platform to be validated through an intelligent algorithm.

4. Platform Evaluation

This section compares the different algorithms used in the state of the art to solve problems similar or related to the one being addressed here [61–64], these models have been accepted for real world problems due to their dataset results with data unbalance and saturation issues, this comparison will be performed with the same amount of data and on an objective quantitative basis. Furthermore, the present proposal is described in detail.

4.1. Data Model

In this study, samples of data from a real environment have been obtained, where a subject was subjected to various scenarios in simulated environments, considering the different risks that could arise. The five analyzed parameters are shown in Table 7. The acquired dataset consists of a total of 11,755 samples, where five descriptive variants are proposed with respect to the target of the study.

Table 7. Parameters for which data are collected.

1. Brightness
2. Variation in X, Y and Z axis
3. Force Sensitive Resistor
4. Temperature, Humidity, Pressure
5. Air quality

This research tackles a multi-class type of problem, for this reason there is a set of labels that have a different meaning. When the programming of the microcontroller was carried out, the different parameter values that could trigger an alarm signal were investigated, for example, if the air quality falls below the threshold (measured by the Air Quality Index, AQI) it is possible to associate this situation with the values for other parameters measured by neighboring sensors. The 12 labels proposed in this work are described below, where research was carried out on the most common problems in industrial areas and from there the type of sensors in the helmet were included [65,66]:

0. Good for health air (AQI from 0 to 50) with sufficient illumination in the working environment.
1. Moderate air quality (AQI of 51 to 100) with slight variation in temperature and humidity.
2. Harmful air to health for sensitive groups (AQI 101-150) with moderate variation in temperature and humidity.
3. Harmful air to health (AQI 151 to 200) with considerable variation in temperature and humidity
4. Very harmful air to health (AQI 201 to 300) with high variation in temperature and humidity.
5. Hazardous air (AQI greater than 300) with atypical variation in temperature and humidity.

6. Lack of illumination and variation equivalent to a fall in axes.
7. Lack of illumination and variation equivalent to a fall in axes and considerable force exerted on the helmet.
8. Atypical variation on the detected axes and moderate force detected on the FSR.
9. Illumination problems, air quality and sudden variation in axes.
10. Very high force exerted on the FSR.
11. Variation in axes with illumination problems.
12. Outliers on the 5 sensors.

Once the information has been understood, it is cleaned. As proposed by [67], the data were cleaned due to common problems such as missing values solved with the clamp transformation, see Equation (2).

$$a_i = \begin{Bmatrix} lower & if a_i < lower \\ upper & if a_i > upper \\ a_i & Otherside \end{Bmatrix} \tag{2}$$

where a_i represents the $i-$th sample of the data set, lower and upper thresholds respectively.

The upper and lower thresholds can be calculated from the data. A common way of calculating thresholds for the clamp transformation is to establish:

- The lower threshold value $= Q_1 - 1.5IQR$;
- The upper threshold value $= Q_3 + 1.5IQR$.

Where Q_1 is the first quartile, Q_3 is the third quartile and IQR is the interquartile range ($IQR = Q_3 - Q1$ the interquartile range). Any value outside these thresholds would become the threshold values. This research takes into account the fact that the variation in a data set may be different on either side of a central trend. Each sample that had missing data was eliminated so as not to bias the model. However, the search for outliers was only used to find erroneous data generated by the electronic acquisition system since outliers usually provide a large source of information for the analysis of a dataset.

4.2. Intelligent Models Evaluation

The comparison part describes each of the models used for the current project, detailing the Support Vector Machine, Naïve Bayes classifier, Static Neural Network and a Convolutional Neural Network. Each model used the dataset of 11,755 where 80% was used for modeling and 20% for evaluation, in other words 9404 in training and 2351 in evaluation. The following confusion matrices reports the result of the validation and after that, we include a figure for each model in order to present the information clearly. It is worth mentioning that all models were trained and validated with the same data division in relation 80-20, it is also notable above an imbalance of classes, given the imbalance some models had unfavorable behavior in cross validation. To handle the imbalance it is possible to opt for techniques such as oversampling or undersampling but it is not desired to change the quality of the data, that is why the model with the best performance will be chosen and evaluated with 10 folds for validation.

Support Vector Machine

SVMs belong to the categories of linear classifiers, since they introduce linear separators better known as hyperplanes, regularly made within a space transformed to the original space.

The first implementation used for the multi-class classification of SVM is probably the one against all method (one-against-all). The SVM is trained with all the examples of the $m-$th class with positive labels, and all the other examples with negative labels. Therefore, given the data of the $(x_1, y_1), ..., (x_l, y_l)$ where $x_i \in R^n, i = 1, ..., l$ y $y_i \in \{1, ..., k\}$ is the class of x_i, the $m-$th SVM, and solve the problem in Equation (3) [68], which involves finding a hyper plane so that points of the same kind are on the same side of the hyperplane, this is finding a b and w such:

$$y_i(w'x_i + b) > 0,\ i = 1, \ldots, N \tag{3}$$

Equation (4) looks for a hyper plane to ensure that the data are linearly separable.

$$\underset{1 \le i \le N}{min} \quad y_i(w'x_i + b) \ge 1 \tag{4}$$

where $w \in \mathbb{R}^d,\ b \in \mathbb{R}$ and the training dataset x_i is mapped to a higher dimensional space. Thus, it is possible to search among the various hyperplanes that exist for the one whose distance to the nearest point is the maximum, in other words, the optimum hyperplane [68], see Equation (5).

$$\begin{gathered} \underset{w,b}{min} \frac{1}{2} w^T w \\ individual \ \ a \ \ y_i(w^T, x_i + b) \ge 1, \forall_i \end{gathered} \tag{5}$$

Given the above, we are looking for a plane with the maximum distance between the samples of different classes on a higher dimension. As mentioned above, the SVM was of the type one against all in the mathematical description since it is a multi-class problem. Furthermore, the type of kernel was linear. The modeling was performed and the confusion matrix was obtained with 20% of data for evaluation. The accuracy of each class in comparison to the others can be observed in Table 8. The SVM was the model with the worst performance out of the four evaluated according to the recommendation in the literature where the overall accuracy was 68.51%.

Table 8. Confusion matrix SVM.

Predicted Class (Vertical)/ True Class (Horizontal)	**Class 0**	**Class 1**	**Class 2**	**Class 3**	**Class 4**	**Class 5**	**Class 6**	**Class 7**	**Class 8**	**Class 9**	**Class 10**	**Class 11**
Class 0	153	10	31	0	0	0	0	0	0	1	1	6
Class 1	0	122	0	0	1	6	0	12	0	2	1	5
Class 2	20	0	192	0	0	0	0	0	0	120	0	0
Class 3	20	0	0	158	3	0	13	25	2	101	0	7
Class 4	1	0	0	0	12	0	0	0	3	5	9	0
Class 5	0	25	23	0	0	135	0	0	0	2	8	7
Class 6	0	0	0	0	0	0	110	30	0	1	0	0
Class 7	15	5	30	0	0	57	0	159	0	5	0	0
Class 8	1	9	0	30	0	0	20	0	11	1	0	9
Class 9	13	0	5	40	0	0	10	0	0	432	0	0
Class 10	0	8	0	4	0	0	0	6	0	3	53	0
Class 11	0	0	0	0	0	0	8	0	0	2	5	72

Naive Bayes Classifier

A Gaussian NB classifier is proposed that is capable of predicting when an accident has occurred in a work environment through different descriptive characteristics, which is based on Bayes' theorem. Bayes' theorem establishes the following relationship, given the class variable y and the vector of the dependent characteristic x_1 through x_n [69,70], Equation (6).

$$P(y \mid x_1, \ldots, x_n) = \frac{P(y)P(x_1, \ldots x_n \mid y)}{P(x_1, \ldots, x_n)} \tag{6}$$

where $\forall i$, the relationship can be simplified as shown in Equation (7).

$$P(y \mid x_1, \ldots, x_n) = \frac{P(y)\prod_{i=1}^{n} P(x_i \mid y)}{P(x_1, \ldots, x_n)} \tag{7}$$

where $P(x_1, \ldots, x_n)$ is constant based on the input; the classification rule presented in Equation (8) can also be used.

$$P(y \mid x_1, \ldots, x_n) \propto P(y) \prod_{i=1}^{n} P(x_i \mid y)$$
$$\Downarrow \tag{8}$$
$$\hat{y} = \arg\max_{y} P(y) \prod_{i=1}^{n} P(x_i \mid y),$$

The difference in the distributions of each class in the dataset means that each distribution can be independently estimated as a one-dimensional distribution. This in turn helps reduce the problems associated with high dimensionality. For a Gaussian NB classifier the probability of the characteristics is assumed to be Gaussian, see Equation (9).

$$P(x_i \mid y) = \frac{1}{\sqrt{2\pi\sigma_y^2}} \exp\left(-\frac{(x_i - \mu_y)^2}{2\sigma_y^2}\right) \tag{9}$$

In other words, in order to use the NB classifier in the grouping of the different work circumstances that put the worker at risk, it is assumed that the presence or absence of a particular characteristic is not related to the presence or absence of any other characteristic, given the variable class. The confusion matrix of the NB is shown in Table 9, where on average the accuracy was of 78.26%.

Table 9. Confusion matrix NB.

Predicted Class (Vertical)/ True Class (Horizontal)	Class 0	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9	Class 10	Class 11
Class 0	174	10	31	0	1	0	0	0	0	5	1	0
Class 1	0	140	0	0	1	0	0	12	0	2	1	9
Class 2	10	0	220	0	0	0	0	0	0	70	0	0
Class 3	15	0	0	181	0	0	13	5	1	62	0	7
Class 4	1	0	0	0	13	0	0	7	0	1	5	0
Class 5	0	25	13	0	0	155	0	9	0	11	4	1
Class 6	0	0	0	0	0	0	126	1	0	0	0	0
Class 7	9	2	15	0	0	37	0	180	0	0	0	0
Class 8	1	1	0	30	0	0	20	0	13	0	2	4
Class 9	3	0	1	20	1	6	2	18	1	520	0	3
Class 10	0	1	1	1	0	0	0	0	1	0	60	0
Class 11	0	0	0	0	0	0	0	0	0	3	4	82

Static Neural Network

Neural networks are simple models of the functioning of the nervous system. The basic units are the neurons, which are usually organized in layers. The processing units are also organized in layers. A neural network normally consists of three parts [71]:

1. An input layer, with units representing the input in the dataset.
2. One or more hidden layers.
3. An output layer, with a unit or units representing the target field or fields.

The units are regularly connected with varying connection forces (or weights). Input data is presented in the first layer, and values are propagated from one neuron to another in the next layer. At the end, a result is sent from the output layer. All the weights assigned to each layer are random in the first instance of the training. However, there are a series of methods that can be employed to optimize this phase. Furthermore, the responses that result from the network are offline. The network learns through training [71]. Data for which the result is known are continuously presented to the network, and the responses it provides are compared with the known results.

The use of a static NN is proposed in this research. The performance of the classic model Adam has been compared with the performance of a CNN. The architecture of the NN is shown in Figure 7, which is a three-layer static model, where the first layer contains five neurons that correspond to each of the five data being obtained from the multisensory case, the hidden layer has 32 neurons with the ReLU activation function and finally the output layer has 12 neurons representing the situations a worker may find themselves in. They range from safe to risky situations. The last layer has a SoftMax activation function because it is a multi-class problem. The learning step was 0.05 and the model was trained with 500 epochs. In which the approach for the proposed structure is based on "trial and error", since as it is well known establishing a neural network is more an art than a science. That is why the number of neurons on the second layer was modified, which obtained a better result than adding other layers on the network. However, CNN showed better results than the rest of the models with a predetermined structure (12 neurons in the hidden layer).

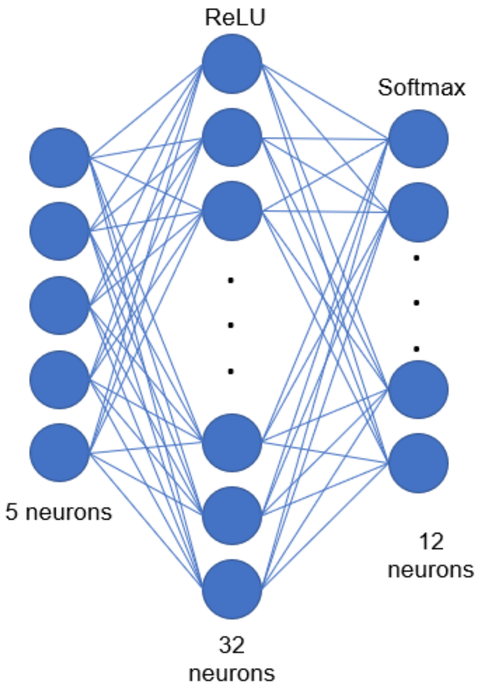

Figure 7. Proposed architecture, static neural network.

The result of the static NN are given in Table 10. It is possible to observe its performance was not very different from the NB classifier, where an average accuracy of 78.56% was obtained.

Table 10. Confusion matrix NN.

Predicted Class (Vertical)/ True Class (Horizontal)	Class 0	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9	Class 10	Class 11
Class 0	175	10	30	0	0	0	0	0	0	5	1	0
Class 1	0	141	0	0	0	0	0	7	0	2	1	9
Class 2	9	0	221	0	0	0	0	0	0	60	0	0
Class 3	13	0	0	181	0	0	13	5	0	50	0	7
Class 4	1	0	0	0	15	0	0	7	0	0	25	0
Class 5	0	23	12	0	0	150	0	9	0	9	9	1
Class 6	0	0	0	0	0	0	134	1	0	2	0	0
Class 7	9	3	16	0	0	32	0	185	0	15	0	0
Class 8	1	1	0	30	0	0	12	0	14	0	2	4
Class 9	3	0	1	20	1	16	2	18	1	526	0	2
Class 10	0	1	1	1	0	0	0	0	1	0	30	0
Class 11	0	0	0	0	0	0	0	0	0	5	9	83

4.3. Convolutional Neural Network

A Convolutional Neural Network (CNN) was the selected model, it is a deep learning algorithm mainly used to work with images in which it is possible to use an input image (instead of a single vector as in static NNs), assign importance, weights, learnable biases to various aspects/objects of the image and be able to differentiate one from another [72]. The advantage of NNs is their ability to learn these filters/characteristics. Given the abovel we propose the use of a CNN to classify the data coming from the multisensorial helmet.

The proposed CNN's operation is illustrated in Figure 8. The CNN consists of segmenting groups of pixels close to the input image and mathematically operating against a small matrix called a kernel. However, the part of the image is replaced with the input vector of size 5, where a re-shape is made to obtain a vector of 5×1. Therefore, the kernel proposed in the current CNN is of size 1, and moves from 1×1 pixel, in our case it would be different dimensions. With that size it manages to visualize all the input neurons and thus it can generate a new output matrix; a matrix that will be our new layer of hidden neurons.

A CNN can contain the spatial and temporal dependency characteristics in an image by applying relevant filters, the same applies to a data set that has been re-organized. The proposed architecture is an input layer for the transformed vector with size $5 \times 1 \times 1$ with two hidden convolutional layers for two-dimensional data (Conv2D) and ReLU activation functions with a total of 64 and 32 neurons respectively. Finally a layer with 12 output neurons with SoftMax activation function for multiclass classification.

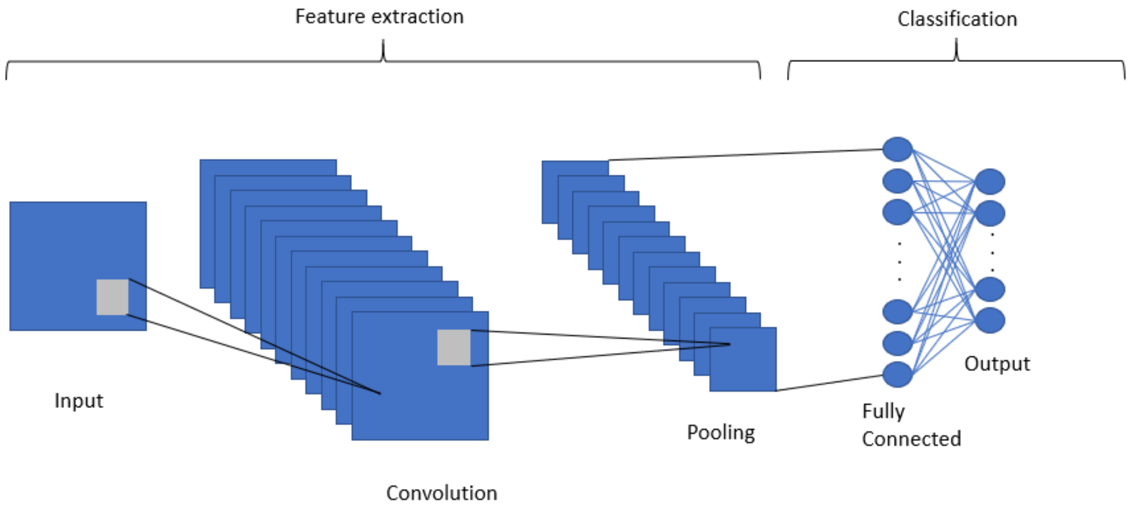

Figure 8. Deep convolutional neural network operation.

A classical model of Adam was proposed and trained with 500 epochs, the parameters were the same for the static NN and CNN to have an objective margin with respect to their evaluation. The following are the results on the AI models used for their implementation in the multisensorial helmet. Table 11 shows the evaluation for CNN where an overall accuracy of 92.05% was achieved.

Table 11. Confusion matrix CNN.

Predicted Class (Vertical)/ True Class (Horizontal)	Class 0	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9	Class 10	Class 11
Class 0	190	0	8	0	0	0	0	0	0	0	0	0
Class 1	8	169	0	0	0	12	0	3	0	0	0	0
Class 2	18	0	267	0	0	3	0	2	0	3	1	0
Class 3	4	0	0	209	0	1	0	0	0	30	0	0
Class 4	1	0	1	0	15	0	0	0	0	0	1	0
Class 5	1	8	0	0	0	179	0	4	0	0	0	0
Class 6	0	2	0	4	0	0	150	0	4	29	0	0
Class 7	1	0	0	0	0	0	0	115	0	0	0	0
Class 8	0	0	0	3	0	0	0	0	67	1	0	0
Class 9	0	0	4	16	0	2	11	1	6	612	0	0
Class 10	0	0	1	0	1	0	0	0	0	1	73	0
Class 11	0	0	0	0	0	1	0	0	0	0	2	106

4.4. Results

As mentioned above, each model was evaluated with 20% of data for cross validation. The SVM presented a general accuracy of 68.51 % which was the model with the lowest performance in cross-validation. Its behavior is compared with that of the rest of the analyzed classes in Figure 9. Therefore, the use of this model in the multisensory helmet has been discarded.

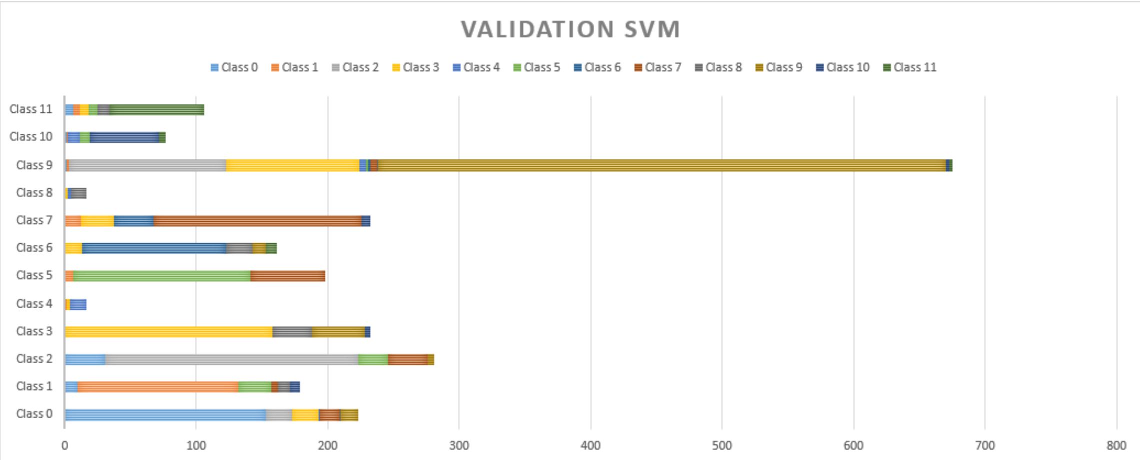

Figure 9. Cross-validation results with 20% for the SVM.

An average accuracy of 78.26% has been achieved by NB in all the classes, as shown in Figure 10. Its performance has been better in class 5 and class 11. Despite having a better result than SVM it has been discarded since there were models that had better performance.

