IIOT FOR ACCIDENT PREVENTION AND CONTROL FOR HYBRID INDUSTRIES

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ABSTRACT

The recent advancements in the Internet of Things (IoT) are giving rise to the proliferation of interconnected devices, enabling various smart applications. These enormous number of IoT devices generates a large capacity of data that further require intelligent data analysis and processing methods, such as Deep Learning (DL). Notably, the DL algorithms, when applied in the Industrial Internet of Things (IIoT), can enable various applications such as smart assembling, smart manufacturing, efficient networking, and accident detection-and prevention. In this study, a method for quantitatively evaluating the effectiveness of IoT technologies for accident prevention is presented. Taking the domino theory of accident causation into account, this method has three aspects: the degree of the causes of accidents that an IoT technology prevents, association between accident types and their causes, and frequency of each accident type. To quantify these, two different types of survey were conducted, and statistical records about construction accidents by type were used. To test the applicability of this method, the effectiveness of two IoT technologies was calculated. The method successfully quantified how much each technology contributes to preventing certain types of accident as well as the overall accident-prevention effect.

***Keywords**: Industrial Internet of Things, deep Learning, smart industries, Accident-prevention.*

INTRODUCTION

Due to rapid growth of world population, the demand for vehicles has increased tremendously, resultantly problems of traffic congestion and a road accident has also increased. The general population's life is under high risk, if any accident occurs there's a long reaction time which increments the number of deaths, therefore an automatic accident detection system must exist to overcome this situation. Statistics show that leading cause of death by injury is road accidents. There can be multiple causes of road accidents, some of them are, driver negligence due to drowsiness, driving while intoxicated, over speeding etc. Some studies show that weather conditions can also contribute towards the severity of an accident such as fog, rain, high winds. High winds can directly influence the vehicle which may deviate the vehicle from road, or indirectly due to obstruction dangers present on the roads such as trees, walls etc.,. Road crashes can be seen as a collision between any on road vehicles, obstacles or pedestrians. The survival rate of victim is highly reliant on how long an ambulance takes to reach the site of the accident and then carry the patient to the hospital. In most cases of road accidents, the injuries are not severe and the life of the victim can be rescued, however due to late arrival of the rescue teams, the injuries turn deadly.

The industrial internet of things (IIoT) is the use of smart sensors and actuators to enhance manufacturing and industrial processes. Also known as the industrial internet or Industry 4.0, IIoT uses the power of smart machines and real-time

analytics to take advantage of the data that "dumb machines" have produced in industrial settings for years. The driving philosophy behind IIoT is that smart machines are not only better than humans at capturing and analyzing data in real time, but they're also better at communicating important information that can be used to drive business decisions faster and more accurately. Connected sensors and actuators enable companies to pick up on inefficiencies and problems sooner and save time and money, while supporting business intelligence efforts. In manufacturing, specifically, IIoT holds great potential for quality control, sustainable and green practices, supply chain traceability, and overall supply chain efficiency. In an industrial setting, IIoT is key to processes such as predictive maintenance (PdM), enhanced field service, energy management and asset tracking.

LITERATURE REVIEW

Unaiza Alvi et al (2020) With population growth, the demand for vehicles has increased tremendously, which has created an alarming situation in terms of traffic hazards and road accidents. The road accidents percentage is growing exponentially and so are the fatalities caused due to accidents. However, the primary cause of the increased rate of fatalities is due to the delay in emergency services. Many lives could be saved with efficient rescue services. The delay happens due to traffic congestion or unstable communication to the medical units. The implementation of automatic road accident detection systems to provide timely aid is crucial. Many solutions have been proposed in the literature for automatic accident detection. The techniques include crash prediction using smartphones, vehicular ad-hoc networks, GPS/GSM based systems, and various machine learning techniques.

