INERTIAL MEASUREMENT SENSOR FOR ACCURATE DETECTION AND NOTIFICATION USING INTERNET OF THINGS

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Abstract

If vehicle accident information could be intimated to an emergency service or a rescue center automatically by tracking the accurate location valuable human lives could have been saved. This paper focuses on determining the exact location of the targeted accident vehicle. The accident is detected by the data fusion of drift, deceleration, vibration, speed strength of a vehicle with the Timing Inertial Measurement Unit device which senses all the possible ways for an accident to occur and gives input to arduino for intimating the nearest emergency center.

Keyword -TIMU, deceleration, GPS, Arduino, Satellite,

I. INTRODUCTION

The Internet of Things is the network of physical objects and other things that are embedded with sensors, electricity, software and network connectivity which makes these objects to collect and exchange data.[3] The Internet of Things allows objects to be controlled and sensed remotely across network infrastructure, creating opportunities for increased direct integration between the physical world and computer-based systems which results in improved efficiency, accuracy and economic benefit.

The term ‘Things’ refers to, devices and everyday objects, from small objects like wrist watches and medical sensors to really big objects like robots, cars and buildings. Every object contain devices that interact with users by generating and retrieving information about and from the environment. They also contain hardware that allows them to control. The core concept behind all IoT technology and implementation is the same: devices are integrated with the virtual world of the Internet and interact with it by sensing, monitoring, tracking objects and their environment.[5] Users and developers of IoT based software or hardware add components for sensing and networking capabilities and are programmed to perform the assigned tasks and build Web applications that interact with the devices. This paper which proposes a mechanism for sensing the accident and intimating it automatically uses hardware which is embedded with sensors for predicting the vehicle accident and uses arduino for intimating the targeted system (i.e. emergency service) thereby forming an internet for objects which interacts by itself.

II. ARCHITECTURE OF IoT

The following are the examples which elaborately explains about the architecture and working of IoT based systems.

A) Collecting and transmitting data

The device can sense the environment like ones home, human body and collect information related to it like temperature of a place and light intensities and transmit it to a different device like mobile phones or laptop which is located in a different place or to the Internet.

B) Activate devices based on triggering

It can be programmed to activate other devices like turning on the street lights when it becomes dark by sensing which reduces the labor work. and turning off the heat when the temperature reaches a certain level which if not turned off may lead to danger.

![Fig. 2.1 Interaction using IoT technology](image)

C) Receive information

Unique characteristic for IoT devices is that they are designed in a way to receive information from other devices in the same network or through the Internet for instance, information from targeted source, new triggers, status of an operation and addition of new functionality).[2]

Having all these functionalities an IoT based system interacts efficiently with the targeted devices and thereby receives and shares information with those devices. Sends information when at the appropriate time for instance when the sensors predict a change in temperature it will intimate automatically.

Many accidents are not being detected and it is no intimation is given to the emergency service even though it is detected. The existing accident detection and location system is done by determining the deceleration and data fusion from accelerometers, IMU and GPS. The bias, drift and noise errors of accelerometers and GPS outage limitation are overcome by integrating with Kalman filter. The test result shows the correct deceleration for accident
detection and location but the integration of all devices is a tedious process.

In the last few decades, the total number of vehicles around the world has experienced a remarkable growth. The effect of this situation is the increase of traffic accidents on the road, representing a serious problem in most countries. When a traffic accident takes place, assisting injured passengers as soon as possible is most important to minimize the negative effects on their health. Hence the following section describes a working model which when implemented helps in saving many lives.

III SYSTEM ARCHITECTURE

The proposed system consists of TIMU (Timing Inertial Measurement Unit) to sense accident and GPS technology to find the exact location of the accident, if the GPS fails then TIMU supports to track the location. An intimation message which is stored in the microprocessor in the car is sent automatically to the emergency service when the accident is confirmed by the sensor by taking various parameters like drifting, toppling, sudden deceleration with respect to time, opening of air bags, vibration etc.

The accident intimation message can also be sent to family members, relatives and friends to let them know about the accident. This message can either be a text message or a voice message. Along with this message the driver's medical details can also be sent.[4] A vehicle may not have a specific driver so the driver's medical details is identified and sent choosing the name in the list that is stored already, before the driver starts to drive. The next step is to locate the place of accident this is done using GPS. In a case where the accident is confirmed by the sensor but everyone in the car are safe then the person who is driving must send a voice message or a text message to the emergency services and family that accident did not cause any injury and damage.

A) Sensing the accident

The accident is first detected with various parameters such as car drifting, vibration, sudden deceleration, toppling of the car, triggering of the air bags. Having all these parameters the car sensing system will give an alert message that the car is in risk. This is done by the TIMU sensor which is present inside the car, which detects the accident parameters accurately the next step is to intimation with is automatically done after sensing.