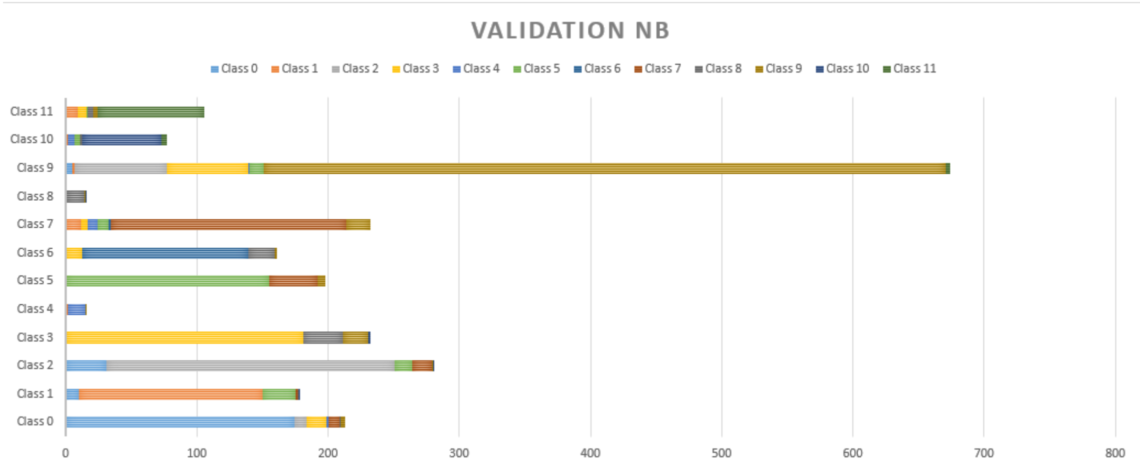

Figure 10. Cross-validation results with 20% for the NB.

Figures 11 and 12 show the performance of static NN and CNN respectively. In Figure 8 it can be observed that there is not a significant difference in the performance of NB, which had an accuracy of 78.56%. On the contrary, CNN, which allows for the implicit extraction of characteristics and for maintaining the relationships between the information regarding the dataset, had a considerably better result, with an accuracy of 92.05%. Our innovation comes on the proposed implementation of a CNN in a safety helmet as a proposal to reduce accidents and fractures in work areas, also through the use of technologies such as IoT for rapid synchronization of alarms that are sent to supervisors to take immediate action.

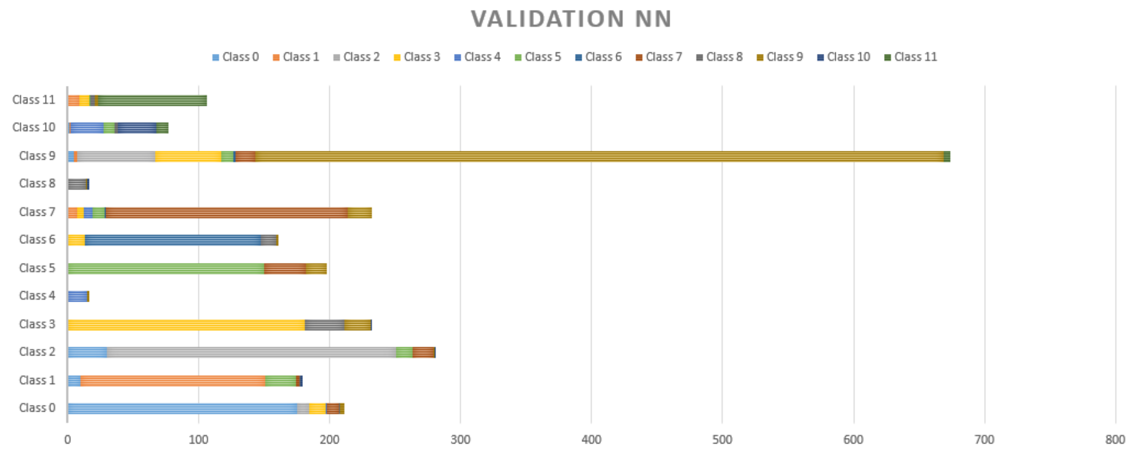

Figure 11. Cross-validation results with 20% for the NN.

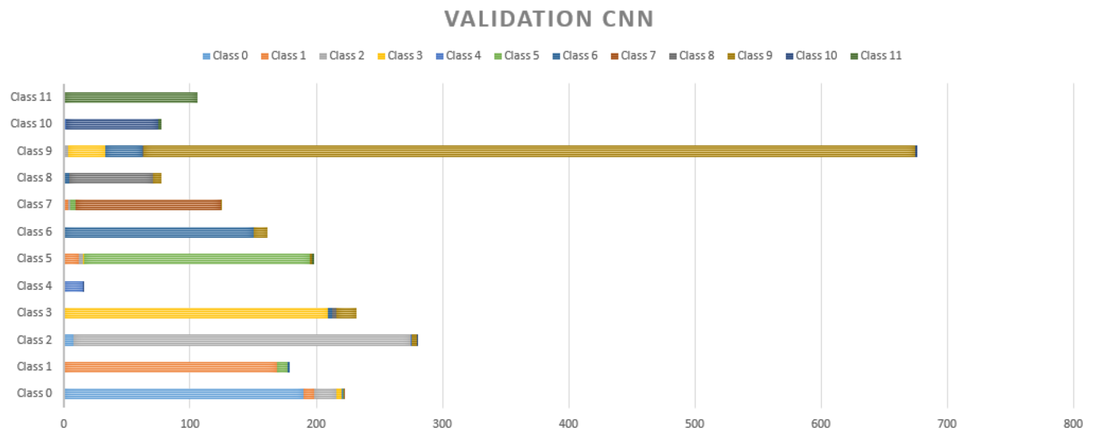

Figure 12. Cross-validation results with 20% for the CNN.

Given the above, CNN is the model that has been implemented in conjunction with the ThingsBoard platform. ThingsBoard and CNN work independently, creting an alarm system in a simulated environment that can serve as an higher security approach to a work environment. CNN is in charge of validating the information obtained from the platform, see Figure 13.

Previously it was mentioned that the creation of the deep models was through the "trial and error" approach, but the possible problem of overfiting should not be left aside, that is why Table 12 shows the results for the CNN in 10-Folds that shows the average performance from an objective point of view of the models.

Table 12. Ten-fold validation for CNN.

Ten Fold Cross-Validation Test Sets	Accuracy (%) (Automated Risk Situations Develop in This Research)
1	93.18
2	93.09
3	90.73
4	94.12
5	91.27
6	92.75
7	92.61
8	92.59
9	92.76
10	91.99
Average Accuracy	92.509

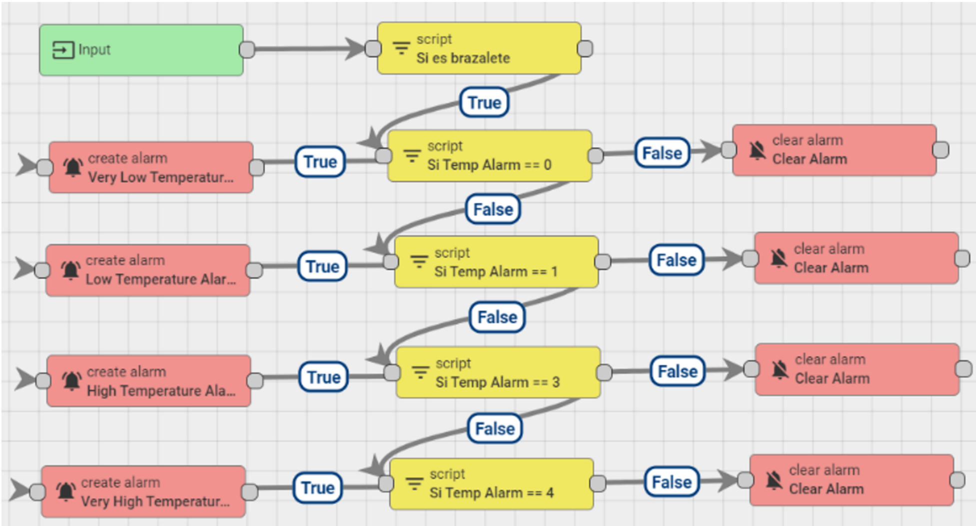

Figure 13. System of alarm rules established in ThingsBoard.

In the next section, the conclusions drawn from the conducted research are described, and the contributions of this work to the state of the art are highlighted.

5. Conclusions and Discussion

Our work has a history of electronic development in which the use of a multisensory helmet was established. Through a conditional model of input–output rules, we tried to detect the different situations to which a worker was subjected. However, the input–output techniques presented false positives and false negatives with 60% accuracy in the best of cases, which is why after several stages, it was decided to implement AI in the helmet. The 60% that was described a moment ago is due to the combination of different circumstances, that is to say, the correlation that exists on the independent characteristics, is for that reason, that through techniques that find linear and nonlinear relations we decided to innovate in the present work. Since it is necessary to find the patterns that determine a particular action, for them there are the techniques of deep learning as our work presents

The comparison between different models of AI has been made in this research. Our innovation comes from the moment of using a CNN that in the literature has been used to analyze images or videos in intelligent helmets with the aim of saving lives. However, we proposed a multisensory approach to real-time feature analysis. Through the transmission of data through specialized IoT devices, a smart helmet has been designed to monitor the conditions in a working environment. The application areas of this proposal are industrial and agricultural sectors and any other sector that involves risk for the workers. Thanks to the helmet, different injuries can be avoided, and in case an accident occurs the damage caused to the worker is lessened through prompt attention or detection.

It is possible to observe in Figures 9–11 that the MSA presented many false positives on majority classes in sample size, and even false positives of repeated classes (class 6) on more than five different classifications. NB and NN had a better performance in minority classes, however, there are three different classifications in false positives in classes such as 11, 9, 7, 2, 1 and 0. The NN has a strong resolution where the classes mentioned above still present false positives but with a decrease to 2 wrong classes in almost all cases.

5.1. Limitations

The work has different limitations. It is well known that artificial intelligence has the ability to find patterns that can hardly be found in linear analysis models. However, as stated in [73] risk analyses are not yet common in project-oriented industries. A problem with current risk analysis procedures is that procedures that are simple enough to be used by normal project staff are too simplistic to capture the subtlety of risk situations. Those that are complex enough to capture the essence and subtlety of risk situations are so complex that they require an expert to operate them. That is why the combination of possible risk situations can be counterproductive in the industrial area, an area that should be analyzed in more detail, with the following consequences:

- False positives would result in economic losses that would eventually affect the services and production areas involved, since the medical service and will be attending to situations that were not risky, the industry part will have to make production stops every time a false positive is found.
- On the other hand, false negatives are even more dangerous because the misinterpretation of data due to the complexity that can cause the unbalance of classes with less data set would result in losses not only economic but also of human personnel due to situations that were not attended to in the indicated time.

Our system has limitations on the amount of data that can be processed due to the microcontroller and the data that the model supports through the ESP32 module. That is why other techniques can be adopted, as will be seen in the next part of future work.

5.2. Future Work Opportunities

The use of paradigms such as edge computing or fog computing for the processing of many data as would be the integration of images or video would be the viable option to allow a transmission of information in real time, avoiding problems of saturation by the microcontroller. Several state-of-the-art researches have proposed smart helmets, among them is the US6798392B2 patent [74], which integrates a global location system, an environmental interaction sensor, a mobile communications network device, a small display panel, a microphone and a speaker. The helmet knows the location of the user and their interaction with the environment. The helmet can provide data to a user, monitor the actions of the user and conditions. This work is quite interesting since it offers device–user interaction. On the contrary, the advantage of our proposal is that it strives towards the autonomy of the system where decisions are made by the convolutional method.

Furthermore, the US9389677B2 patent [75], which is a smart helmet that includes a camera, a communications subsystem and a control subsystem. The control subsystem processes the video data from the camera, and the communications subsystem transmits this video data from the smart helmet to a target device. This work can be taken as a reference for a future sensor integration, since in our proposal it would be possible to integrate a camera that can process data through Deep CNN, for example thermal radiation data or even data regarding those who are infected with COVID-19.

Furthermore, the US registered patent, US20150130945A1 [76], in which a smart helmet is proposed that includes a helmet shell, a visor and a projector mounted on the helmet shell. The projector is configured so that content can be selected for display on the visor. The visor is rotatably attached to the helmet shell, and is configured to expose or cover the passage. The hull of the helmet defines an internal cavity and a passage that communicates with the internal cavity. The internal cavity is designed to receive the head of a user. This proposal's focus is directed at the ergonomic part for the user, in addition to having navigation systems and control modules. This research is comparable to our proposal.

Moreover, in 2013 a helmet was proposed by Rasli Mohd Khairul Afiq Mohd et al. [77] for the prevention of accidents in which an FSR and a BLDC fan were used to detect the head of the driver and the speed of the motorcycle, respectively. A 315 MHz radio frequency module was used as a wireless link for communication between the transmitter circuit and the receiver circuit. PIC16F84a is a microcontroller for the control of the different components of the system. The motorcyclist could start the engine only when they had fastened their helmet. In comparison, our proposal communication takes place through IIoT for optimized decision making in case of accidents.

With reference to smart helmets connected to IoT, in 2016 [78], Sreenithy Chandran et al. presented a design whose objective is to provide a channel and a device for monitoring and reporting accidents.

Sensors, a Wi-Fi enabled processor, and cloud computing infrastructures were used to build the system. The accident detection system communicates the accelerometer values to the processor that continuously monitors erratic variations. When an accident occurs, details about the accident are sent to emergency contacts using a cloud-based service. The location of the vehicle is obtained using the global positioning system. This work has a close relationship with the one proposed by us where there is optimized communication to reduce the consequences of accidents, the approach is different since we propose it for a work environment that can later be adapted for a case focused on vehicle safety, mainly on motorcycles.

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Abbreviations

The following abbreviations are used in this manuscript sorted alphabetically:

AI	Artificial Intelligence
AQI	Air Quality Index
ARCTM	Accident Root Causes Tracing Model
CM	Condition Monitoring
CNN/ConvNet	Convolutional Neural Network
EEG	Electroencephalographic
GMM	Gaussian Mixture Model
ICTs	Information and communication technologies
IIoT	Industrial Internet of Things
IITEM	Internet of Things for Equipment Maintenance
JSA	Job Safety Analysis
KC	K-means Clustering
LAN	Local Area Networks
LCC	Latent Class Clustering
LP	License Plate
MEMS	Micro-Electromechanical System
ML	Machine Learning
MNL	Multinomial Logit
NB	Naive Bayes Classifier
NN	Neural Netowork
NNC	Nearest Neighbor Classification
OHS	Occupational Health and Safety
PPE	Personal Protective Equipment
RF	Random Forests
SVM	Support Vector Machine
UKF	Unscented Kalman Filter
VOC	Volatile Organic Compounds

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DESIGNING OF IOT BASED SMART HELMET

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ABSTRACT:

Main objective of smart helmet is to provide a means and apparatus for detecting and reporting accidents. With the rapid increase in number of 2-wheelers , frequency of accidents is increased rapidly. A major cause of the fatalities occur because either the person was not wearing a helmet, or his accident was not reported in time, and he could not be saved because of the delayed admittance to a hospital, or because he was riding while drunk. So efforts should be made to avoid accidents and to minimize their consequences. Today we are living in a world where the conditions of the road have no importance for people and they are regularly violated. In addition, its human nature to resist what is imposed on them. So there is a need to make smart helmets using IOT[6][7][8]

Keywords: Internet of Things(IoT),Smart Helmet, Cloud Computing; Hypertext Transfer Protocol; Internet of Things,Sensor; alcohol Sensing;

INTRODUCTION It is a fact that young generation prefers bikes and motorcycle than four wheelers. A survey indicates that more than 70% of the riders avoid wearing helmet without any specific reason Speed driving and drunk driving have become common issues. Due to lack of experience or focus and violation of traffic rules, result in severe accidents. The Global status report on road safety 2015, reflecting information from 180 countries, indicates that close to 1.25 million people die every year as a result of road accidents . Near about one fourth of the people involved in accidents are motorcyclists. The main cause of death in two-wheeler drivers is over speeding and careless driving. Number of lives could have been saved if emergency medical service could get accident information and reach in time to the scene . Up to 75% of all deaths occur within the first one hour of impact. Thus, in this crucial phase of time, if proper aid reaches the victims, mortality rates can be reduced. In this survey we focus on to build an Internet of Things (IoT) application that leverages on ubiquitous connectivity, sensing and data analytics that are the basis of IoT applications. The IoT is made of smart machines communicating and interacting with other machines, objects, environments and infrastructures[6][7][8]. The huge volumes of data thus generated, is processed into useful actions that can “command and control” things, to make our lives much easier and safer [3][. IoT applications focus on numerous benefits like the capability to remotely monitor, manage and control devices, and to get new insights and useful information from massive streams of realtime data. The foundation however lies on the intelligence of the embedded processor.

LITERATURE REVIEW

In the process of literature survey, we have found a lot of smart helmets with different approaches and with different methodologies.

C. J. Behr et al [2] had proposed a smart helmet for mining industry in order to identify hazardous event detection and air quality. This system can identify the concentration level of the harmful gases such as CO, SO2, NO2, and particulate matter by using electro chemical sensor and also detects the removal of Helmet by using an IR sensor. It also identifies an incident when miners are struck by an object in contradiction to their head with a high force exceeding a value of 1000 by using the Head Injury Criteria. An accelerometer was used to calculate the acceleration of the head after hit and the HIC was calculated in software.

Edna Elizabeth et al [3] had developed a smart helmet device for detecting and reporting bike accidents. Smart helmet system comprises of various sensors, and it identify the accident by evaluating uneven or irregular variations obtained from sensor system, and a trigger will be sent to Pager Duty from the microcontroller. Pager Duty will then triggers a call to the phone number registered by the motorist. If the driver does not respond to it for a period of 5 minutes after the first call is initiated, then the emergency contacts will be informed with the details about the accident. The emergency contacts will be alerted through text message, e-mail, and phone call until they acknowledge the incident. In real time, this system assures a reliable and quick delivery of information relating to the accident.

Rashmi Vashisth et al [4] had proposed a methodology which uses Piezo electric buzzer in order to identify over speeding bike and it also equipped with a feature called velocity limiter, which restricts the speed limit of the bike. It also has a feature which prevents the drunk and drive scenarios of the rider called as ALCHO-LOCK and an accelerometer to identify accidents, upon detecting accidents it automatically send a message to concerned person. A fog sensor has been used in this system in order to improve the visibility for the rider in case of fog or smog. It also features automatic deduction of required or needed amount from the riders registered virtual wallet in wireless to helps the rider to stop and do the payment.

Selvathi et al [5] had designed a system which automatically detects if the rider is wearing a helmet and also checks whether the rider has consumed alcohol before starting the ride. The relay attached to the engine will turn ON if and only if both the conditions are met. The Microcontroller in the system controls the functioning of relay and thus the ignition. This system also identifies the bike accident at any place and alerts the concerned person about the accident.

Archana D et al [6] had proposed a system which will not allow driver to start the engine without wearing the helmet. When rider wore the helmet, helmet will be locked and engine will be switched ON. This system also identify the approaching vehicle's speed on both sides of the bike while riding by using ultrasonic sensor and alert the rider by generating vibrations in bike's handlebar.

SayanTapadar et al [7] had proposed a methodology for smart helmet which can detect whether rider is wearing the helmet or not, and detect whether the person has over-consumed alcohol and can also detects about the accident. This system gathers the data generated from the accelerometer and pressure sensors and the same will be sent to cloud server via an online application programming interface (API) to train a support vector machine (SVM). SVM can help in detecting accident precisely so in the future enough data will be gathered and analysed to provide more accuracy about event detection. The proposed system (smart helmet) can be connected to any smart phone via Bluetooth in order to communicate with the online API, by using the smart phone internet connection.

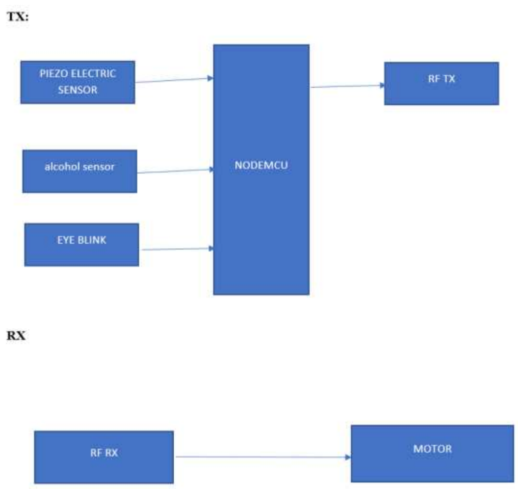
Prudhvi Raj R, Sri Krishna Kanth, BhargavAdityaBharath K, (2014) "Smart-tec Helmet" Electrical and Electronics Engineering, GITAM University,Rushikonda, Visakhapatnam, India. Advance in Electronic and Electric Engineering 4: 493-498

In present day scenario we encounter numerous cases of two wheeler road accidents leading to death. The main reason being severe head injuries. Despite of the fact that helmets are available everywhere, people are not wearing them for protection. In this regard, and infer that people abandon use of helmet primarily due to inconvenience caused by excess heat generated inside it. In this paper we present the design of the prototype we upgraded the helmet with Peltier module and GPS. With inventory included in helmet, comfortable temperature can be maintained in helmet by using Peltier module which works on the basis of thermoelectric effect. In the event of road accidents the precise location of the rider can be tracked out using GPS system and gives the message to emergency vehicle, Also if any bleeding occurs can be clotted by the thermoelectric module so that person can be rescued from critical conditions In present day scenario we encounter numerous cases of death due to two wheeler road accidents. The main reason being severe head injuries. Despite of the fact that helmets are available everywhere, people are not wearing them. The reason behind not using the helmets showed the main reason to be uncomfortable temperatures generated. In our prototype we upgraded the helmet with Peltier module and GPS. With inventory included in helmet, comfortable temperature can be maintained in helmet by using Peltier module which works on the basis of thermoelectric effect. In the event of road accidents the precise location of the rider can be tracked out using GPS system and gives the message to emergency vehicle. Also if any bleeding occurs can be clotted by the thermoelectric module so that person can be rescued from critical conditions.