Mohammad Sanaullah Chowdhury (2019) Internet of Things (IoT) together with Machine Learning has a great impact on the new era of technology. Technological advancement and invention of smarter devices are going neck and neck in today's world. A common incident such as car accidents hampers the advancement of human life. Most common reasons for the accidents are - driver's unawareness and uncontrolled speed of vehicle. We have developed an IoT based solution to detect and prevent such incidents. This paper focuses on a smart system that alerts and controls the speed of the vehicle. It measures real-time distance between vehicles and/or obstacles in front of the vehicle using Ultrasonic sensor. It controls speed of the vehicle and alerts respective individuals if an accident occurs.

Difference between IoT and IIoT

Although IoT and IIoT have many technologies in common, including cloud platforms, sensors, connectivity, machine-to-machine communications and data analytics, they are used for different purposes. IoT applications connect devices across multiple verticals, including agriculture, healthcare, enterprise, consumer and utilities, as well as government and cities. IoT devices include smart appliances, fitness bands and other applications that generally don't create emergency situations if something goes amiss. IIoT applications, on the other hand, connect machines and devices in such industries as oil and gas, utilities and manufacturing. System failures and downtime in IIoT deployments can result in high-risk situations, or even life-

threatening ones. IIoT applications are also more concerned with improving efficiency and improving health or safety, versus the user-centric nature of IoT applications.

IIoT applications and examples

In a real-world IIoT deployment of smart robotics, ABB, a power and robotics firm, uses connected sensors to monitor the maintenance needs of its robots to prompt repairs before parts break. Likewise, commercial jetliner maker Airbus has launched what it calls the factory of the future, a digital manufacturing initiative to streamline operations and boost production. Airbus has integrated sensors into machines and tools on the shop floor and outfitted employees with wearable tech -- e.g., industrial smart glasses -- aimed at cutting down on errors and enhancing workplace safety

Figure 1: IIoT Applications

Benefits of IIoT

One of the top touted benefits of IIoT devices used in the manufacturing industry is that they enable predictive maintenance. Organizations can use real-time data generated from IIoT systems to predict when a machine will need to be serviced. That way, the necessary maintenance can be performed before a failure occurs. This can be especially beneficial on a production line, where the failure of a machine might result in a work stoppage and huge costs. By proactively addressing maintenance issues, an organization can achieve better operational efficiency. Another benefit is more efficient field service. IIoT technologies help field service technicians identify potential issues in customer equipment before they become major issues, enabling techs to fix the problems before they inconvenience customers. These technologies might also provide field service technicians with information about which parts they need to make a repair. That way, the technician has the necessary parts with them when making a service call.

INTERNET OF THINGS

IoT (Internet of Things) is an advanced automation and analytics system which exploits networking, sensing, big data, and artificial intelligence technology to deliver complete systems for a product or service. These systems allow greater transparency, control, and performance when applied to any industry or system. IoT systems have applications across industries through their unique flexibility and ability to be suitable in any environment. They enhance data collection, automation, operations, and much more through smart devices and powerful enabling technology.

METHODOLOGY

This section describes the methodology of our proposed system in detail. In this paper, a smart system is proposed which helps to prevent accidents, alerts the driver from time to time to control the speed of that vehicle, and controls the speed of the

car by the system when necessary, based on real-time captured data from the environment. It also alerts responsible persons when an accident has occurred for any uncertain situation. This smart system is easily applicable for both existing and new vehicles.

ACCIDENT DETECTION TECHNIQUES

Millions of people die in road accidents every year, most of the time accidents are not serious, but there is still a huge loss of life due to delay of emergency services. So a system capable of analyzing a situation and able to detect it as an accident would be very helpful in providing timely assistance. Various strategies used to detect accidents are discussed in this section.

CONVENTIONAL ACCIDENT DETECTION TECHNIQUES

The problems of traffic congestion arise due to vehicle failure or due to accidents in no network area. They proposed a system to solve this problem based on VANET. In this system every moving vehicle is considered as a node. The alert messages are transmitted using RF module, and alert messages are received by the moving vehicles that are in the range of RF module. Finally, the vehicle in the network area receives the message, then the received message is transmitted to the base station. The alert message contains four types of messages. These are detected by piezo electric sensor, MEMS (Micro-electro-mechanical systems) sensor, flame sensor, and temperature sensor.