B) Intimating the emergency service

The next step after detection of the accident is to intimate the emergency service in order to let them know about the accident. This is done with the help of a communicating device named Arduino which will be present along with the sensing system, this gets triggered once the accident is detected by taking the input from the TIMU [3]. This message is basically stored in a storage device made of microprocessor gets activated after the detection of the accident.

The following is the flow diagram which shows the actions that are being done by the system one after the other automatically. After sensing, arduino gets triggered and if the person is injured the rescue is done by the emergency system else a safe notification is being sent.

Fig. 3.1 Flow of the system

C) Tracking the absolute location of the accident

Once the accident is detected the emergency service must be able to view the accurate location where the accident has taken place. [1]This is done with the help of GPS which shows the place of accident. When the vehicle accident takes place in the outer areas of the town, satellites may not respond to the GPS device fails to locate so it is supported by a TIMU device which does the tracking job as well.

D) Reporting the individual details

Medical details of the owner or the driver of the car must be stored in a microprocessor chip along with the sensing device so if accident takes place these details must be sent to the emergency service along with the intimation sent by the Arduino. When a person decides to drive a car one's details must be entered and stored in the chip. This will send the medical reports of the driver correctly. So that the prerequisite for the patients can be arranged even before the injured person is diagnosed.

The following are the components of the system. TIMU senses with various parameters and Arduino gets triggered and sends the notification automatically along with the drivers medical details which is already stored in the microprocessor. This happens one after the other with a minimum time delay and intimation is sent at a very faster rate compared to other methods. If the person is not injured then a safe message is send in the same way.

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E) Rescuing and safe informing

The one who is injured is rescued by the emergency service by getting to the location where the accident has happened. After rescuing, an intimation is being sent to the family members and friends of the person who had met with an accident. So they will be knowing that the person is safe and the location details where the injured person is admitted is also sent. So, along with the accident message that is sent to the emergency service mobile or phone numbers of family and friends are also sent.

IV EXPERIMENTAL RESULTS

The system is designed with TIMU which supports the system when the GPS is not able to track the location. TIMU thus predicts the vehicle movements and also senses the car acceleration which confirms that it is an accident by taking various parameters into account. Processing time for GPS and TIMU may take a few seconds and the processing time for TIMU and arduino will take around 14 seconds and provides an accuracy of 75% and 90% respectively.

The previous way that was followed to measure and confirm an accident took long time compared to the existing one and may not assure maximum accuracy. TIMU and Arduino are components of the system which guarantees maximum accuracy and efficiency, making the system performance good among all.

Table 4.1 Performance of the components of the system

<table>
<thead>
<tr>
<th>Performance and Devices used</th>
<th>GPS with TIMU</th>
<th>TIMU and Arduino</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processing time (maximum)</td>
<td>9 seconds</td>
<td>14 seconds</td>
</tr>
<tr>
<td>Accuracy</td>
<td>75%</td>
<td>90%</td>
</tr>
<tr>
<td>Connectivity in semi urban areas</td>
<td>85%</td>
<td>90%</td>
</tr>
<tr>
<td>Connectivity in urban areas</td>
<td>93%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Connectivity in semi urban places may fail at times in a GPS system so it is integrated with TIMU which predicts the movement of a vehicle with the measured acceleration. But this may not produce accurate results in the long run, so this is supported by a satellite device which is the last option when GPS is not working for a long time. Hence a such a system provides the necessary input for the Arduino and the system can sense, track and intimate. Finally the system assures 90% connectivity and tracking of a vehicle in semi-urban areas and assures 100% connectivity in the urban area.

![Fig. 3.1 Working of the system](image)

**Fig. 3.1 Working of the system**

**Fig. 4.2 Comparison of time delay for receiving packets**

The graph shows the time difference of receiving and transmitting the packets of data between the TIMU and the normal device which manipulates data. Which clearly shows TIMU manipulates data at a faster rate and with higher accuracy compared to other methods which was followed earlier. Hence, if results are to be produced at a faster rate TIMU must be used which must function when the GPS is not available. Satellite will be the last chance for tracking the location when the GPs fails for a long time. Here Arduino becomes the integral part which intimates when the sensors confirms the car movement is an accident.

V. CONCLUSION

A GPS and TIMU based acceleration detection system is developed to determine the deceleration for accident detection and intimated using Arduino. The higher rate of TIMU’s accelerometer data can detect any instantaneous deceleration and also can fill the gap during GPS outage. All these steps are taken after the accident has taken place. In future, an accident can be detected even before it happens. This is done by instructed the driver whenever there is an unusual movements in and around the vehicle. Instructions for a vehicle are like to watch the speed and to know other vehicles on the road this can be done by communicating with the vehicles on the road within a certain range.

The communication between two vehicles can be achieved by having a ad-hoc network (V2V- Vehicle to Vehicle communication) so that accidents alerted even before it happens. This works by giving an alert message when a vehicle within the specified range is about to cross another vehicle. Hence valuable lives can be saved without causing any harm.
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V. REFERENCES