Behr, C.J., Kumar, A., Hancke, G.P " A Smart Helmet for Air Quality and Hazardous Event Detection for the Mining Industry" Proceedings of the IEEE International Conference on Industrial Technology 2016-May,7475079, pp. 2026-2031 A smart helmet has been developed that is able to detect of hazardous events in the mines industry. In the development of helmet, we have considered the three main types of hazard such as air quality, helmet removal, and collision (miners are struck by an object). The first is the concentration level of the hazardous gases such as CO, SO2, NO2, and particulate matter. The second hazardous event was classified as a miner removing the mining helmet off their head. An IR sensor was developed unsuccessfully but an off-the shelf IR sensor was then used to successfully determine when the helmet is on the miner's head. The third hazardous event is defined as an event where miners are struck by an object against the head with a force exceeding a value of 1000 on the HIC (Head Injury Criteria). An accelerometer was used to measure the acceleration of the head and the HIC was calculated in software. The layout of the visualisation software was completed, however the implementation was unsuccessful. Tests were successfully done to calibrate the accelerometer. PCB's that were designed and made included a breakout board and a prototype board. A whole software implementation was done based on Contiki operating system in order to do the control of the measuring of sensors and of calculations done with the measured values..

Sreenithy Chandran, Sneha Chandrasekar, N Edna Elizabeth "Konnect: An Internet of Things(IoT) based smart helmet for accident detection and notification" 2016 IEEE Annual India Conference (INDICON) The objective of the smart helmet is to provide a means and apparatus for detecting and reporting accidents. Sensors, Wi-Fi enabled processor, and cloud computing infrastructures are utilised for building the system. The accident detection system communicates the accelerometer values to the processor which continuously monitors for erratic variations. When an accident occurs, the related details are sent to the emergency contacts by utilizing a cloud based service. The vehicle location is obtained by making use of the global positioning system. The system promises a reliable and quick delivery of information relating to the accident in real time and is appropriately named Konnect.

IMPLEMENTATION:



The increased complexity associated with integrating monitoring, deployment, and ticketing systems results in ine_ectual delivery of alert, st raining the competent working of the helmet. The major problems that needed to be overcome include alert fatigue, possibility of missing an event, sending the message to a wrong person , increased time for information transfer and incident resolution. In order to overcome these drawbacks, we make use of an incident resolution platform PagerDuty. We make use of the PagerDuty REST API to inform the emergency contacts whenever an accident has been detected. The monitoring tools send PagerDuty a trigger event to report a new or ongoing prob lem. Incoming events that are sent via the API are routed to a PagerDuty service and processed. Usually a customized API is created by making the system make a simple HTTP call or run a command-line script. The REST (Representational State on Demand) is an architectural style based on which the protocol s are designed. It is resource-based and the resources are identified by URIs. The representation is transferred between client and server in the form of either JSON or XML. PagerDuty REST API accepts JSON and form encoded content as input and the output is in JSON.Whenever the rider passes through the range of RF transmitter balance is automatically deducted from its wallet known as EWallet.indicator, DC motor. The R F receiver receives the encoded binary data transmitted by the RF transmitter and provides it to the decoder. The decoder decodes the incoming digital data and provides four bits in the MCU, only if the address bit of the encoder and the decoder match. This is done to ensure the safety and security of the system. Thus matching of encoder and decoder increases the security and integrity of the system. The MCU controls the DC motor upon receiving data. If the sensor detects that the rider is wearing the helmet, then the engine is turned on and also if the MQ6 sensor detects alcohol, the module installed on the bike turns o_ the engine to avoid any accidents and so that the drunken person takes appropriate measures to reach his destination. Decoder HT12D decodes all incoming data and then forwards it to the microcontroller for implementation. The NODEMCU is a programmable microcontroller with a small instruction set. It controls the working of the module by analysing the input data stream and then giving correct control signals. Voltage regulator 7805 is used to regulate the erratic voltage received from the power source. The 7805 voltage regulator gives a 5V output. The above components together make our helmet smart and work in synchronization to ensure a safe and comfortable experience for the user. Alsowhenever the rider enters the speci_c range of speed limiter its maximum speed limit is set and whenever that limit is exceeded LCD displays overspeeding and alarm buzzes.

IDEAS FOR SMART HELMET We could sure use some innovative ideas to improve helmet technology.At today era of technology upgradation of system is required.For our system like samrt helmet we can add many features which could be very bene_cial for the riders.

1. The helmet that's like Google Glass When pedestrians get a bit lost, they can pull out a smartphone and open Google Maps. This is nearly impossible (and very dangerous!) as a cyclist. That's why a London-based ideas lab called the Future

Cities Catapult has prototyped a helmet that comes with a Google Glass-like visor to help cyclists navigate the city with better ease and safety. The helmet could use data from bike and street maps to highlight direct routes, warn about danger zones, and detect blind spots around large vehicles. "If these displays talked to the city around them if they knew where the cyclist was and what they were looking at they could give much more subtle spatial and contextual information that builds on the surroundings of the cyclist."

2. The invisible airbag helmet For anyone who hates helmet head but also the idea of bicycling around unprotected, the Hvding helmet is a compelling innovation. Hovding is essentially an airbag for your head. It comes in the form of a collar you wear around your neck that's stued with an airbag and sensors that register your movement 200 times a second. If the sensors recognize abnormal movement, the airbag deates in one-tenth of a second to absorb the impact shock and protect your head, face, and throat. Aside from being a stylish option, the Hvding has some impressive safety specs. According to one test, the Hovding is three times more protective than the best mainstream helmets on the market. It costs around 299 euros, or dollar340. Unfortunately, once it inates, it can't be used again.

3. The helmet that tells cars where you are Volvo is taking steps to make it nearly impossible for drivers and cyclists to sneak up on one another. The Volvo Car's Safety system, standard in all new XC90s, detects cyclists and warns drivers when they're nearby, even auto-braking to avoid crashes. At CES this year, the car maker unveiled the second part of its plan: a connected helmet that communicates with the smart car system and vibrates or illuminates when a vehicle is approaching or a crash is possible. The logistics are a bit complicated; the cyclist and driver would both need to use a smartphone app to track their position and send it up to the Volvo cloud. Right now it's just a concept and still just for Volvo, but it's a good demonstration of how cars and bikes can co-exist in the future.

4. The helmet that measures your heart rate Many athletes use chest straps loaded with sensors to measure their heart rate and overall performance. A startup called LifeBEAM wants to get rid of the strap by integrating these same sensors into a bike helmet. The company was originallydesigning a sensing platform to be used on astronauts and pilots, but pivoted to focus on cyclists. The LifeBEAM helmet, which sells for dollar229, has a built-in heart rate sensor, calorie counter, and performance analysis,

all of which can be beamed to smartphones and smartwatches for analysis later. Oh, and it protects your head.

5. The helmet that tests for concussions Students at Oregon State University teamed up with Intel last summer to create a sensor-packed smart helmet that knows when a crash has occurred and, depending on the severity of the injuries, can call an emergency contact and send a text message including the location of the crash. The helmet also connects with an app that asks the rider a series of basic questions similar to those a doctor might ask during a concussion test, like "what month is it?" Acting as a sort of "black box" for bicyclists, the helmet also collects and stores information about the location and severity of crashes.

6. The helmet that reads your mind You want your bike ride to be safe, but also enjoyable. A helmet called the MindRider "tracks, in real time, how your rides, movement, and location engage your mind." Its creators basically took a standard EEG brainwave sensor and combined it with a regular bike helmet. The info collected on your ride gets sent back to an app that maps the trip, showing "Sweetspots" when you felt relaxed and "Hotspots" of intensefocus. Using the data, you can avoid the most stressful routes next time you're out for a ride. MindRiderdidn't have a particularly successful Kickstarter campaign, but its creators are now using the helmet to track patterns for cyclists in NYC.

7. A Smart Helmet That Gives Riders Eyes in the Backs of Their Heads Like Skully AR-1, the augmented reality gadget-helmet that aims to protect motor cycle riders heads better and smarter than ever before. Yes, smart. The helmet puts real-time video of everything thats happening behind and around them on an always in-focus transparent screen, inside the tinted visor, directly in their _eld of vision. Described by a former Tesla tech as a smartphone for helmets, the Skully doesn't just show riders tra_c (and any other potential road hazards) in front and behind them on its trademarked Synapse Smart Heads-Up Display System. It also delivers turn-by-turn GPS navigation and live tra_c and weather conditions.

CONCLUSION Smart helmet is an effective solution to many problems. Wearing the helmet and being sober are necessary conditions for the bike to start, reducing the possibilities of accidents. Even if a person takes caution sometimes accidents do occur. Here our engine cut off feature reduces the chances of fatalities significantly. The smart helmet acts as a virtual policeman keeping the drivers in check and making roads safer.

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Smart Helmet Using IOT

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ABSTRACT

Now a day's road accidents are increasing in our country due to the violations of traffic rules like drink and drive, not wearing helmet, over speeding which may leads to severe head injuries and death. By considering all these issues the idea of smart helmet came into our mind which will ensure the safety of biker. The main idea behind this is to provide protective headgear for the riders to make their driving safer than before. This can be implemented by using advanced features like alcohol detection, accident identification, location tracking, and fall detection. This makes it not only a smart helmet but also a feature of smart bike.

Keywords : Headgear, Alcohol Detection, Location Tracking, Fall Detection.

I. INTRODUCTION

As per the WHO Global Report on road safety 2018, India accounts for almost 11% of the accident related deaths in the world. A total 4, 67,044 road accidents have been reported by States and Union Territories in the calendar year 2018. To reduce the road accidents ratio, Government of India made every biker compulsory to wear a helmet as per Section 129 of Motor Vehicle Act, 1988. Also drink and drive under the influence (DUI) is a criminal offence according to a motor vehicle act 1939 as mentioned by author in [1].

To ensure that the bikers should follow the traffic rules we propose "Smart Helmet Using IOT" for supporting the policies of the Government. The main motive behind our work is to make it mandatory for biker to wear a helmet during ride and prevent drink and drive scenario. One more feature of this system is to notify the concerned people about the accident of biker along with the location. This system comprises of two sections helmet section and bike section as proposed by author in [2]. Helmet section consists of push button, alcohol sensor, accelerometer and Arduino. Bike section consists of Wi-Fi module, GPS tracking.

The system will start the bike ignition on two conditions:

1] Push button should be pressed.
2] Biker should not consume alcohol.

II. LITERATURE REVIEW

1. "Smart Helmet for safe drive", system proposed by Keesari Shravya et al. in which they have used Force Sensing Resistors (FSR) which is placed inside the helmet which is used to recognize whether the helmet is worn or not before the bike is start. FSR are strong polymer thick film devices whose resistance is inversely proportional to force apply to the face of sensor.

2. Akshatha et al. had developed a system consists of microcontroller which makes the system hardware based; we are replacing it with Arduino to make it IoT.
3. For accident detection K Venkata Rao et al. presented a smart helmet in which there is no storing of biker's location data due to which they cannot be able to keep the track of their location history.
4. Bluetooth speaker with microphone is one of the features added by Ainapurapu Manoj et al. in their system which are used to play the songs which leads to the safety issue and can caused the accidents.

As FSR increases the cost of system, so to overcome this we are replacing FSR with push button. GPS module used for transferring the location message is comparatively slower than Wi-Fi module which we are using in our system. We are using cloud storage to store the location history which will be act as a surveillance feature. We removed Bluetooth speaker with microphone feature from our system for safety reasons.

III.PROPOSED SYSTEM

This project is aimed at building a system which will detect the consumption of alcohol by a suspect and display a digital reading indicating the level of alcoholic consumption and also will check whether the push button inside the helmet is pressed or not which will indicate that helmet is worn by the biker.

The MQ-3 sensor is used to detect alcohol level. The sensor detects the alcohol consumption by the smell of the breath. If driver is drunk then bike ignition will not start. The vibration sensor is used to detect the accident and SMS containing location of biker will generated through cloud server which will send to the family members.

IV.CONCLUSION

The "Smart Helmet using IoT" system will overcome above mentioned issues and will provide the safety to the biker and reduces the after effects of the accident, notifying about the accident. Our system is cheaper than previously existing systems. The surveillance feature in the system is helpful for parents for keeping the track of their children's location. As we are using Wi-Fi module it will send the SMS faster than GPS module.

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Research Article **EAI.EU**

A Review on Smart Helmet for Accident Detection using IOT

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Abstract

As we know that accidents are increasing day by day, we can also notice that many laws and regulations are posed by government in order to avoid this accidents. Accidents can be defined as the unplanned event or the mistake that may occur resulting in injury and sometimes it also leads to death. The accidents in case of two wheelers are more compared to other vehicles. This may be avoided by wearing helmets and riding vehicles without consuming alcohol. This survey is on smart helmet for accidence avoidance and also examining various related techniques. This research also helps us to understand IOT technology which is being emerged now a days .From the literature survey we find that the method proposed using microcontroller RF transmitter and other sensors is cost effective but we find the system proposed using Raspberry pi module, Pi camera, Pressure Sensor, GPS system which uses image processing algorithms is most efficient since the image processing is included so that we can easily detect the use of helmet from the rider. Smart helmet system helps to provide safety and security to the two wheeler riders.

Keywords: Accidents, smart helmet, IOT, Laws and Regulation.

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1. Introduction

Internet of things are currently being used in many fields such as wearable's, home automations, smart appliances, smart agriculture etc where there is a mutual communication between devices and people over a network. The work of the IOT devices is to sense the data and send the data to server by this huge amount of data can be generated. By the generated data we can draw the conclusion by processing and analysing the data obtained. This gives the advantage in real time data reporting from environment. Now a days motorbike accidents are increasing day by day and we can notice numerous loss in lives. We can avoid this by using smart helmet. From the survey we can know that in India 4 people die every hour because they do not wear helmet. In 2017, more than 48,746 two wheeler user died in road accidents, Incidental 78.3% of them did not wear a helmet. To go through or to solve this, there are two important conditions that should be checked before the bike starts by the smart helmet. First most condition is that we should check whether the rider is using the helmet and not just keeping it. Second to check whether the user has consumed alcoholic substance or not by his breath, this can be verified by using sensors. Third if a person meets with an accident, the sensor check the condition of person and bike and send information of location to nearby hospital. If the person has no major injurious then the button is pressed which is present in the bike this indicate that the person condition is good.

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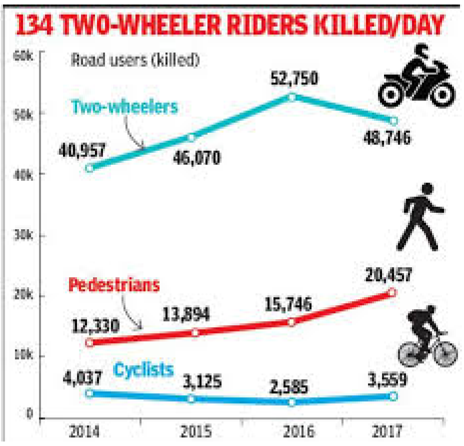

Figure 1. Representation of rate of accidents in two wheeler

The figure 1 gives the picture of rate of accident in two wheelers. The comparison is done between two wheelers, pedestrians, cyclists and the rate of accident is more as represented in graph.

2. Literature survey

In this survey we are discussing various smart helmets with various approaches and methodologies.

Jesudoos A et.al[1] proposed a mechanism, where sensors such as IR sensor, vibration sensor and gas sensor, mems are used. The gas sensor is used to detect the amount of liquor he had consumed by checking the breath of a person wearing the helmet. The bar control of the vehicle is handled by MEMS. Accident is detected by vibration sensor. Load of the vehicle is recognized by load checker. The Sensors are interfaced with the PIC microcontroller. The gas sensor will detect if a user consumed alcohol and display on the LED display. If an accident occurs the vibration sensor, sense the accident and send information through GPS to the hospital .If there is any rash driving is done by the rider the MEME sensor detect the amount of the person from his bank account. To check whether the rider is wearing the helmet or not IR sensor is used. In this system exactness and accuracy are high and ambulance is booked automatically based on ten location.

K.M. Mehata et.al[2] proposed a techniques which provide safety to the workers or to identify any fall of the workers in working area. The proposed system has two components. One is the wearable device built using sensors and electronic elements. Another component is the cell phone. The communication between the two components is provided by GSM module. These devices also monitor the health and safety of the worker is continuously. This system ensures good fall detection and alert the register person to give medical attention.

Divyasudha N et.al[3] proposed a system consists of micro controller, position sensor, Alcohol sensor, piezoelectric sensor, RF Transmitter, IOT Modem, GPS receiver, Power supply & Solar panel to avoid the accidents and check the alcohol consumption. In this system two condition is checked that is whether the rider is wearing the helmet or not and to check whether he had consumed alcohol or not if this is not followed by the rider the bike will not start and it is indicated by beep sound. If any accident Occur it is informed to predefined number and police station using IOT modem. This system is cost efficient compare to other kind of helmets.

Manish Uniyalet.al[4] proposed a system with two units that is helmet unit and two wheeler unit. RF receiver of the matching frequency gives the helmet position data to the two wheeler section. The microcontroller placed on the TW section will have information of the helmet position which is continuously checked. There are various other sensors such as accelerometer (tilt angle measurement), Hall-effect sensor (speed measurement), GPS module (location pointer) placed on the TW vehicle. The sensors collect the data and send the data to the microcontroller then if there is a internet connection then it is sent to the server. The speed of the vehicle can be accessed by the people at any instant by this method. In this system people can access the speed of the vehicle. Parents can see that is their child have worn helmet or not.

ShoebAhmed Shabbeer et.al [5] proposed the smart helmet method which detect and report the accidents. In this method they use microcontroller interfaced with accelerometer and GSM module. The notification and report of the accident is provided using cloud infrastructures. In this method if the level of the acceleration exceeds than the threshold or if any accident occurs the information is sent to the emergency authority server which then sends the message to the assigned emergency contact through GPS module. The result of this system was able to identify accidents is of 94.82% and sends the correct coordinates 96.72% of time.

P.Rojaet.al[6] has proposed a system consisting a 6 units as follow, that is remover sensor, IR sensor, Air quality sensor, Arduinouno microcontroller, GPRS, GSM. This helmet provides the alert about the harmful gases in the mining areas to the workers and also proved information to the server if helmet is removed. Here this data transmission is done using IOT technology .

C.J Bheret.al[7] has proposed a system of smart mining helmet that detects three types of hazards that is harmfull gases, remove of helmet and if any collision. Here they uses many sensors such as IR sensors, gas sensors, accelerometer.

SreenithyChandran et.al [8] has proposed a system of smart helmet named konnect. Here they use integrated network of sensors, WiFi enabled processors, cloudcomputing infrastructures to detect and prevent the accidents. This system also provide the information to the provided contact by text message if the speed is increased than the threshold level.

Mohammed Khaja Areebuddin Aatifet.al[9] proposed a technique consisting of arduinouno, Bluetooth module, push button and 9V battery. Here the smart helmet integrated with Bluetooth is connected to the cell phones and push button is used if any emergency occur.

Archana.Det.al[10] proposed a system to reduce accidents, here the system consist of a sensor which sense the human touch when he plug in the bike key. After he wear the helmet the sensor automatically lock the helmet and he can only remove is when bike is stopped.

Ahyoung Lee et.al [11] proposed a system based on three sensors: acceleration sensor, ultrasonic sensor, and carbon monoxide sensor, and also based on an Arduino MCU (Micro Controller Unit) with a Bluetooth module to provide safety to the workers.

Agung Rahmat Budiman et.al [12] proposed a system of smart helmet which is integrated with several functionalities. Warning notification is given if a rider is not wearing helmet and if he come with unsafe conditions and if helmet is not correctly locked so that to provide safety to the rider. In this system warning to the rider is generated in the form of notification to notify him in the unsafe condition. In the functionality test it is 100% success rate in 4 smart helmet features and 98.3% success rate in the communication test between the 2 modules.