A VANET is a type of MANET (Mobile ad hoc network) which considers vehicles as mobile nodes. VANETs can be used in ITS to ensure convenience and road safety. A typical scenario for reporting emergency situations in a VANET environment is demonstrated in Figure 2. The main issue in VANETs is, it's highly dynamic topology due, to which different problems like network congestion, frequent disconnections etc.

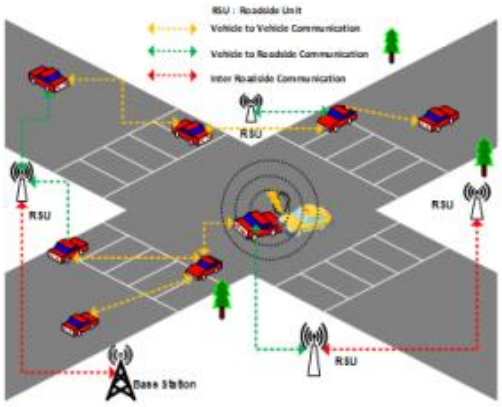

Figure 3: Accident reporting scenario in VANET

ACCIDENT PREVENTION TECHNIQUES

Accident prevention can be defined as the strategy or an approach, or actions taken to avoid or stop an accident before it occurs. Majority of the accidents occur due to human negligence. These factors are over speeding, traffic law violations, drunk driving etc. So controlling these factors can help to avoid accidents and save the precious lives. Different approaches used to prevent accidents are discussed in this section.

USING GPS, GSM

The system is proposed, that considers the speed as one of the major cause of accident. It uses a GPS receiver to monitor the speed and detects an accident based on monitored speed. The GPS module continuously monitors the speed and compares with the previously monitored speed every second using a micro-controller unit. Whenever the system identifies that the speed is less than the pre-fetched threshold limit it will detect the situation as an accident. The location is

detected by using a GPS module. An alert message is sent to the emergency services using a GSM module. Figure 4 illustrates a GPS/GSM based accident detection system.

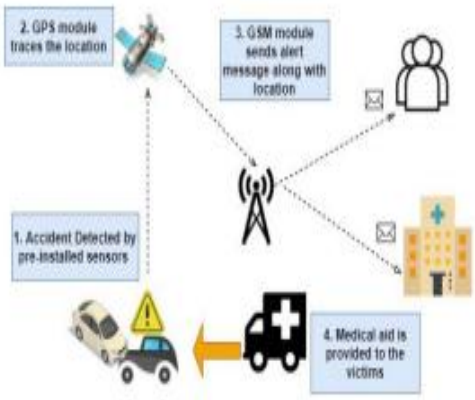

Figure 4: An accident detection system using GPS and GSM

USING ALCOHOL SENSORS, GPS, GSM

The system to prevent accidents using alcohol sensors to prevent drunken driving, since 70% of the cases of accidents are due to ''drunk and drive''. An alcohol sensor placed in the system, is used to monitor the contents of alcohol in blood. A workflow of such a system is illustrated in Figure 7. Sensor is placed above the steering so that, as the driver breathes the sensor could determine the alcohol level. A threshold is set and if the contents are more than the pre fetched limit, the car doesn't move. GPS detects the location of the vehicle. Messages are sent by means of GSM to the pre-fetched mobile numbers and inform them that the person is highly intoxicated and can't drive. The system focuses on the preventive measures to avoid any hazardous situation. The system would be helpful to public in general as well, since it won't allow drunk person to drive.