Sayan Tapadaret.al[13] also proposed a prototype which detects the rate of alcohol consumed by the rider and detecting the accidents using IOT module and sensors. Here they are trying to use Support Vector Machines to predict if the values of the sensors correspond to an accident or not, by training the device using real-time simulation. This system gives satisfactory results. The accuracy and precision is also high.

Prashant Ahujaet.al[14] proposed smart helmet system using GSM and GPRS module. As we all know that the arrival of ambulance to the location may be late this prototype helps to inform the concerned person first about the accident and he may take the steps. In this system we can notice the feature such as high accuracy, cost efficient and giving information about the accident within minute.

Mingi Jeong et.al[15] proposed a system consisting sensors such as thermal camera, visible light camera, drone camera, oxygen remaining sensor, inertia sensor, smartwatch, HMD and command center system to avoid the accidents.This framework allows IOT services to be easily integrated and efficiently managed and able to notify the information in real time.

S.R.Kurkuteet.al[16] proposed a system consisting Raspberry pi module, Pi camera, pressured sensor, inbuilt wifi and GPS system. Image processing algorithms are used to capture the face of the biker. It can be applied in real time and it is cost efficient and effective and also used in any type of vehical.

Kabilan M et.al[17] proposed a system using vibration sensors. When the rider wear the helmet consisting of the vibrator sensor with a frequency if the frequency crosses the threshold then the message is sent to the emergency responses using GPS module. This system helps to detect and report the accident and can save the life. Dr. D

Vivekananda Reddy et.al [18] proposed a system consisting of two sections ie helmet section and bike section. In the helmet section there is a alcohol gas sensor to check if a person is drunk and it also contain IR sensor, Alcohol sensor, LCD display to display the information. In Bike section there is a vibration sensor which sense the accident and sends the information using GSM network and GPS module.

Kimaya Bholaram Mhatreet.al[19] proposed a system which consists of helmet module and bike module. It consists of IR sensors, MQS alcohol sensor, vibration sensor, GSM module, GPS module, Arduino, Intercom system. The workflow of the system is as follow, when the bike starts if the rider has consumed the alcohol and if it is greater than the threshold then the bike don't start else the bike will start and if the vibration sensor limit is greater than the threshold message is sent to the registered number about the accident. This system is cost effective and provide better security to the biker.

3. Comparison

In this section we briefly discuss existing literature review on smart helmet and also discuss various methods applied along with the limitations and accuracy.

Table 1. Provides the comparison of the survey on Smart helmet using IOT.

Authors	Methodology	Limitations	Accuracy
Jesudoss A et.al[1]	Uses Sensors that are interfaced with PIC through the wires. Sensors such as gas sensor, load sensor, vibration sensor, IR sensor and mems sensors are used.	Exactness and accuracy is high.	90%
K.M.Mehata et.al [2]	This method consists of 2 modules Such as health monitoring and safety monitoring of workers. It uses heart beat sensors, temperature sensors, tri-axis accelerometer.	Ensure good fallen detection of the workers in working place.	67%

DivyasudhaN et.al[3]	The system consists of micro controller, position sensor, alcohol sensor, piezoelectric sensor, RF transmitter, IOT modem, GPS receiver, power supply and solar panel.	Cost effective.	85%
Manish Uniyal et.al[4]	There are 2 units namely helmet unit and two wheeler section which Uses helmet sensor switch, microcontroller unit, RF encoder, RF transmitter, accelerometer module, GPS module, speed sensor.	Tilt angle of the vehicle is also detected using accelerometer module. This helps us to know whether the has fallen or not.	92%
Shoeb Ahmed et.al[5]	Microcontroller interfaced with accelerometer and GSM module.The notification and report of the accident is provided using cloud infrastructures	System canfunction as remote immobilizer in case if vehicle is stolen.	94.82%
P.Roja et.al[6]	It consists of data processing unit(arduinouno),air quality sensors, infrared sensor, GSM modem, alerting unit, liquid crystal display to detect the danger in mining area.	The helmet should be properly weared. It works with proper power supply.	88%
C. J. Behr et.al[7]	Composed of Air Quality Sensor, Helmet Removal Sensor, Collision Sensor, Wireless Transmission, Data Processing Unit, Alerting Unit to detect hazards in industries.	Distance of workers want to be limited from interface.	90%
Sreenithy Chandran et.al[8]	Sensors, Wi-Fi enabled processor, and cloud computing infrastructures are utilised for building the system.	Depends on the response of authorized person	82%
Archana.D et.al[10]	Uses ultrasonic sensors, arduinouno , microcontroller, DC motor,LED	Proper power supply should be provided.	78%
MingiJeong et.al[15]	The smart helmet system consists of Bio & Framework Subsystem(BFS), Multimedia Processing Subsystem (MPS), and Communication Subsystem (CPS).	Power must be on.	81%
AgungRahmatBudiman et.al [12]	Consists of bike module, helmet module, external module.	No alcohol detection	78%
SayanTapadar et.al[13]	Consists of several sensors with accelerometer connected to cell phones with API’s.	There may be wrong detection some times	83%

PrashantAhuja et.al [14]	Consists of IR sensor, vibration sensor, tilt sensor, NC sensor, microcontroller interface, GSM, GPRS connected to mobile.	The tilt sensor may fail to detect.	79%
S.R Kurkute et.al[16]	Consists of Raspberry pi module, Pi camera, Pressure Sensor,GPS system and uses image processing algorithms.	-	98%
Kabilan M et.al[17]	Consists of vibration sensor, GSM module, GPS module.	Network issues	86%
Dr. D. Vivekananda Reddy[18]	Consists of Helmet section and bike section consisting of sensors.	Power supply is important.	76%
KimayaBholaramMhatre[19]	Consists of Helmet module and Bike module which consists of IR sensor, MQS alcohol sensor,vibration sensor, GSM module,GPS module,Arduino,Intercom.	Need of 3.3V voltage supply for RF module.	81%

From the comparison and survey we can come across the methodology limitations and accuracy. Here we find the method proposed using microcontroller RF transmitter and other sensors is cost effective but we find the system proposed using Raspberry pi module, Pi camera, Pressure Sensor, GPS system and uses image processing algorithms is most efficient as the image processing is included so that we can easily detect the use of helmet from the rider.

4. Applications of Smart Helmet

1. We can use smart helmets in real life it acts as real time application.
2. The Smart helmets can be used as the key as without the helmet we cannot start the vehicle.
3. Smart helmets can be used to warn triple riding, alcohol consumption, using mobile phone and also rash riding.
4. We can also use smart helmet in mining areas and also in construction area to provide safety to the workers.

5. Conclusion

The survey demonstrates Smart helmet for accident avoidance. The helmet should be designed in order to reduce number of accidents in two wheelers this can be done by designing the device using IOT technology. Some sensor like IR sensor, alcohol sensor, GPS modules etc can be used to design a cost effective and user friendly smart helmet. The result should be accurate and should be useful to the government and society. This smart helmet can also be changed to seat belt system in case of four wheelers and can be implemented in future.

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NOVEL COVID-19 DETECTION AND DIAGNOSIS SYSTEM USING IOT BASED SMART HELMET

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NOVEL COVID-19 DETECTION AND DIAGNOSIS SYSTEM USING IOT BASED SMART HELMET

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Abstract--*Coronavirus is the new virus that has not been identified in humans before which it causes the coronavirus disease called COVID-19. This disease was firstly discovered in Wuhan, China, on December 2019 and spread to the world until now. The virus can easily pass from person to person which make it spreaded rapidly. One of the common symptom of COVID-19 that can be easily identified is fever. Since the virus outbreak, thermal screening using infrared thermometers are used at public places to check the body temperature to identify the indicated infectee among crowd. This prevention still lacking because it spends a lot of time to check the body temperature from every person and the most importance is the close contact of the infectee might lead to spreading it to the person who do the screening process or from the one in charge of screening to the checked people. This study proposes the design of system that has capability to detect the coronavirus automatically from the thermal image with less human interactions using smart helmet with Mounted Thermal Imaging System. The thermal camera technology is integrated to the smart helmet and combined with IoT technology for monitoring of the screening process to get the real time data. In addition, the proposed system is Equipped with the facial-recognition technology, it can also display the pedestrian's personal information which can automatically take pedestrians' temperatures. This proposed design has a high in demands from the healthcare system and can potentially help to prevent for coronavirus spreading wider.*

Keywords: COVID-19, Coronavirus, IoT Technology, Smart Helmet.

1. INTRODUCTION

A coronavirus is a sort of virus that can make ailment in animals [1] and individuals [2,3]. The function of normal body is disturbed by the action of such virus which breaks into cells within their host and exploits them to replicate itself. The name of Coronaviruses was taken from Latin term 'corona', that means crown, since they are encompassed by what look like royal crown of a spiked shell shape. The World Health Organization (WHO) officially announced that a new virus had been identified which then is called by 2019-nCoV on January 2020 [4]. The virus was recognized as part of the coronavirus group, which involves SARS and the other known colds [4,5]. The first reported case was from Wuhan, China and has infected 7,711 people and 170 reported deaths in China before coronavirus was declared as a global pandemic which produces a sickness authoritatively defined as COVID-19 that has diffused to a minimum 141 nations and regions, causing death over 5,700 individuals around the world [6]. Someone who infected by coronavirus will show common symptom such as fever, dry cough, and tiredness or some cases, infected person will feel pains &aches, runny nose sore throat, nasal congestion, or diarrhea [7–9]. However, some people infected with the virus do not show any symptoms and do not feel uncomfortable. Around 80% of individuals infected by COVID-19 can get recovery without acquiring particular treatment [6],but it is so dangerous for older people or someone with develop serious illness

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which the probability for them to get serious illness and develops difficulty breathing are higher. Right now, no effective vaccine for COVID 19 was produced or particular medication for treatment such virus was developed. However, potential vaccines and some particular medicine treatments are still under investigation and now being subjected to comprehensive test by leading medical research centres. Further, extraordinary efforts are coordinated by WHO to develop and produce effective vaccines and drugs to avoid and treat COVID-19. As the reported case of death and infected people keep increasing [6], many nations have performed lockdown to minimize the spread impact of coronavirus. They also try to identify the infectee among crowd by screening the temperature in public places using infrared thermometer. But the usage of the infrared thermometer gun itself is still lacking because it might not cover all of people and time-consuming. That way also can lead to the spreading virus widely because the health officer has to do it one by one through a lot of people queuing when one of them has probability to infect people around. To prevent this flaw, an alternative technology is needed. The internet of things (IoT) has been adopted in a smart city as infrastructure's key since the introducing the concept of a smart city. The big research efforts that are done presently are a confirmation on prosperity monitoring by remote sensing is based on IoT. The internet of things (IoT) is the interconnection between the physical objects or things that are attached with sensors and software to gather and deliver informations among them and primary servers with least human mediation [10]. IoT healthcare is modern worldview that conveys the services and medical data associated indeed farther areas. The IoT system in medical is now in an advance setup that contains so many varieties of mechanism like smart sensors, medical equipment, big data, cloud computing, telemedicine, clinical information system, and many more. IoT technique is categorized into; remote monitoring of patients, remote tracking and monitoring of health, sensor based devices for hand wash monitoring, and monitoring of interactive RFID activities [10–13]. It delivers best evaluation, better diagnosis, and maintains efficient treatment of patient. The main applications of IoT in the field of medical health care incorporate [14-16]: Therapeutic data administration, Telemedicine and portable medical care and management of health. With the IoT technology that has widely implemented in the health care sector, this study aims to design of system that has capability to detect the coronavirus automatically from the thermal image with less human interactions using smart helmet with Mounted Thermal Imaging System. The thermal camera technology is integrated to the smart helmet and combined with IoT technology for monitoring of the screening process to get the real time data.

2. METHODOLOGY

This section describes the working flow of three subsystems due to the interrelationship between each other to perform the entire application. In addition, the necessary system’s element, excluding module of decision making, are image processing module that is in charge of data processing of optical and thermal cameras. Furthermore, the task of the required data collection is assigned to the smart helmet when needed. The interfacing of a modular system that is based on IoT communication link and GSM is done. This system delivers a notification if detecting temperature higher than normal temperature. The GPS module determine the position coordinates after tagging it and a notification is sent to assigned smart mobile through a GSM. The officer will get the data of people’s face and temperature to identify someone who is indicating as infectee of COVID-19 as shown in figure 1. The proposed smart helmet is integrated into three segments. The first segment of the system involves the input source of the mechanism that consists of the thermal camera, optical camera and mobile phone application. The processor development was the second segment of system development. In this segment, the microcontroller processor was integrated using the Arduino IDE software to perform coding of the source code. The software enables compilation of the necessary commands and source code into the NODEMCU V2 processor. Meanwhile, the third segment of the system focused on the output source for the mechanism.

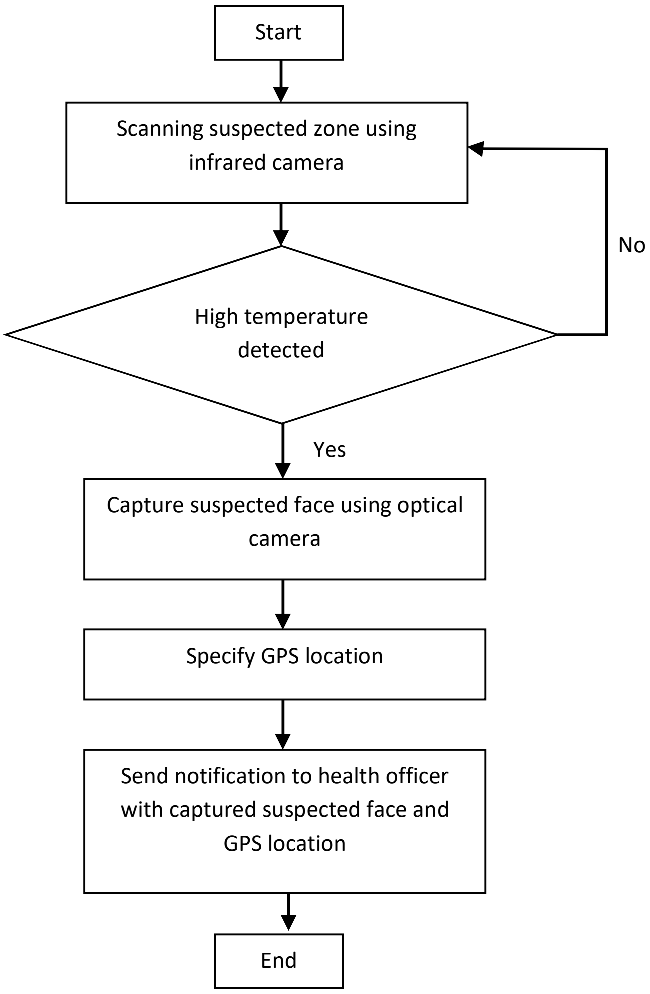

Figure 1. Work Flow of Smart Helmet

The smart helmet was equipped with two different types of cameras, allowing the gathering of detailed information of the face detection details and temperature measurements. Optical camera and infrared thermal camera which provided information about the temperature at which the different focuses of interest were found. A thermographic camera, which sometimes named by thermal imager, thermal imaging, or infrared cameras, is a device using infrared radiation to create image similarly to traditional camera that utilize visible light to produce image. This module regards segmentation approach of an image according to the recorded temperature and captured colour images by both thermal and optical cameras. Thermal camera is utilized for hot body detection and recognizing by adopting the variability of high temperature compared with other objects within the scanned zone. If thermal camera visualizes high temperature body, then it creates high intensity levels of infrared spectra.

In this project, the Arduino IDE (Arduino integrated development environment) is adopted which is written in Java language and represents a cross-platform App. It involves many features code editor such as syntax highlighting, auto-indentation, and brace matching. The IDE additionally uploaded an Arduino board by compiled and uploaded programs using essential one-click mechanism. It also supports C and C++ languages in using special rules to order code. Further, it utilize wiring project that produces several input-output method to provide software library known by Wiring as depicted in Figure 2. In addition, Proteus software includes schematic, simulation and circuit design. It is mainly used for drawing several schematics and performing real time circuit simulation that empowers human to get access during running phase, and thus creating real-time simulation [17-18]. For face detection process, this prototype uses EmguCV cross platform. Net wrapper to the Intel OpenCV image processing library and C# .Net. The normal APIs are generated during programming by Open CV library. Ardunio UNO board is used with a computer stick driven by Intel processor. The face detection is done by using Cascade Classification algorithm which is based on Hair feature. It is presented by Paul Viola and Michael [14]. Further, Machine learning algorithm is used with a cascade function for training both of positive and negative images. The open CV library already has the Cascade object detection that recognizes the face of the captured image. Many common features are extracted from the human Face to make a standardized size rectangle to enable image preprocessing algorithm to grayscale image as well as histogram equalization [14].

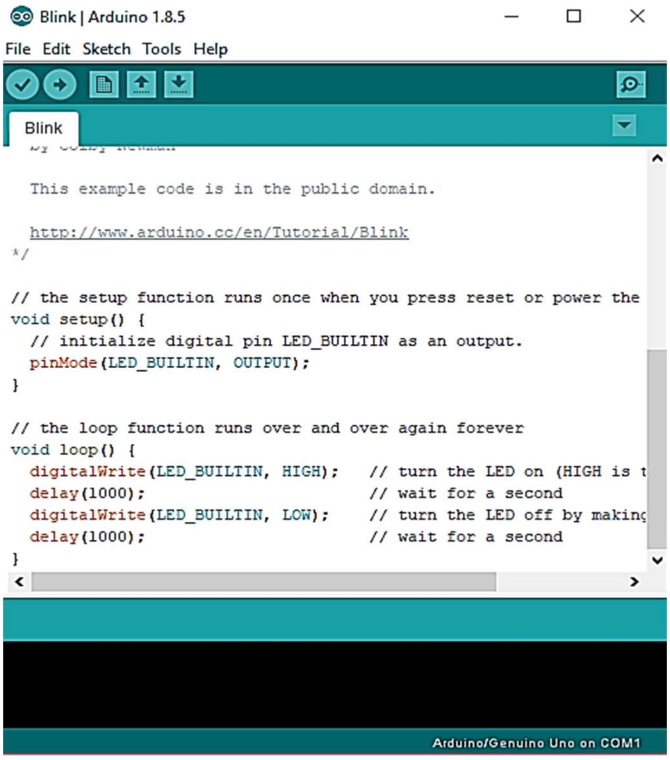

Figure 2. Arduino Coding

3. RESULT AND DISCUSSIONS

The presented design should be checked at the beginning by simulation to look at its achievability and confirm the unwavering quality of a control technique that was said over. A basic model of the created system is designed by Proteus software as appeared in Figure 3. For approving the system tentatively, the testing stage was focused on logical interims of the software to guarantee that all statements are tried and a functional interim is carried out within the tests to identify the errors. It also keeps up that the defined input will create real outcomes that are coordinated with the required ones. Each of Program and models level testing have been integrated and performed. The circuit simulation imitated the performance of the real electronic device and circuit on the cell phone-aided software.

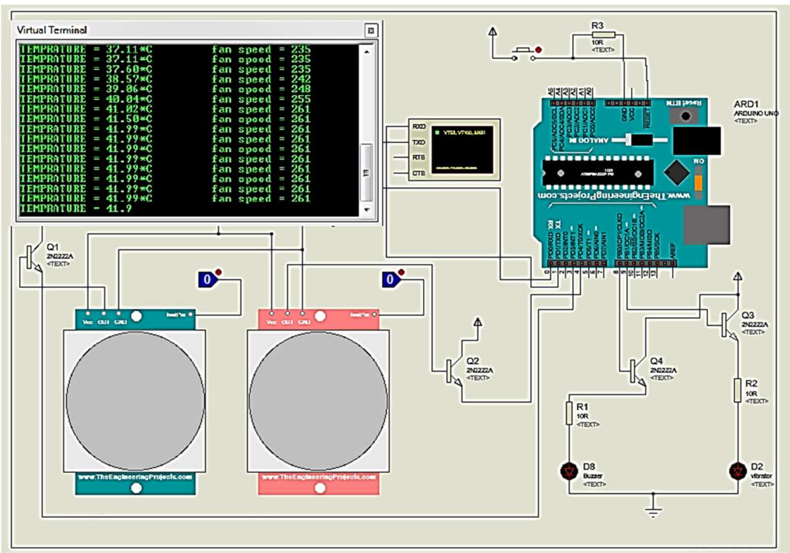

Figure 3. Proteus Circuit Simulation

Figure 4 shows the configuration of the system. The current innovation concerns with applicable kind of thermal imaging frameworks for detection an increase of body temperature as well as surveillance process, and more especially to an enhanced helmet-fixable camera system which may be promptly deployed and utilized to visualize thermal image with high resolution for the infected site coordinated to either user's eye whereas keeping up directed and coordinated visual contact of the client with the location to supply superior perceivability of the encompassing zones. An important indicator for an infection is increased body temperature (compared to other people in the immediate surroundings), generally known as fever. Thermography is the ideal method for scanning not just individuals, but also large flows of people. To do this, the temperature is measured, and an alarm triggered if it deviates. This allows persons with increased body temperature to be identified quickly and reliably, and to be isolated for more exact testing. Beyond checking body temperature, artificial intelligence is being used to diagnose COV19. Infervision, software that automatically detects symptoms via screening images, and can make diagnoses quicker and reduce the risk of human error. The Figure 5 illustrate how the smart helmet work generally.

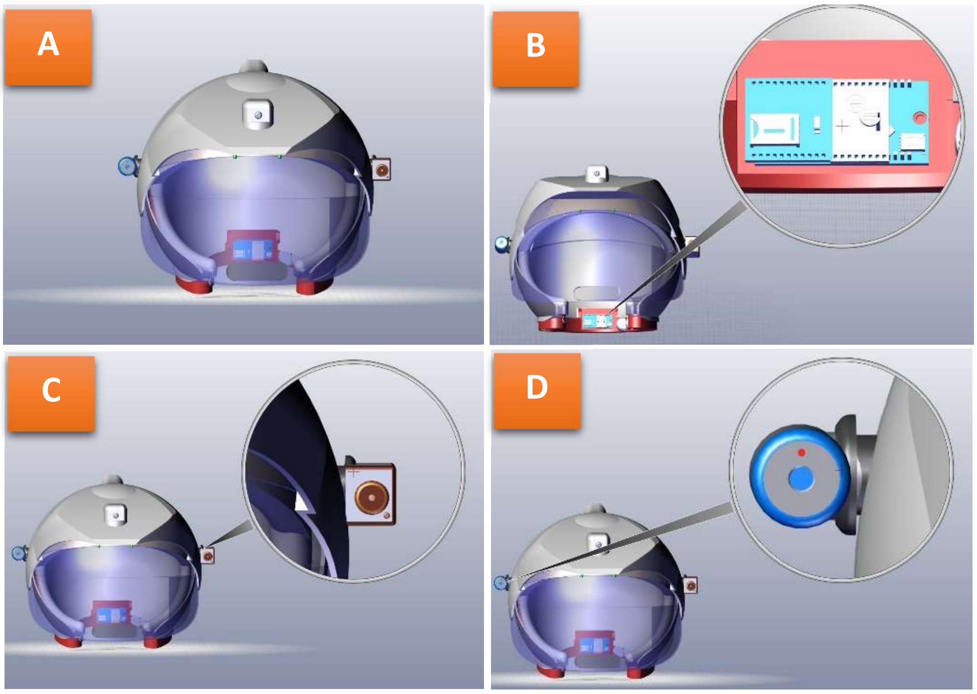

Figure 4: Configuration design of the system (a) Over all system, (b) System Controller, (c) Thermal Camera and (d) Optic Camera.

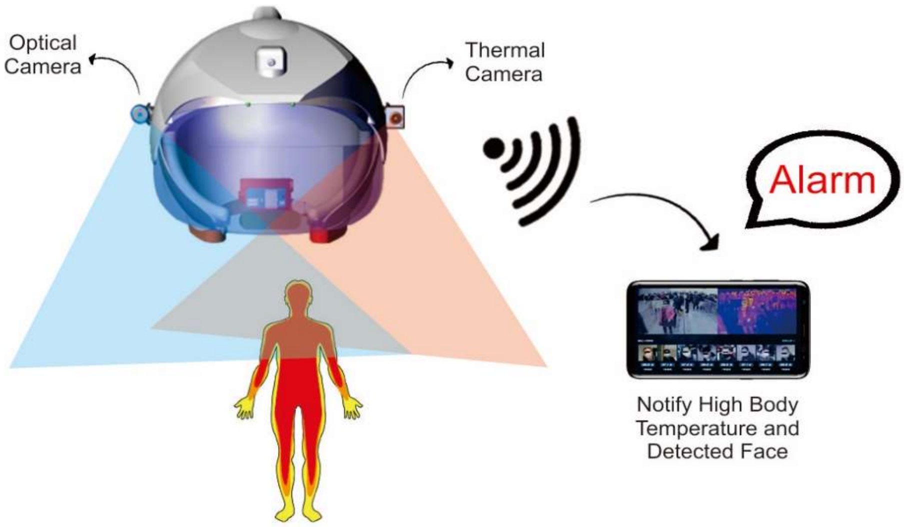

Figure 5. Smart Helmet System Work

Face recognition has been broadly examined since few decades. With the quick progresses in processing performance and memory, the online and live video processing of computer vision in portable devices became reachable. The algorithms of conventional computer vision like the Viola–Jones and deformable part methods and related extensions have really advertised great performance in the context of restricted conditions. In addition, to detect the history of visited place made by a person suspected as infectee, the Google Location History (GLH) can give the system the detail of places that have been visited by the infectee until now (Figure 6). GLH itself is Google service that saves where user go with every mobile device. The user experience can be improved by using any Google App or services which adopt Google Location History & Reporting. Like most Google services and features, the entire history and management is completely connected with user's Google account, like most Google features and services. GLH has been used on assessing user's habit [15], and user's mobility [16] as well to provide visions, involving planning of infrastructure, control of infection diseases, and suitable reaction to disastrous occasions.

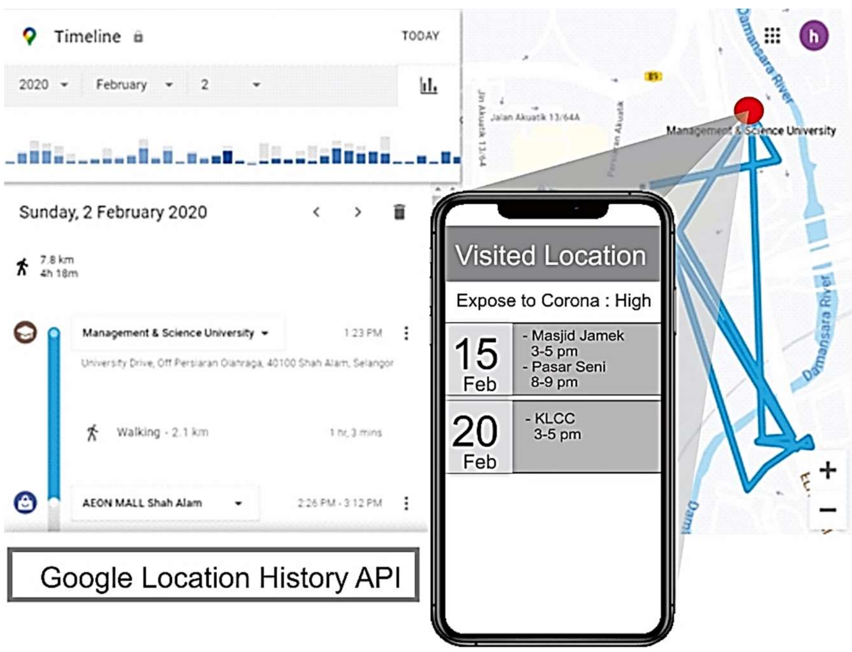

Figure 6. Google Location History System

After getting information incorporating the recognized face, body temperature, and GPS position delivered by Arduino through sequential communication, the micro-controller (type NodeMcu) had these values transferred to it over the Web to supply independent online worldwide access to of this information. For this reason, an exterior server called Blynk was utilized. When the thermal camera detects high temperature body as shown in Figure 7, the system notifies the authorities to alert them about the threat. At the same time the system will take a picture and sent to the health officer.

Figure 7. Thermal Image that detect variety of temperature

4. CONCLUSION

An innovative real-time early detection of coronavirus and monitoring system using smart helmet which integrated with thermal imaging system has been developed. The smart helmet can also detect high body's temperature in the crowds and send the measured data to be displayed on a phone application. As the latest big issue nowadays that happened across the world, the spreading of coronavirus give so much attention and awareness among people. Early detection of the coronavirus symptoms will be one of the suitable ways to prevent the spreading of coronavirus. As the high body temperature of people is one of the very common symptoms, a real time monitoring system of the screening process that automatically appearing the thermal image of temperature of people is needed. So the diagnosis of the screening process will be less time consuming and less human interactions that might cause the spreading of the coronavirus faster. It can be concluded that the remote sensing procedures, which provide an assortment of ways to identify, sense, and monitoring of coronavirus, give an awesome promise and potential in order to fulfil the demands from the healthcare system.

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IRJET- SMART HELMET CONTROLLED VEHICLE

IRJET Journal

SMART HELMET CONTROLLED VEHICLE

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Abstract - *Smart Helmet Controlled Vehicle is a project undertaken to increase the rate of road safety among motorcyclists. Several countries like India enforcing regulations to wear a helmet while riding. The idea is obtained when the increasing number of fatal road accidents over the years is cause for concern among motorcyclists. The accident detection system communicates the vibration values to the processor which continuously monitors for erratic variations. When an accident occurs, the related details are sent to the emergency contacts by utilizing a SMS alert. Using the Global Positioning system the vehicle location is obtained.*

Key Words: Automation system, Smart Helmet, Accident detection, Helmet detection, SMS alert.

1. INTRODUCTION

Helmets for riders are extremely important and many lives can be saved by the use of these Helmets in the event of accidents. Motorcyclists have a perception that wearing a helmet causes discomfort and they do not appreciate its importance, especially the youth. And perhaps the most misleading idea is that short trips do not involve any risk. Smart helmet helps to curb “riding without helmet” by ensuring that the rider mandatorily wears the Helmet while driving. The system is designed in such a way that if the rider does not wear his/her helmet the bike’s ignition is turned off. It also has emergency features which come in need during mishaps. With the implementation of this concept, we would like to make commuting safe and reduce the number of motorcycle accidents. The design also has pollution information gathering technology where the sensor records the "ppm" of various greenhouse gases and with respect to the location, the information is updated on the cloud. Wearing a helmet reduces the risk and increases the chances of survival. A helmet is lined with polystyrene and, on hard impact absorbs the shock. The government has been working on this situation and has come up with road laws. The domain of safety has a wide scope for development and a number of research papers have been published has built a system using encoders, RF transmitters and receivers to improve the safety and use of a helmet while commuting on a two wheeler. This was further improvised by where the safety helmet system included a vibration sensor, GSM and GPS modules that could track the person and send a distress call upon hard impact.

1.1 Proposed System

The Automation system is used for the safety of a person, it has been developed to tackle the shortcomings faced by the preceding systems. There is no need for manual control. For perfect detection of accidental conditions, the vibrational sensors and IR sensors should be used. As the whole system will be embedded inside the helmet and vehicle, it will be easier to detect the occurrence of an accident. The vibrational sensors will be helpful in detection of an accident. The IR sensor must be fitted inside the helmet and vibrational sensors will be fitted on the helmet as well as on the vehicle. IR sensors are used to detect whether the rider wears the helmet or not. ZigBee XBee modules are used as wireless communication between the boards, without any wired connection between them. The master part of the system will decide about sending the longitude and latitude of the location to the predefined number using the GSM module. Then the computer receives the GPS location through short messaging service (SMS). Using IoT module all the information is stored on the cloud.

2. LITERATURE SURVEY

2.1 Smart Helmet Using GSM and GPS Technology

The Author has discussed safety and security of the bikers against road accident. Smart helmet has special idea which makes motorcycle driving safety than before, this is implemented using GSM and GPs technology. Other advantages of this project is to measure the alcohol level of the drunken people who is riding the bike. Whenever the alcohol level crosses the predefined value, the alarm starts and get notification about the drunken driver. The author have also discussed about the accident detector and the sensor will active the GPS and find the location and further SMS will send to ambulance or family members.

As they have used microcontroller for controlling their overall operation due to that the project will might be fail to upgrade newer versions.

2.2 Helmet using GSM and GPS technology for accident detection and reporting system

According to the author this project is specially developed to improve the safety of the motorcycle’s rider. The objective of this project is to study and understand the concept of RF transmitter and RF receiver circuit. The project uses ARM7, GSM and GPS module. The project also uses buzzer for indication purpose. This project is only concentrated on only one specific purpose that is an accident. Whenever the accident will occur then accident spot will be noted down and information will send out on the noted mobile number.

The major disadvantage of this project is they are not using any display device for showing the current status. Also the cost of helmet is still high since helmet is designed for only one purpose.

2.3 Microcontroller based smart wear for driver safety

In this paper author has discussed on the speed of the vehicle. In this application the project will be monitoring the areas in which the vehicle will be passing. On entering any cautionary areas like schools, the speed of the vehicle will be controlled to a predefined limit. He worked on the phenomenon of speed of vehicle along with some security factor. LCD is used for showing the various types of messages after wearing the helmet.

The author has worked only on the phenomenon of accident which is generally happens due to drunk and drive. But as we know that the accident in the area is not happens only due to consuming alcohol but also other parameters are also responsible.

2.4 Smart Helmet(March 2016)

In this paper the prime objective of author is to force the rider to wear the helmet throughout. Considering the increasing number of motorcycle riders in our country and the number of accident happening each year. In this competitive world one of the survey says that the death tolls due to motor bike accidents are increasing day by day out of which most of these casualties occurs because of the absence of helmet. Traffic police cannot cover remote roads of city. Thats why over primary target is to make the usage of the helmet for two wheelers ”compulsory “ .Thus ,no one other than the owner himself ,who doesn’t have “password” which would have been created by the owner, can use the bike. In this author has proposed the feature that the bike will not start unless the helmet is not worn by the rider .The other this module basically deals with the checksum of rider if he is wearing the helmet or not on first place to achieve this ultrasonic sensor is been used .based on this the signal are been sent to the next module voice recognition module use for authentication purpose. Arduino is also used in this project which is an open source tool for making computer that can sense and control more of physical world than your desktop computer.

Hence they have use ultrasonic sensor it is very expensive and the microcontroller is been used it may have major drawback in future as it is not able cope up with highly updated world in future .

2.5 Smart Helmet (May 2015)

In this project the author has proposed the smart helmet because of growing bike accident now a days .people get injured or might be dead and one of the reason is not wearing helmet. Continuously road rules are violated .so as to overcome these problem this helmet is been proposed .The craze of motor bike is really remarkable .the middle class families prefer to buy motor bike over four wheelers ,because of the low prices , various variety available in the market ,due to cut-throat completion between two wheeler company and durability . Author has also used encoder IC receives parallel data in form of address bits and control bits the other author has used smart system for helmet.

But in this project author have not focused on the major issue that will occur in future regarding the alcohol and many other.

3. TECHNICAL STUDIES

3.1 ESP-12E Based NodeMCU

The ESP8266 is the name of a micro controller designed by Espressif Systems. The ESP8266 itself is a self-contained Wi-Fi networking solution offering as a bridge from existing micro controller to Wi-Fi and is also capable of running self-contained applications. This module comes with a built in USB connector and a rich assortment of pin-outs. With a micro USB cable, you can connect NodeMCU devkit to your laptop and flash it without any trouble, just like Arduino. It is also immediately breadboard friendly.

Fig -1: ESP8266 – IoT module

3.2 GSM Modem

A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves. The working of GSM modem is based on commands, the commands always start with AT (which means ATtention) and finish with a <CR> character. For example, the dialing command is ATD<number>; ATD3314629080; here the dialing command ends with semicolon.

The AT commands are given to the GSM modem with the help of PC or controller. The GSM modem is serially interfaced with the controller with the help of MAX 232. Here max 232 acts as driver which converts TTL levels to the RS 232 levels. For serial interface GSM modem requires the signal based on RS 232 levels. The T1_OUT and R1_IN pin of MAX 232 is connected to the TX and RX pin of GSM modem.

Fig -2: GSM Modem

4. CONSTRUCTION

Our project is divided into two unit namely helmet and vehicle section.

4.1 Helmet Section

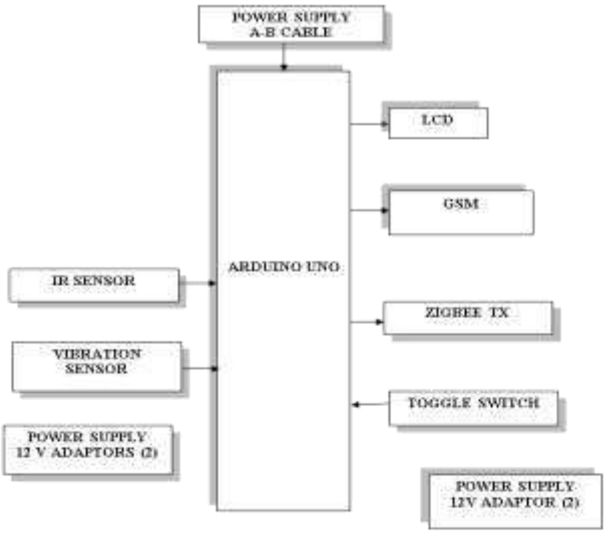


Fig -3: Block diagram of helmet section

Helmet unit consists of two sensors which is monitored by Arduino UNO. IR sensor is placed on inside upper part of the helmet where actually head was touched with sensor surface. And Vibration sensor is place outside the helmet. So that whenever the accident occurs, Zigbee transmitter sends the signal to the receiver. Eventually the vehicle stops and the message is sent to the registered number. GSM modem is used to find the latitude and longitude. This information is sent through SMS. And the battery and regular circuits can be fixed inside or even outside the helmet.

4.2 Vehicle Section

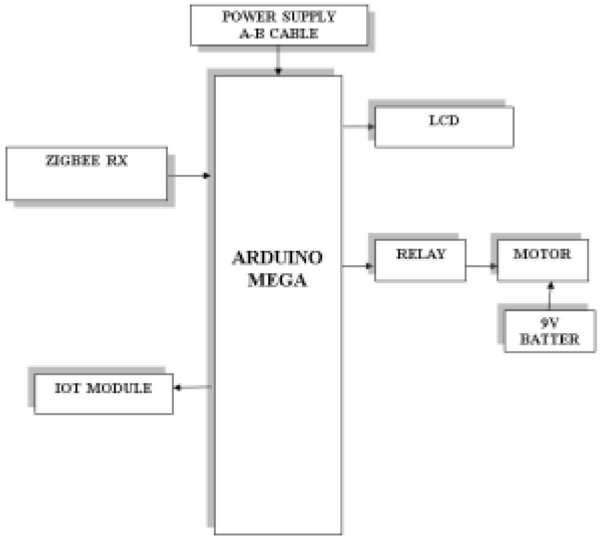
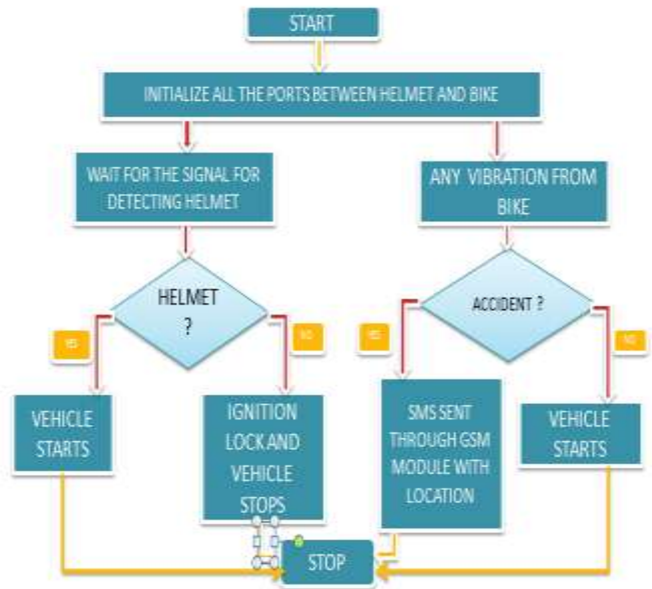


Fig -4: Block diagram of vehicle section

The vehicle unit is mounted on actual bike. Our main controller is positioned in to storage case of bike. And the vibrational sensor in the helmet section is used to detect the accidents. And the Zigbee receiver receives the signal from the Zigbee transmitter which is in the helmet section and immediately it stops the vehicle. And the SMS containing the information about latitude and longitude is sent through SMS. Even the information is stored on the cloud using IoT module.

5. FLOWCHART



1. The first step of project is to check the initialization of all the ports.

2. The next step is to check whether the rider wears the helmet or not. If the rider wears the helmet, then the vehicle

starts. If the condition fails means the rider does not wears the helmet then the ignition locks and vehicle stops.

3. Accident Detection is also featured in the project. If accident is detected, immediately the signal is sent using wireless communication to the vehicle. And the vehicle is stopped and the message is sent to the registered number with location in terms of latitude and longitude positions. And if the condition fails then the vehicle moves on.