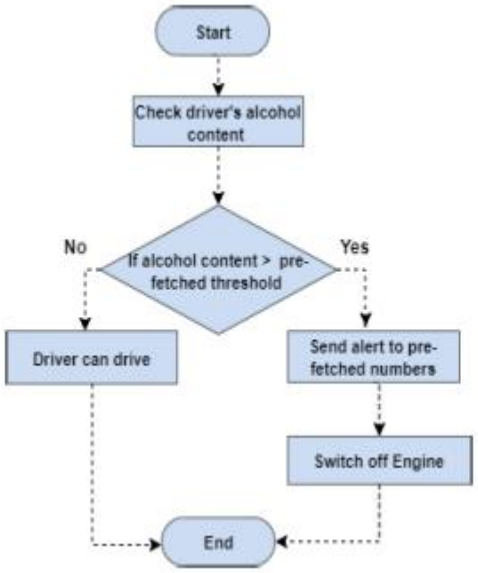

Figure 5: Workflow of alcohol sensor based systems to prevent drunk driving.

HYBRID TECHNIQUES

Road collisions are one of the leading cause of fatalities. In most cases, injuries are not serious and if victims are rescued in time, lives may be saved. Many factors contribute to accidents, including driver negligence, drowsy and drunk driving etc. Thus a system that can detect as well as controls the factors contributing to accidents will be helpful in preventing accidents and saving lives. Hybrid techniques are techniques which use both accident detection and prevention mechanisms, as shown in Figure 6. Some of the systems based on hybrid techniques are discussed below.

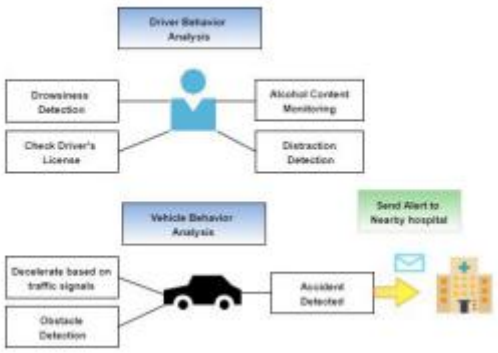

Figure 6: An accident detection and prevention system

In this section, various systems discussed in the survey are compared according to the parameters defined. The systems are compared in terms of accuracy, their implementation cost to incorporate them in existing vehicles, what's their communication mechanism to send alert messages to the rescue and emergency teams, are the messages sent automatically on detection of an accident or they have to be sent manually by the user etc. Since no system is perfectly accurate, there's always a chance of error in any system, so the systems are also compared against their chance of generating a false positive, i.e. triggering of alarm in non-accident circumstances.

Moreover, in some cases, the accident severity may not be serious and the driver may not need immediate medical aid, so in those cases a mechanism should be there to stop the sending of an alert message, to save the time of rescue teams. So the presented systems are also compared if they've the mechanism to stop sending of an alert message or not. Most of the systems presented in the literature survey, relied on some sort of hardware based technologies like sensors for implementing accident detection and prevention mechanisms. A summary of different type of sensors such as alcohol, seat belt, vibration, pressure etc.

Conclusion

The number of casualties associated with road collisions is growing rapidly. If victims are rescued in due time, several lives may be saved. We discussed various strategies which focused not only on accident detection but also on its prevention. These strategies utilized various sensors such as accelerometer sensors, shock sensors, pressure sensors etc. and various machine learning techniques such as neural networks, support vector machines, representation learning etc. for accident detection. Various strategies for accident prevention were also addressed, which include detection of drunk and drowsy driver, regulating vehicle speed, maintaining safe distance from obstacles etc.

Recommendations

Various methods for accident detection and prevention were discussed in this paper. The methods included warning the driver for over-speeding, maintaining safe distance from other vehicles, avoiding intoxicated and distracted driving etc. Integration of these systems with the vehicles would be very beneficial to the society. These systems would be effective in minimizing the casualties associated with road accidents. Additionally, patient history such as blood group, age, allergies etc. can also be included in these systems to provide medical aid accordingly. Moreover, data obtained from sensors after an accident has occurred, can be used in data mining to deduce important results. Performing analysis on the data can give us valuable insights on how most of the road accidents occur, which factors contribute the most in event of mishaps, which roads are dangerous and the time stamp in which most of the accidents occur.

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