4. Even the whole information is stored on the cloud.

6. WORKING PRINCIPLE

In this proposed method, the helmet mechanism contains **ARDUINO MEGA** microcontroller, which continuously monitors the sensor values. The **IR sensor** is used to detect whether the person wear the helmet or not. If the person wears the helmet, the controller detects and transmits the **START** signal to the vehicle section and turns **ON** the vehicle. If the person removes the helmet, the controller sends the **STOP** signal to the vehicle and turns **OFF** the vehicle. The helmet also detects the vibration level and if there is any abnormal vibration is detected it gets the location of the person and transmits the emergency alert through SMS for the rescue persons. The **IoT ESP8266-12E** module is used for live tracking and the vehicle can be controlled from cloud. The software used in this project are **Arduino IDE** and **Embedded c.**

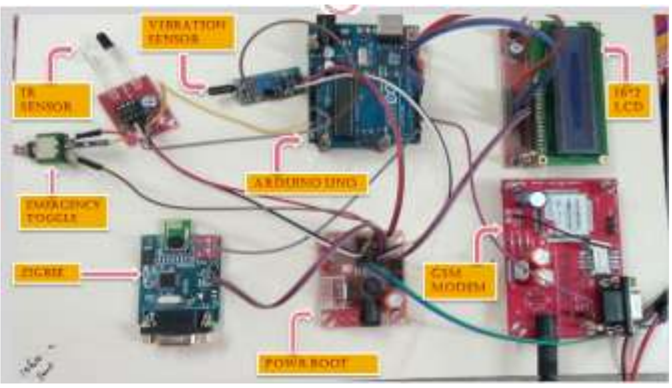


Fig -5: Helmet section

The hardware used in the helmet section are IR sensor, Vibration Sensor, Arduino UNO, GSM modem, 16*2 LCD, Power Boot, Zigbee, Emergency Toggle Switch. Except IR sensor all other devices can be embedded inside or outside the helmet. But IR sensor must be inside the helmet to check whether the rider wears the helmet or not. Even in the vehicle section consists of the devices such as Arduin uno and Zigbee. The IoT module ESP8266-12E is used in the vehicle section to store the information on the cloud. The DC motor resembles the vehicle.

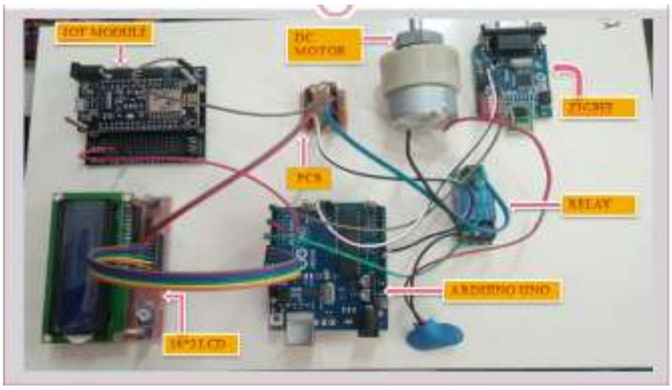


Fig -6: Vehicle section

7. RESULTS

7.1 Helmet Section

7.1.1 If the rider wears the helmet, then the vehicle starts. And the LCD displays the messageas **"ENGINE START".**

7.1.2 If the rider does not wears the helmet, then the vehicle does not start. And the LCD displays the message as **"ENGINE STOP".**

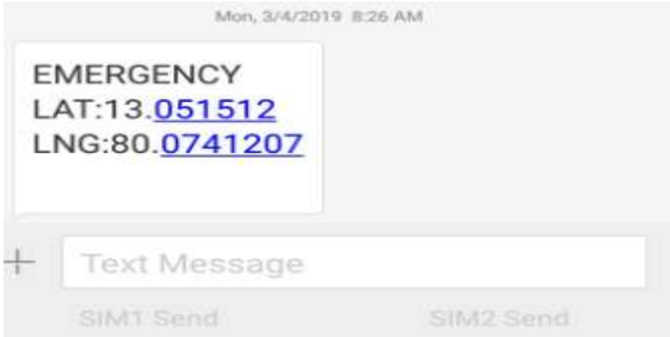
7.2 Vehicle Section

7.2.1 If accident occurs, the vehicle is stopped. Then the message is displayed on the LCD as **"Emergency".** And it also sends the SMS to register number with their current geographical location.

7.2.2 To alert the rider the message displayed on the LCD as **"SAFE".**

7.2.3 When the vehicle is stopped due to accident the message displayed on the LCD as **" ENGINE STOP".**

7.2.4 The SMS is sent to the registered number.



7.3 Cloud Storage

http://www.iotclouddata.tech/527/index.html

http://www.iotclouddata.tech/527/readalltable/readalltable.php

The IoT module ESP8266-12E is used in the vehicle section to store the information on the cloud.

8. ADVANTAGES

- Detection of accident in remote area can be easily detected and medical services provided in short time.
- Simply it will reduces the probability of accident.
- It can be used in real time safety system.
- We can implement the whole circuit into small module later.
- Less power consuming safety system.

- This safety system technology can further be enhanced in car and also by replacing the helmet with seat belt.

9. FUTURE SCOPE

The project can be enhanced by adding Google Glass Technology. Through this technology, biker can see the upcoming road before reaching that particular place. Also, biker can see navigation on it and can alert him while taking sharp turns.

10. CONCLUSIONS

The system implemented is very useful and advantageous application for two wheelers or with some modification even cars. Implementation of this system by manufactures or by individuals will decrease the deaths ratio from accidents.

The medical staff will be well prepared than an emergency case and will efficiently treat the casualty.

Hence it can be inferred that the SMART HELMET CONTROLLED VEHICLE is a flexible system to operate and remarkable improve the life expectance of the victim.

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IRJET- LIFE SAVING DEVICE: A SMART HELMET

IRJET Journal

LIFE SAVING DEVICE: A SMART HELMET

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Abstract - *The aim of this unique helmet is to provide Safety to the bike rider. With the help of Proper Switch Mounted in helmet the two-wheeler would not start without helmet so safety of rider is assured and if accident has occurred our system will give information to the ambulance about the accident, so they can take certain measures to save the life of the person who meet with an accident. It is developed using Arduino. We place sensors in numerous sides of helmet that is connected to Arduino board. So once the bike rider crashes sensors sense and therefore the Arduino extract Globel Positioning System (GPS) location information from GPS that is interfaced with Arduino. When the device information exceeds most limit of pressure then Global System for Mobile communication (GSM) module will sends message to ambulance, police or family members. In case of minor injuries, the rider can stop message by the SMS stop switch. We also introduce one unique feature for ignition the bike engine when helmet is stolen.*

***Key Words*: Arduino mega2560, Arduino Uno R3, GSM SIM900, GPS receiver, Adxl335, MQ3 sensor, HC05 Bluetooth sensor.**

1. INTRODUCTION

In recent times helmets have been made compulsory in Maharashtra State. Accidents in India have increased day by day. As per Section129 of motorized vehicles Act, 1988 makes it needed for each single riding a two-wheeler to wear protecting headgear following to standards of the BIS (Bureau of Indian Standards). Drunken drive case could be a criminal offence of the car act 1939. This states that the bike rider can get penalized. In existence bike rider simply get free from law. These are three main problems that motivates for developing this project. The first step is to check the helmet is wear or not. If helmet is wear then ignition can begin otherwise it'll remains off until helmet isn't wear. For these we use pressure sensor. The second step is alcohol detection. Alcohol detector (MQ3) is use as breath instrument that observe the presence of alcohol in rider breathe if it's exceeds permissible vary ignition cannot begin. When these 2 conditions are true then ignition can begin. The third main issue is accident and late medical facilitate. If the rider met accident with him he cannot receive medical facilitate instantly, it is huge reason for deaths. Around each second persons die because of late medical facilitate or the accident place is unmanned. In fall detection, we place GSM and GPS module at this unit. Due to these mechanisms we can observe that accident happens or not. The aim of this project is to create a protection system in a helmet for a better safety of motorcycle rider. The sensible helmet that we created is sense that helmet wear or not. There are two Arduino are placed in this this project as a processor. Each unit has used a separate processor, for bike unit we use Arduino mega 2560 and for helmet unit we use Arduino uno. Signal transmission between the helmet unit and bike unit is established by RF trans receiver.

2. Literature survey

The thought of developing this paper comes from the accident which occurs in our daily life.As we can see many accidents occurring around us; there is lot of loss of life. According to survey, many people die in road accidents occurring due to bike crashes per year. The reason for the accidents may be such as no proper driving knowledge, damaged bikes, rash driving, drunken drive etc. But the major reason was found to be the absence of helmet on that persons head, resulting in an immediate death due to brain damage.

Gunprabh Chadha, et al. [1] described that to overcome the accidental situation, a security system has been embedded within the "Smart Helmet" and this circuit is placed within the helmet. If helmet is not buckled the bike will not start. An alcohol level detector is additionally placed within the circuitry. If the rider has consumed alcohol the vehicle cannot turn on. Also when an accident takes place a message will be sent to the pre-stored numbers. Prof. Chitte P.P. et.al. [2] Said that if helmet is wear then ignition willstart otherwise it'll remain off until helmet isn't wear. Forthese we use FSR sensor. The second step is alcohol detection. Alcohol sensing element is use as breath analyser that detect the presence of alcohol in rider breath if it's exceeds permissible range ignition cannot start. It will send the message to register number. MQ-3 sensor is used for these. When these two conditions are satisfied then ignition will start.Mr.VivekA.Patel, et.al. [3] described that their helmet ensures that the rider has were the helmet and he/she has nonalcoholic breath and if accident has occurred it will inform the ambulance on time even there is no person to give information of the accident to the ambulance. Rambabu et.al. [4] Focused on an optimal Driving System with the help of Wireless Helmet .They has used a wireless communication between bike to helmet and bike to traffic light and speed breaker. The system is comprised of a helmet module together with stereo speakers and microphone, and a motorcycle mounted base unit. The system will make use of different wireless communication protocols together with ZigBee and another frequency (RF) protocol. Sudharsana Vijayan, et al. [5] described the alcohol Detection with sensible Helmet System, here they used a switch which detect whether rider is wear helmet or not. Alcohol sensing element is employed to notice the biker is drunk; the output is fed to the MCU. If any of the 2 conditions ar dissatishfy then the engine won't turned ON. Manjesh N, Prof., et al. [6] focused on Smart Helmet Using GSM & GPS Technology for Accident Detection and reporting System. The idea of this work is to give information concerning the rider carrying the helmet or not, whether the biker drunken or not and if accident occures then through GSM & GPS module the location of biker will send on perticular mobile numbers. In this system P89V51RD2 microcontroller is used. In this paper they used Vibration sensing element, Alcohol sensing element, Temperature Sensor & Solar Cell as power supply.R. Pruthvi Raj, et.al. [7] Researched about Smart-Tec Helmet. The prototype has three inputs and as many outputs routed to and from the P89V51RD2Microcontroller respectively. The two sensors incorporated in the prototype one is LM35D temperature sensor and ADXL3 tilt sensor, along with the GSM and Global Positioning System; module comprised the input circuitry while the Peltier module, the LCD module and also the international System for Mobile communications(GSM) module forms the output circuitry. K. Sudarshan, et.al. [8] described that people need to wear helmet and to prevent road accidents. Thus road accidents prevented to some extent and safety of motorbike riders is ensured. Vijay, B.Saritha, et.al. [9] Said that the system efficiently checks the wearing of helmet and drunken driving. By implementing this technique a secure 2 wheeler journey is feasible which might decrease the pinnacle injuries throughout accidents and conjointly cut back the accident rate due to drunken driving. Harish Chandra Mohanta et.al. [10] Described the embedded safety and security system for vehicle by integrating and modifying existing modules. This system endures primarily with 3 modules specifically Gas sensing module, Obstacle detection module and Anti-Theft alert system; this square measure interfaced with ATmega16 microcontroller. Wilhelm von Rosenberg, et.al. [11] Focused on Smart Helmet: Monitoring Brain, Cardiac and Respiratory Activity. In this paper they have obtained a ballistocardiogram and a single lead ECG from sensors is placed behind the ear showed the possibility to collect cardiac data non-invasively from head locations. Prof. N. B. Kodam [12] described data about the rider wearing the cap or not, whether the rider smashed or not furthermore. It included block diagrams of bike unit and helmet unit. A. Srikrishnan et.al. [13] Focused on Cloud Incorporated Smart Helmet Integrated with Two-wheeler Communication Setup.The entire system is followed into two halves: (a) Helmet System (b) Vehicular SystemReported works in the field of Helmets include, the usage of RF technology to detect crash and notify to the control room.Vibration Sensors placed on the helmet to check the vibration. Aviral Ajay, et al. [14] focused on GSM module which is used with microcontroller and transmitter circuit. Piezo sensor is used to sense the vibration. It included the block diagram of GPS and GSM module and also block diagram of accidental free transportation system. Saravana Kumar K et.al.[15] published a paper on Smart Helmet .This paper on "Smart Helmet" basically it used three main modules called Helme system module, voice regnization module , Bike system module. The helmet can be used to communicate with the bike module all the time during the riding to detect if the person is wearing the helmet or not and then the bike module or processor is asked for a password in the form of speech to unlock the bike by matching a user-unique password. Jennifer William et.al. [16] Published Intelligent Helmet. The proposed system is an intelligent helmet. The system ensures the safety of the biker. This system also detect the helmet is stolen or not and send signal to proposed processor to further processes.

3. Methodology

There are two Arduino are placed in this this project as a processor. Each unit has used a separate processor, for bike unit we use Arduino mega and for helmet unit we use Arduino uno. Signal transmission between the helmet unit and bike unit is established by RF transreceiver. We also implement the HC05 Bluetooth sensor in emergency condition, if helmet is stolen then every user having a unique self-generated password which can be used to unlock the bike ignition model and start the bike. The technology used in it is wireless and is completely same for long usage. Once activated the transmitter sends a some signal to the receiver circuit and hence there is some time lag in wearing the helmet and switching on of the circuit large scale production solid state relays is place to use which have higher response. The sensible helmet mentioned in this paper is depends on one single idea that is to make it somehow necessary to wear it when riding a bike by the assistance of some technology. This helmet in observes acts as a second key to the vehicle and successively will increase security. Moreover because the rider will neither starts nor run the vehicle without wearing the helmet it ensures that the rider should wear the helmet always while riding the vehicle.

4. Proposed System

4.1 Proposed system in Helmet

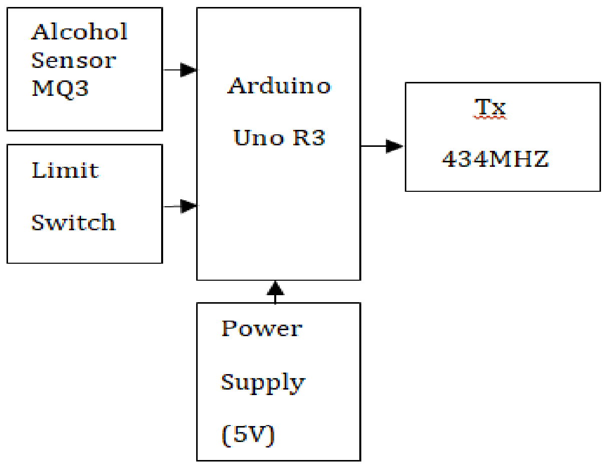

Figure1: block diagram of transmitter section

Figure.1 shows block diagram of transmitter section helmet module. We are used here Arduino Uno R3 as a main processor. Alcohol sensor (MQ3) is used to detect the content of alcohol from the user's breath. Alcohol sensor (MQ3) is placed near the mouth of the rider. Pressure sensor can sense the presence of helmet. If helmet is not buckled then this sensor send fall signal to the Arduino uno and further process is proceed by transmitter section. It requires 5V power supply. All the data is then send to the receiver section.

4.1 Bike Module System

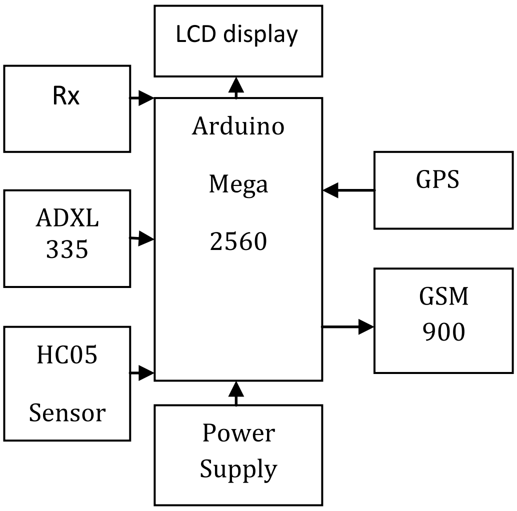

Figure2: Block diagram of receiver section

Figure.2 shows block diagram of receiver section bike module.In bike module, we used here Arduino mega 2560 as a main processor. Receiver collects all the data and then an LCD display the result weather helmet is wear or not also it shows that rider drunken or not. In emergency cases helmet is get stolen then we can use Bluetooth sensor as an alternative process for engine start. GPS receiver is used to show the location of the rider if accident occurs and it will send message to registered mobile number and ambulance.

4.2 Working principle

The thought of doing this project is to provide safety to bike rider while riding, if accident occures then the arduino processor will send text sms to the registered mobile number using gsm gps. This is done by using the GSM module. We are using SIM808 as the GSM module. When the accident has happened the Tilt sensors sense the accident and give signal to the Arduino. Then Arduino can take location from the GPS and it will send the location of accident in the form of the latitude and longitude but normal user can't understand how get location from the latitude and longitude so we have implemented our system to send the google map link. Which will open in location maps, family members and the ambulance can take certain actions to save the life of biker. But we don't need to call ambulance every time. Sometimes the biker has minor injuries but piezo electric sensor will sense that as accident. In this case bike rider can stop sending of the SMS. This is done by using the pressing switch to stop accident. Before sending the accident message to the ambulance and family members the buzzer will ring for the 40 seconds if the bike rider has minor injuries then it can stop the sending of the SMS by pressing the switch on helmet. Above system mentioned was for the accident reporting. This is done by using the MQ3 sensor and the Rider detection switch. The vehicle part contains the Arduino mega and other circuit to start or stop the ignition

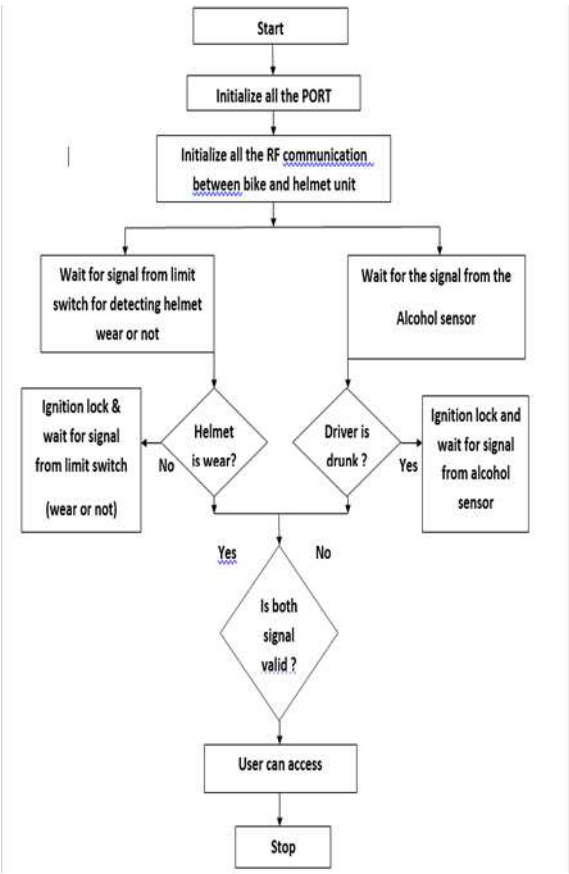

Figure3: Flowchart of Smart Helmet

5. Future scope

- We can implement numerous bioelectric sensors on the helmet to detect various activities.
- We can use camera for the shooting and recording the rider's activity.
- It can be used for passing message from the one vehicle to a different vehicle with the help of wireless transmitter.

- We can use solar energy for helmet power supply and same power supply will charge our mobile
- It can be used for location tracking.
- GPRS may be used for the storing information online.
- GPS can be programmed to calculate the speed of the bike in case of more speed.

6. Conclusion

In paper, we represented a smart helmet based system which will successfully able to detect whether the rider as worn the helmet or not. It also sets an alcohol sensor rider has consumed alcohol beyond permissible levels. This helmet will overcome the range of road accidents that takes place each day. If accident occurs it will sends the victim's location to family members and nearby police station. Also, death rate can drastically be reduced by implementing this circuit as mandatory while riding and make everyone's life easier and smoother. We also implement a new feature like Bluetooth controlled bike starter. The project can be increased by adding Google Glass Technology. Also, biker will see navigation and it alert him when taking sharp turns. Further, it can implement on cars also.

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Accident detection system based on Internet of Things (IoT)-Smart helmet

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Accident detection system based on Internet of Things (IoT)- Smart helmet

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ABSTRACT

The objective of our smart helmet is to provide the means for detecting and reporting accidents. The working of this smart helmet is very simple; vibration sensors are placed in different places of the helmet where the probability of hitting is more, which are connected to the microcontroller board. When the rider met with an accident and the helmet hits the ground, these sensors sense and gives to the microcontroller board, then controller extracts GPS location using the GPS module that is interfaced to it. When the data exceeds the minimum stress limit then the GSM module automatically sends a message to the registered emergency contacts and the link through which the location and the speed of the victim will be displayed in the mobile application and in a web application.

Keywords— *Camera, Emergency contacts, GPS, Internet of Things, Raspberry Pi, Smart helmet*

1. INTRODUCTION

"Internet of things" is now become an essential part of our day to day life. The usage of electronic and digital devices is increasing more than 13 billion, in equals of 2 devices per person. Suitable examples for the IoT is "Smart Home", the smartest devices are developed with programmable and remote controlled appliances. Future growth in IoT basically from every sector of the economy like a commercial, industrial, health care and public safety.[1]The utility components and all other everyday objects are combined with Internet connectivity and powerful data analytic capabilities, which are changing the way we live and work. Hence the term "Internet of Things" is defined as extending the network connectivity and computing capabilities, not only to computers but also to everyday items to generate exchange and consume data with minimal human intervention.[2]

2. RELATED WORK

The working scenario of the helmet is described (3), when the rider meets with an accident and the helmet falls on the ground, the sensors sense the vibration and sends to the microcontroller board (P89V51RD2), Then controller senses the location information using the GPS module that is interfaced to it. When the vibration exceeds minimum stress limit then GSM module (SIM300) automatically intimates the information by sending a message to the emergency responses. Authors proposed a new helmet model (4) when an accident occurs, cloud-based service is used to send the alert message with the details to the emergency contacts. The location of the vehicle is sensed through the GPS module. BMA222 accelerometer, Wi-Fi enabled processor (TI CC3200), sensors and cloud computing platforms The authors have designed a helmet for the riders to provide extra features like Listening to music while riding, sending SOS messages along with the location in case of emergency via a microcontroller (ATmega328P)[5]. This helmet is integrated with latest Bluetooth (HC-05 Module) technology through which it will get connected to the driver's Smartphone and can receive calls while driving through the Arduino Software (IDE) are used for constructing the system. The helmet is upgraded with a Peltier module for rider comfort (6), by Peltier module (TEC-12706T125), which maintains the heat inside the helmet by the thermoelectric effect. The temperature sensor (LM35D) is used to detect the temperature. If an accident occurs the GPS module sends the accurate location to the emergency contacts and in case of bleeding, it can be clotted by thermoelectric module so the risk of danger can be reduced. Smart helmet works on GPS and GSM technology (7). The accident is identified by the probability of vibration experienced by the helmet. Here vibration is detected by placing a vibration sensor on the helmet and gives to microcontroller board (P89V51RD2). Then the controller finds the location by GPS module and sends a message automatically to the pre-defined numbers by GSM module. To avoid accidents a GSM-based helmet model is introduced by developers which the helmet acts as an intelligent system (8). Here it checks whether the person is wearing the helmet and also senses the alcoholic smell before the rider starts the bike. If any of these conditions occur, the transmitter on the helmet sends a signal to the receiver on the bike via RF transmitter. These signals don't allow to start the bike and the signals are detected by a switch and alcohol sensor MQ-6. The signal and microcontroller (AT-89S552) are decoded by the receiver, and then messages are sent to concerned contacts by GSM module (SIMCOM SIM900A) accordingly. For detecting the rider's head movement and detection of motorcycle's speed authors used, a Force Sensing Resistor (FSR) and BLDC Fan (9). To communicate between the transmitter circuit and receiver circuit, a 315 MHz Radio Frequency Module as a wireless link is used. The entire component in the system is controlled by PIC16F84a microcontroller is used. The motorcycle will be started only when the rider wears and lock the helmet. Whenever the speed limit exceeds 100km/hr, the motorcyclist will be warned and an LED light will glow. This paper about the two modules affixed on the bike (10), as well as helmet using an alcohol sensor MQ-3 is used to detect whether the rider has consumed alcohol or not. Detecting the accident and notify them to the nearest police station is also possible with the help of GSM module (SIM 900A). The rider can avoid the message from sending by pressing the abort switch when the accident is not major. In this paper (11),Smart Helmet is nothing but a Micro-controller (Intel Edison on Arduino Board) embedded inside the helmet along with Accelerometer (MPU6050), Headset (Intex), Camera (Logitech) and when the rider crashes and helmet hits the ground, from the accelerometer values Micro-controller detects accident and sends information to phone via Wi-Fi and finally Smart Helmet connects to Smartphone via Bluetooth to give audio guidelines for navigating the rider, inform about emails and phone calls. Here the Smart Helmet is proposed (12), having a Control System inside the helmet consisting of an RF transmitter through pin17 of HT12E and an RF receiver system. The bike will not get started without wearing helmet by the user, a user wears the helmet an RF signal radiates from transmitter and once this signal gets sensed by the receiver placed in the ignition switch of the bike, bike will get start and hence traffic rules will follow with this providing better security to the user. Smart Helmet is implemented with the features of alcohol detection, accident identification, location tracking, use as a hands-free device, solar powered, fall detection like a smart bike by authors in this paper (13). It is compulsory to wear a helmet, without a helmet ignition switch cannot ON. An RF Module's wireless link and an MQ-3 sensor enable communication between transmitter and receiver. If the rider gets drunk ignition switch is locked automatically and the message is sent to the registered numbers with the current location. When an accident occurs, it will send a message by GSM to registered numbers with the current location by GPS module. To communicate with the bike a proposed helmet model (14), during the initiation of the ride all the time to detect if the person is wearing the helmet or not using ultrasonic sensor (HCSR04) and then the rider is asked for a password in the form of speech to unlock and ignite the bike by matching a user-independent password using voice encrypted password mechanism via microcontroller ATmega 328. The primary objective is to force the rider to wear the helmet throughout. Smart Helmet is proposed with an Arduino controller, microcontroller (ATmegal1280) and Arduino Wi-Fi unit by authors [15]. The presence of alcohol sensor (MQ-3) in the vehicular setup of the system detects the presence of Alcohol Content in the person's breath and the pressure sensor (NPA 700) doesn't allow the vehicle to start in spite of the user wearing the helmet.

2.1 Motivation

Accident detection and reporting system based on the existing system makes use of the sensors, GSM module, GPS module, Wi-Fi enabled controller and cloud computing infrastructures for the development of the system [3]. The system builds a smart helmet for accident detection and notification. This system could be implemented only for the purpose of a smart helmet. The helmet is designed to detect an accident and immediately alert the emergency contacts. When an accident occurs and the data exceeds the threshold limit, a text message containing the location of the rider is automatically sent to the family members through the module [4]. The location details are sensed and reported by the GPS module. The related details of the rider are sent to the emergency contacts by utilizing a cloud-based service. A Wi-Fi enabled controller is used to connecting to a data network for accessing cloud services [15].

3. PROPOSED WORK

An accident is an unpredicted and unintentional event. Considering the alarming increase in the number of motorbike riders and the number of accidents happening in our country, this system ensures to make the two-wheeler driving safer than before for the rider. The lack of treatment in proper time is the major reason for half of the deaths in road accidents. At the time of the accident, the process of intimate and locating the place of the victim is a bit difficult task that is to be discovered. The credentials of the victim are unknown which is tedious during crucial moments for the people at the accidental spot. The main motive of the project is to design the IoT detection and reporting system. The unique feature of the system is to locate the victim and report the accident with the relevant information to ambulances and the rider's concerned people to provide a quick medical aid to the victim. A raspberry pi module is used and a unique code is programmed in this module to achieve this functionality. Vibration sensors are interfaced with the raspberry pi module which senses the vibration frequency of the accident. A maximum stress limit of the vibration threshold is programmed in the module. The GPS (Global Positioning System) Module senses and provides the exact current location of the rider. The GPS module is connected to the raspberry pi and all these are embedded in the helmet. The GPS module will be helpful for the family members and friends, to track the victim's location. The mobile application is installed in the rider's mobile and it is used to display the current geographical location of the victim. Ubidots is an application that acts as a bridge between your mobile application and device and sets the standard for developer updates. This application is installed on all the mobile devices of the registered emergency contacts. Any number of contacts could be stored in the raspberry pi and sent the message. Ubidots provides the way to send notifications from raspberry pi to mobile phones with simple scripting. The access tokens of the respective Ubidots applications are programmed in the raspberry pi module.

3.1 Flow chart

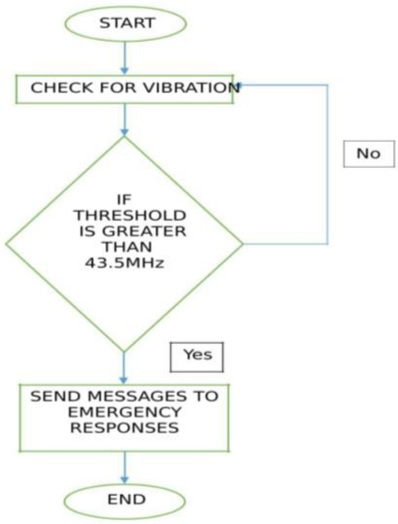

Fig. 1: Smart helmet flow diagram

3.2 Block diagram

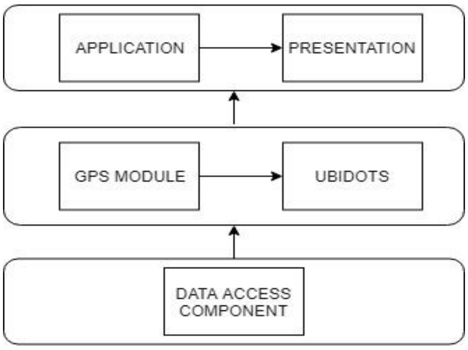

Fig. 2: Block diagram

4. RESULT

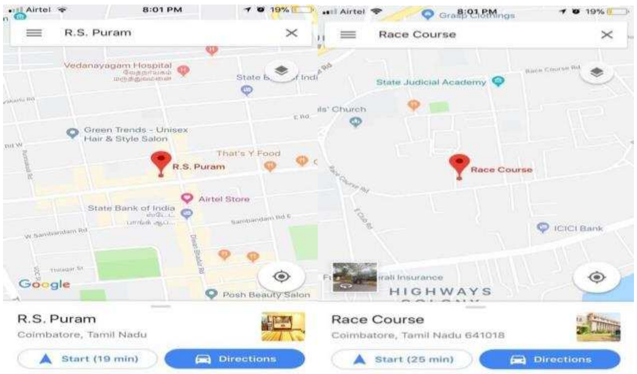

Fig. 3: Latitude and longitude

This proposed system displays the latitude and longitude with the current GPS and speed and this can be viewed in a mobile application or web application. The link for the application is provided with the message sent to the victims' family.

4.1 Mobile application

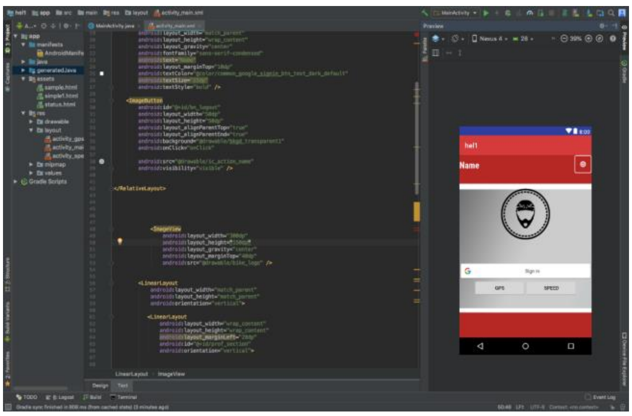

Fig. 4: A mobile application interface

4.2 Web application

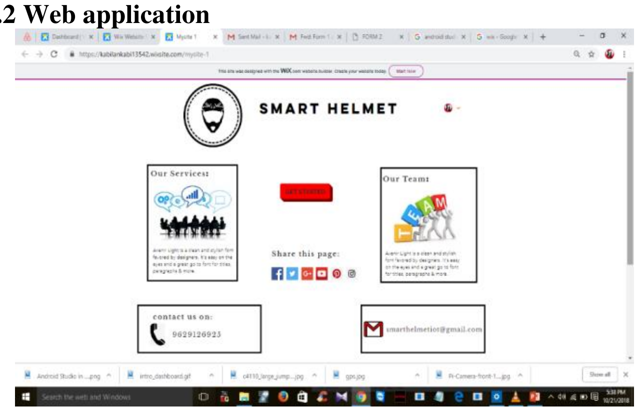

Fig. 5: Web application interface

5. CONCLUSION

In recent days, the occurrence of most of the accidents is by motorbikes. This alarming rise in motorbike accidents leads to loss of many lives. The lack of treatment in the proper time is the major reason for many deaths. The major causes may be the late arrival of the ambulance or no person at the place of accident to give information to the ambulance or family members. The system offers a solution to this problem by introducing accident detection and reporting system aiming to save at least half the lives that are lost due to bike accidents. In future, this system could be implemented for lock protection and for other safety purposes. It could also be implemented to control the speed of the vehicle and to prevent the rider from over speeding by passing the information to the rider's family. The early detection and reporting will account for the responsibility of saving many lives. The development of accident detection and reporting system with required specifications has resulted successfully. The test cases give expected output, without any dispute. The minor defects occurred during the tests are detected and rectified. The developed system works efficiently by providing quick and immediate responses.

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IRJET- SMART HELMET AN INTELLIGENT BIKE SYSTEM

IRJET Journal

SMART HELMET AN INTELLIGENT BIKE SYSTEM

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ABSTRACT--An accident is a specific, unexpected, unusual and unintended external action which occurs in a particular time and place, with no apparent and deliberate cause but with marked effects. Carelessness of the driver is the major factor of such accidents. In order to overcome this we introduces an intelligent system, Smart Helmet, which automatically checks whether the person is wearing the helmet and has non- alcoholic breath while driving. Here we have a transmitter at the helmet and the receiver at the bike. There is a switch used to sure the wearing of helmet on the head. The on condition of the switch ensures the placing of the helmet in proper manner. An alcohol sensor is placed near to the mouth of the driver in the helmet to detect the presence of alcohol. The data to be transferred is coded with RF encoder and transmitted through radio frequency transmitter. The receiver at the bike receives the data and decodes it through RF decoder. The engine should not on if any of the two conditions is violated. MCU controls the function of relay and thus the ignition, it control the engine through a relay and a relay interfacing circuit. A RF Module as wireless link which able to communicate between transmitter and receiver. If rider getting drunk it gets automatically ignition switch is locked, and send message automatically to their register number with their current location. So when accident occurs, it will send message by GSM to register numbers with their current location by GPS module. It can use to receive call while driving. The distinctive utility of project is fall detection, if the bike rider fall from bike it will send message automatically.

Keywords :- RF module, GSM-GPS module, MQ-3 alcohol sensor, Microcontroller,Ulterasonic Sensor, Accelerometer.

1.INTRODUCTION

In recent times helmets have been made compulsory in Maharashtra State. Traffic accidents in India have increased year by year. As per Section129 of Motor Vehicles Act, 1988 makes it required for every single riding a two-wheeler to wear protective headgear following to standards of the BIS (Bureau of Indian Standards).In India drunken drive case is a criminal offence of The Motor Vehicle act 1939. Which states that the bike rider will get punish. In existence bike rider easily get escaped from law. These are the three main issues which motivates us for developing this project. The first step is to identify the helmet is wear or not. If helmet is wear then ignition will start otherwise it will remains off till helmet is not wear. For these we use FSR sensor. The second step is alcohol detection. Alcohol sensor is use as breath analyzer which detect the presence of alcohol in rider breathe if it is exceeds permissible range ignition cannot start. It will send the message to register number. MQ-3 sensor is used for these. When these two conditions are satisfied then ignition will start. The third main issue is accident and late medical help. If the rider met accident with him he cannot receive medical help instantly, its big reason for deaths. Around every second people die due to late medical help or the accident place is unmanned. In fall detection, we place accelerometer at the bike unit. Due to these mechanism we detect the accident occurs or not. The aim of this project is to make a protection system in a helmet for a good safety of bike rider. The smart helmet that we made is fixed with sensors which act as to detect wear helmet or not. There are two different microcontroller is used in this project. Each unit has used a separate microcontroller, for bike unit we use for helmet unit and bike unit same microcontroller belongs to the avr family . Signal transmission between the helmet unit and bike unit is using a RF concept.

The Benefits of this System are :-

- Need to prevent false positives from being triggered.
- Detection of the accident forces accurately.
- Delay in notification reaching the emergency contacts.
- Detection of accident in remote area can be easily detected and medical services provided in short time.
- Simply avoiding drunken drive by using alcohol detector. it will reduces the probability of accident.

- Operates on solar as well as battery supply. If helmet was stolen then we can start the bike by the password.
- Less power consuming safety system.
- It can be used in real time safety system.
- We can implement the whole circuit into small module later.
- This safety system technology can further used in car and also by replacing the helmet with seat belt.

2. BLOCK DIAGRAM OVERVIEW

TRANSMITTER SECTION

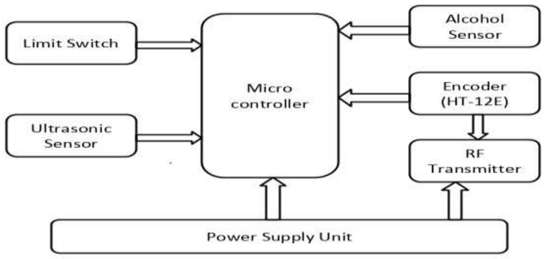

Figure 1 :- Helmet Unit

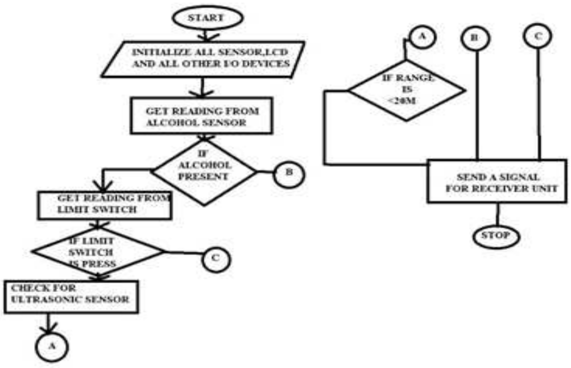

Figure 2 :- Flow Chart Of Helmet Unit

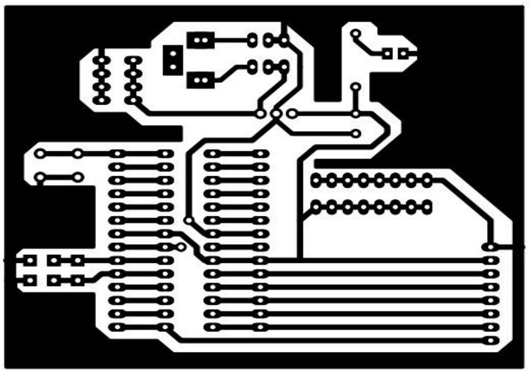

Figure 3 :- Layout of Helmet Unit

This project describes the planning of an efficient security system for a motorbike, so as to avoid accidents and different malpractices. Vehicle accidents because of the utilization of alcohol ar increased today and also the sporting of the helmet reduces the severity of the accidents. In our project we tend to mix these 2 aims in a very single embedded system. This section consists of associate alcohol sensing element, helmet sensing switch, MCU, encoder and an RF transmitter. Both the switch and also the alcohol sensing element are fitted within the helmet. MCU reads information from the sensors, finds if the driver has non-alcoholic breath and helmet sensor switch is in closed position and gives corresponding digital output to an encoder only if the two conditions are satisfied. It encodes one amongst the active inputs to a coded binary output. The coded binary output is transmitted by the rf transmitter from the encoder. Here we use the popular ASK modulation technique. In this RF system, the digital knowledge is delineating as variations within the amplitude of radio radiation. This kind of modulation is understood as Amplitude Shift Keying (ASK).

RECEIVER SECTION

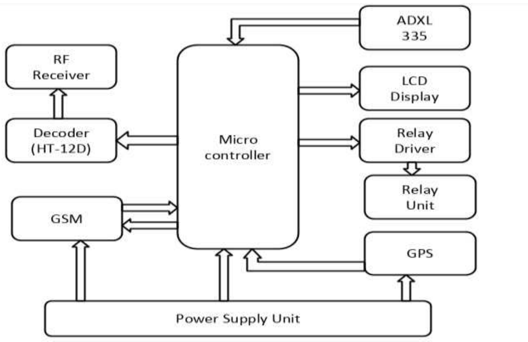

Figure 4 :- Vehicle Unit

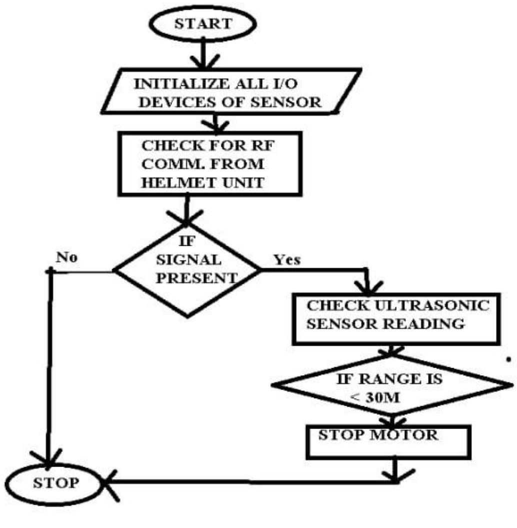

Figure 5 :- Flow Chart of Vehicle Unit

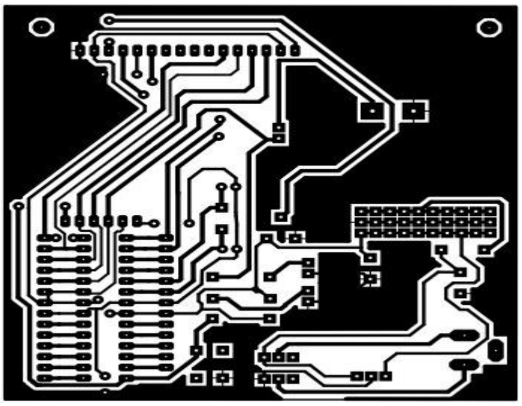

Figure 6 :- Layout of Vehicle Unit

The receiver section is placed on the bike; it consists of Associate in Nursing RF receiver, RF decoder,MCU, audio and visual indications. RF receiver receives the coded binary data transmitted by the RF transmitter and given to the RF decoder. RF decoder decodes the input and provides four bit digital information to the MCU given that the address little bit of encoder and decoder matches. MCU operate the engine of the vehicle once it receives digital knowledge from the transmitter section, it operates the engine through a relay circuit however it cannot operate the relay directly, and therefore a relay interface is additionally used here. The system is provided by the motorized vehicle department to avoid abnormal circumstances. The following are the transient explanations of the working rule of the assorted major blocks or sections employed in the system.

The following are the transient explanations of the working rule of the assorted major blocks or sections employed in the system :-

A. MICROCONTROLLER

The AT mega AVR is a low-power, high-performance 8-bit microcontroller with 8Kilo bytes of In System Programmable Flash memory. The device is factory-made exploitation Atmel's high-density non-volatile memory technology and is compatible with the industry-commonplace AVR instruction set and pin out. Microcontroller is the brain of the complete system. It is truly chargeable for all the method being dead. It will monitor all the peripheral devices or parts connected within the system. In short we will say that the whole intelligence of the project resides within the package code embedded within the Microcontroller. The controller here user will be of AVR family. This unit requires +5VDC for it proper operation. Microcontroller is the CPU of our project.

B. GSM SIM300/900

- High Quality Product (Not hobby grade)
- Quad-Band GSM/GPRS
- Built in RS232 Level Converter (MAX3232)
- Configurable baud rate
- SMA Connector with GSM L Type Antenna.
- Built in SIM Card holder.
- Built in Network Status LED
- Audio interface Connector

C. GPS

- Fast TTFF at low single level
- Support 32-channel GPS
- Up to 5HZ update rate
- Automotive navigation
- Marine navigation
- Build in micro battery to reserve system data for rapid satellite acquisition
- LED indicator for GPS fix or not fix

D. RELAY

Relays are used throughout the automobile. Relays which comes in assorted sizes, ratings, and applications are used as a remote control device.

E. RF MODULE

An RF module is a device which is used to transmit and receive radio frequency signal. In embedded system it's usually fascinating to speak with another device wirelessly. This wireless communication is also accomplished through optical communication or through frequency (RF) communication. For many applications the medium of selection is RF since it doesn't need line of sight. RF communications incorporate a transmitter and receiver. They are of various types and ranges. Some can transmit up to 500 feet. RF modules square measure wide utilized in electronic style because of the problem of planning radio electronic equipment. Good electronic radio style is notoriously complicated thanks to the sensitivity of radio circuits and also the accuracy of parts and layouts needed to realize operation on a particular frequency.

F.ULTRASONIC SENSOR

Ultrasonic sensing is one amongst the most effective ways that to sense proximity and discover levels with high responsibility. An unbearable sensing element is AN instrument that measures the space to object victimisation unbearable sound waves. An ultrasonic sensor uses a transducer to send and receive ultrasonic pulses that relay back info regarding AN object's proximity. High-frequency sound waves mirror from boundaries to supply distinct echo patterns.

F. MQ-3 ALCOHOL SENSOR

MQ-3 gas sensing element is correct for distinguishing the alcohol content from breath. It can be positioned just front of the face. The sensor is responds to various gases. The driver is drunk or not is detected by helmet unit.MQ-3 sensor has potentiometer to adjusting different concentration of gasses. We calibrate the detector for zero.4mg/L of Alcohol concentration in air and use value of resistance is 200 KΩ. MQ-3 has supports for both analogy and digital. MQ-3 has a 4 pin namely GND, VCC, About, Doubt. Here we tend to use digital output of this sensing element that is provides output in terms of high or low. It decided by our helmet unit weather rider is drunk.

G. ACCELEROMETER

ADLX345 The ADXL345 is tinny, tri axial measuring device with resolution of thirteen bit. The output of measuring instrument is digital and use sixteen bit 2's complement knowledge. It is access to connect via Serial Peripheral Interface (SPI 3-4 wire) or 12C interface. ADLX 345 is used for both measurement of static and dynamic acceleration. In this project we have a tendency to use measuring instrument measures the static acceleration of gravity. Free-fall sensing notices if the bike is falling. And Bike unit take call that accident is happens or not. In this project we tend to interfaced ADXL345 by victimisation 12C digital interface technique. The CS connected to high to VDD I/O, the ADXL345 is requiring 2- wire connection. The tokenish operational voltage of this device cannot bigger than VDD I/O that's zero.3 V. For the proper working condition, we use two external pull up resister. The value of pull up resister is 3.3 kilo ohm.

3. CONCLUSION

The outcomes of the project have showed that the bike ignition can begin if the helmet is worn. So,it'll mechanically decrease the impact from accident and it canavoid bike from being taken. AVR microcontroller isgood in controlling all the system and the sensors. Executing the wireless system that frequency Module to send signal from helmet unit to the bike unit. Due to this wireless affiliation is healthier than wired link.

In future We can implement various bioelectric sensors on the helmet to measure various activity. We can use tiny camera for the recording the drivers activity. It will be used for passing message from the one vehicle to a different vehicle by exploitation wireless transmitter. We have used solar battery for helmet power offer by victimization same power offer we are able to charge our mobile.

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IRJET- Bikers Protection through Smart Helmet and Stunt Detection

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Bikers Protection through Smart Helmet and Stunt Detection

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ABSTRACT- *Brain injuries from bike accidents are the leading causes of permanent disability and sometimes even sudden deaths. Despite existing rules making use of safety helmets mandatory at the time of bike riding, most riders do not use them. Also, the delay in shifting an injured person to the hospital after an accident increases the chances of adverse outcome. Deaths due to stunt biking have also increased drastically. This motivates us to create a system which can enhance the safety of bikers, by ensuring the use of helmet. We intend putting together a safety system that when installed on a motorcycle makes certain that the engine ignition occurs only after the rider is wearing a helmet. And also in case the rider crashes, a message with the location of the rider is sent to a nearby hospital and also the family members of the rider. We also intend to detect various stunts performed by the biker and notify the nearby police station using a tilt sensor, GPS and GSM.*

Key Words: Arduino, NRF, GSM, GPS

1. INTRODUCTION

According to WHO report, by the year 2020, the major killer in India will be road accidents; in fact, the accident rate in India (35 per 1000 vehicles) is one of the highest in the world. Motorbike accidents constitute significant proportion of vehicular accidents. Injuries from bike accidents are the leading causes of permanent disability and sometimes even sudden deaths. The majority of these accidents occur due to over speeding and stunts. The inability of bikers in wearing helmets increases the damage. Use of helmets bring down the severity of brain injury, skull fractures and neurological disabilities after an accident. Despite existing rules making use of safety helmets mandatory at the time of bike riding, most riders violate these rules. Also, the delay in shifting an injured person to the hospital after an accident increases the chances of adverse outcome. We propose to develop a system that makes it necessary for the biker to wear the helmet and in case of accidents notify nearby hospital and relatives as soon as possible. We also propose to detect various stunts performed by the biker and notify a nearby police station

2. METHODOLGY

Our system can be divided into two modules; the helmet side and the bike side. In the helmet side we design a sensor which will detect human head presence. The sensor detects the presence of human head and communicates it to the microcontroller. The microcontroller (Arduino) sends this information to the engine using NRF (NORDIC RADIO FREQUENCY). The NRF on the transmitter side receives this message and transfers it to microcontroller which further controls the ignition. We also place an accelerometer in the helmet which detects the degree of tilt so that if the rider crashes, the sensors perceive it and the Arduino extracts GPS data using the GPS module that is interfaced with Arduino. When the tilt exceeds maximum tilt limit, the GSM module automatically sends message to ambulance/hospital, police and family members. In addition to above we also detect the stunts performed by the biker for that we equip the motorbike with tilt sensors. These tilt sensors have a threshold for inclination whenever the biker exceeds that threshold the stunt has been performed, the Arduino processes that input and sends the location and the registration number of the bike to the nearby police station. Figure 1 shows the Block Diagram Helmet side and Figure 2 shows Block Diagram Bike Side.

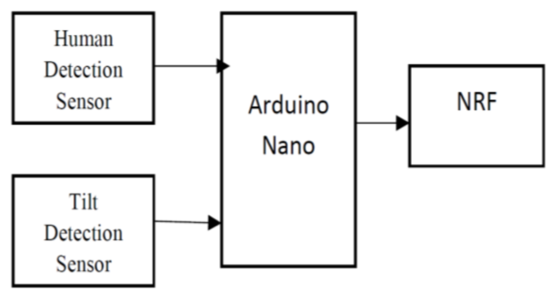

Figure 1. Block Diagram Helmet side

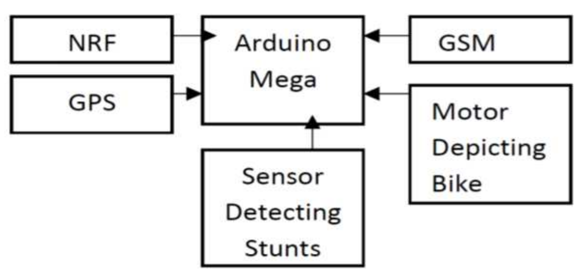

Figure 2. Block Diagram Bike Side

3. HARDWARE REQUIREMENTS

Proposed project consists of following parts:

- Helmet side
- Bike side

3.1. Helmet Side

- Arduino Nano
- NRF
- Skin detection sensor
- Accelerometer

3.2. Bike Side

- Arduino Mega
- NRF
- GPS
- GSM
- Accelerometer
- L293D

C1. ARDUINO

Arduino refers to an open source electronic Platform or board which is designed to make electronics more easily accessible. It can be purchased, preassembled or because the hardware design is open source, built by hand. An Arduino board generally consists of an Atmel 8,16or32bit AVR microcontroller (although since 2015 other makers' microcontrollers have been used) with complementary components that facilitate programming and incorporation in to other circuits. Two microcontroller boards were taken as per requirement for the project:

C1.1 Arduino Mega:

It consists At-mega AVR 2560 R3 microcontroller. It has 54 digital Output /Input pins (of which 15 pins can be used as PWM signals), 16 analog input s, 4 UART (hardware serial port), a 16MHz oscillator. Opening voltage of the microcontroller is 5V.

C1.2 Arduino Nano:

The Arduino Nano is a small, complete, and Bread board friendly boar d based on the ATmega328 (Arduino Nano 3. x) or ATmega168 (ArduinoNano2. x). It has more or less the same functionality of the Arduino Mega, but in a different package. It Lacks only a DC power jack, and works with a Mini B USB cable instead of a standard one. It has14digital Output / Input pins (of which 6pins can be used a PWM signals), 8 analog Inputs.

C2. GLOBAL POSITIONING SYSTEM

The Global Positioning System (GPS) is a space-based navigations system that provides location and time information in all weather conditions, anywhere on or near the earth where there is an unobstructed line of sight to four or more GPS satellites. What is a GPS? The Global Positioning System (GPS) tells you where you are on Earth. The GPS system provides critical capabilities to military, civil and commercial users around the world. The GPS technology has tremendous amount of applications in GIS & Remote Sensing data collection, surveying and mapping. The technology seems to be beneficiary to the GPS user community in terms of obtaining accurate data up to about 100 m for navigation, meter-level for mapping and down to millimeter level for geodetic positing. In simple words it can be said that if one has a small GPS receiver, he can get his position anywhere in the land, sea, air, desert or forest in terms of any co-ordinate system. Development of GPS.

GPS project was developed in 1973, to overcome the limitations of previous navigation systems, integrating ideas from several predecessors, including a number of classified engineering design studies from the 1960s. The current system became operational on June 26, 1993 when the 24th satellite was launched. Bradford Parkinson, Roger L. Easton, and Ivan A. Getting are credited for inventing the GPS.

C3. GLOBAL SYSYTEM FOR MOBILE COMMUNICATION

GSM (Global System for Mobile Communications) is a second-generation digital mobile telephone standard using a variation of Time Division Multiple Access (TDMA). It is the most widely used of the three digital wireless telephone technologies - CDMA (Code Division Multiple Access), GSM and TDMA. GSM digitizes and compresses voice data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900, 1800 or 1,900MHz frequency bands.

GSM was initially developed as a pan-European collaboration, intended to enable mobile roaming between member countries. As at March 2003, GSM digital wireless services were offered in some form in over 193 countries. In June 2002, about 69% of all digital mobile subscriptions in the world used GSM phones on GSM networks.

The GSM network can be divided into three broad parts the subscriber, carrier and the mobile station

The base station subsystem controls the radio link with the mobile station

The network subsystem performs the switching of calls between the mobile users and other mobile and fixed network users

C3.1 Mobile Station

The mobile station consists of the mobile equipment, i.e. the handset, and a smart card called the Subscriber Identity Module (SIM). The SIM provides personal mobility, so that the user can have access to subscribed services irrespective of a specific terminal. By inserting the SIM card into another GSM terminal, the user is able to receive and make calls from that terminal, and receive other subscribed services.

The mobile equipment is uniquely identified by the International Mobile Equipment Identity (IMEI). The SIM card contains the International Mobile Subscriber Identity (IMSI) used to identify the subscriber to the system, a secret key for authentication and other information. The IMEI and the IMSI are independent, thereby allowing personal mobility. The SIM card may be protected against unauthorized use by a password or personal identity number.

C3.2 Base Station Subsystem

The base station subsystem is composed of two parts, the base transceiver station and the base station controller. These communicate across a standardized "Abis" interface, allowing operation between components made by different suppliers.

The base transceiver station houses the radio transceivers that define a cell and handles the radio-link protocols with the mobile station. In a large urban area, there will potentially be a large number of base transceiver stations deployed, thus the requirements for a base transceiver station are ruggedness, reliability, portability and minimum cost. The base station controller manages the radio resources for one or more base transceiver stations. It is the connection between the mobile station and the mobile services switching center.

C3.3 Network Substation

The central component of the network subsystem is the mobile services switching center. This acts like a normal switching node of the PSTN (Public Switched Telephone Network) or ISDN (Integrated Services Digital Network) and connects the mobile signal to these fixed networks. It additionally provides all the functionality needed to handle a mobile subscriber, such as registration, authentication, location updating, and handovers and call routing to a roaming subscriber.

C3.4 Radio Spectrum

Since radio spectrum is a limited resource shared by all users, a method must be devised to divide up the bandwidth among as many users as possible. The method chosen by GSM is a combination of Time and Frequency Division Multiple Access (TDMA/FDMA). The FDMA part involves the division by frequency of the (maximum) 25MHz bandwidth into 124 carrier frequencies spaced 200 kHz apart. One or more carrier frequencies are assigned to each base station.

Each of these carrier frequencies is then divided in time, using a TDMA scheme. The fundamental unit of time in this TDMA scheme is called a burst period and it lasts 15/26 milliseconds (ms) (or approximately 0.577ms). Eight burst periods are grouped into a TDMA frame (120/26ms, or approximately 4.615ms), which forms the basic unit for the definition of logical channels. One physical channel is one burst period per TDMA frame.

Channels are defined by the number and position of their corresponding burst periods. All these definitions are cyclical, and the entire pattern repeats approximately every three hours. Channels can be divided into dedicated channels, which are allocated to a mobile station, and common channels, which are used by mobile stations in idle mode.

C3.5 Speech Coding

GSM is a digital system, so speech, which is inherently analog, has to be digitized. The GSM group studied several speech coding algorithms on the basis of subjective speech quality and complexity (which is related to cost, processing delay and power consumption once implemented) before arriving at the choice of a Regular Pulse Excited - Linear Predictive Coder (RPE-LPC) with a long term predictor loop. Basically, information from previous samples, which does not change very quickly, is used to predict the current sample. The coefficients of the linear combination of the previous samples, plus an encoded form of the residual, the difference between the predicted and actual sample, represent the signal. Speech is divided into 20 (ms) samples, each of which is encoded as 260 bits, giving a total bit rate of 13kbps (kilobits per second). This is the so-called full-rate speech coding. Recently, an enhanced full-rate (EFR) speech coding algorithm has been implemented by some North American GSM1900 operators. This is said to provide improved speech quality using the existing 13kbps bit rate.

C4. ACCELEROMETER

An **accelerometer** is a device that measures the vibration, or acceleration of motion of a structure. The force caused by vibration or a change in motion (acceleration) causes the mass to "squeeze" the piezoelectric material which produces an electrical charge that is proportional to the force exerted upon it. Since the charge is proportional to the force, and the mass is a constant, then the charge is also proportional to the acceleration.

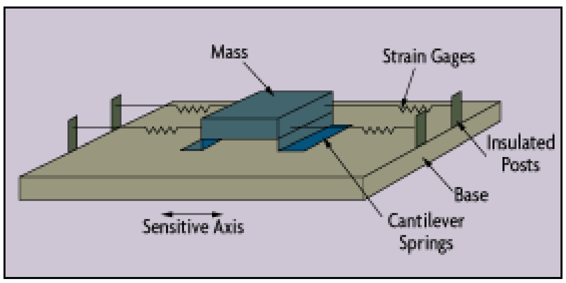

Figure 3. PIEZOELECTRIC FORCE SENSOR

C4.1 Accelerometers Types

There are two types of piezoelectric accelerometers (vibration sensors). The first type is a "high impedance" charge output accelerometer. In this type of accelerometer the piezoelectric crystal produces an electrical charge which is connected directly to the measurement instruments. The charge output requires special accommodations and instrumentation most commonly found in research facilities. This type of accelerometer is also used in high temperature applications (>120C) where low impedance models cannot be used.

The second type of accelerometer is a low impedance output accelerometer. A low impedance accelerometer has a charge accelerometer as its front end but has a tiny built-in micro-circuit and FET transistor that converts that charge into a low impedance voltage that can easily interface with standard instrumentation. This type of accelerometer is commonly used in industry. An accelerometer power supply like the ACC- PS1, provides the proper power to the microcircuit 18 to 24 V @ 2 mA constant current and removes the DC bias level, they typically produces a zero based output signal up to +/- 5V depending upon the mV/g rating of the accelerometer. All OMEGA(R) accelerometers are this low impedance type.

4. SOFTWARE REQUIREMENT

Arduino programs may be written in any programming language with a compiler that produces binary machine code. Atmel provides a development environment for their microcontrollers, AVR Studio and the newer Atmel Studio. The Arduino project provides the Arduino integrated development environment (IDE), which is a cross-platform application written in Java. It originated from the IDE for the Processing programming language project and the Wiring project. It is designed to introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as syntax highlighting, brace matching, and automatic indentation, and provides simple one-click mechanism for compiling and loading programs to an Arduino board. A program written with the IDE for Arduino is called a "sketch".

The Arduino IDE supports the C and C++ programming languages using special rules of code organization. The Arduino IDE supplies a software library called "Wiring" from the Wiring project, which provides many common input and output procedures. A typical Arduino C/C++ sketch consists of two functions that are compiled and linked with a program stub main () into an executable cyclic program:

- setup (): a function that runs once at the start of a program and that can initialize settings.
- loop (): a function called repeatedly until the board powers off.

After compilation and linking with the GNU tool chain, also included with the IDE distribution, the Arduino IDE employs the program avrdude to convert the executable code into a text file in hexadecimal coding that is loaded into the Arduino board by a loader program in the board's firmware.

5. CONCLUSION

The results of this project have proved that the motorcycle's engine will only start when the helmet is worn. It makes one's bike secure at crucial times especially when one is away from bike and someone is trying to steal it.

6. FUTURE WORK

Apart from RF. Module another type of wireless communication can be achieved. Besides, we can add a buzzer in the helmet and when the speed exceeds some limit the buzzer starts ringing and hence the motorcyclist will be more alert and will slow down the motorcycle once they receive the signal.

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