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SCHOOL OF ELECTRICAL AND ELECTRIONICS

REPORT

TECHNICAL WRITING AND PRESENTATION

Topic:

ENHANCE THE SAFETY DRIVING BY USING VEHICLE TRACKING AND MONITORING IOT SYSTEM

Student : ĐOÀN QUANG LƯU

Student code : 20203884

Class : ET-E9 02 - K65

Lecturer : AP.DR. NGUYỄN TIẾN HÒA

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ABSTRACT

Traffic accident is a collision that causes injury or danger that occurs when a vehicle collides with another vehicle, pedestrian, pothole,etc. Traffic accidents often lead to injury, property damage, even death. Currently, traffic accidents are the leading cause of death and disability among adolescents. Therefore, modern research on accident detection systems focuses on reducing reporting time or improving the accuracy of accident detection. Internet of Things (IoT) platforms have been used significantly in recent times to reduce the time required for post-accident rescue. In this paper, a system improves driving safety using an IoT tracking and monitoring system. This work presents an IoT-based automobile accident classification and detection (ADC) system that uses a combination of connected and integrated sensors in smartphones to detect and report accident. This technique can improve the rescue efficiency of various emergency services such as EMS (Emergency Medical Services), fire stations, etc., as understanding the type of accident is extremely valuable in helping planning and executing rescue and rescue operations. Analysts can analyze data from location, type of accident, etc., and based on that data can recommend solutions to improve traffic safety. This work defined five physical parameters related to vehicle motion, i.e. speed, absolute linear acceleration (ALA), altitude change, pitch, and rolling, were used for training and testing. each candidate ADC model to determine the right type of accident between collision, rollover, fall-off, and no accident.

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LIST OF SYMBOLS AND ABBREVIATIONS

IoT	Internet of Things
ADC	Block Difference of Inverse Probabilities
EMS	Emergency Medical Services
NB	Naıve Baye
ALA	absolute linear acceleratio
NMEA	Nation Marine Electronics Association
RC	Radio Controlled

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1 INTRODUCTION

A traffic accident is a collision that causes injury or danger that occurs when one vehicle collides with another vehicle, pedestrian, pothole, etc. Traffic accidents often lead to injury, property damage, and even death. Currently, traffic accidents are the leading cause of injury and death. With the development of means of transport, traffic accidents are more and more frequent, as a result, the number of deaths and disabilities caused by traffic accidents tends to increase each year.

According to the World Health Organization (WHO), the percentage of road accident fatalities to the total number of deaths worldwide has increased by 2.2% . Approximately 1.35 million people diedue to road accidents every year[1].

According to the Golden Hour Principle , the period immediately after an injury in which prompt medical and surgical treatment is most likely to prevent death. Therefore, reducing the response time of urgent medical care can reduce the probability of death by a small percentage.

In recent times, information and communication technologies such as Internet of Things (IoT) have been used to reduce incident response times. IoT is the interconnection of countless embedded and smart devices such as computers, smartphones, smart sensors and actuators, embedded processors, and more. with modern internet. IoT is a potential vehicle for intelligent automotive monitoring and control that can link any connected physical unit to a control server rescue time after an accident. [2]

However, accident detection systems are usually only found in expensive vehicles, and current systems are not yet capable of identifying the type of accident as a collision, rollover or fall. Merely reporting an accident event can affect rescue priorities, which will severely limit the ability of emergency responders to provide victims appropriate form of rescue assistance and medical assistance. In addition, the lack of accident information may also significantly affect the analysis and improvement of traffic safety at that route.

Therefore, in this study, a smartphone-based end-to-end IoT system architecture for auto accident detection and notification, has been proposed. Work also focused on determining the best machine learning ADC model based on one of three different classifiers, namely GMM, DT, and NB.

This classification can become quite useful in planning and executing rescue operations. The proposed solution contributes to reducing costs and improving efficiency. As a result, IoT-based vehicle accident classification and detection systems using Fusion sensors can be easily retrofitted to both expensive and low-priced vehicles, and different vehicle types.

2 ARCHITECTURE OF THE SYSTEM

2.1 Proposed IoT architecture

An IoT architecture is proposed in Figure 2.1 to be able to classify vehicle accidents. In this paper a modern smartphone and a prefabricated sensor platform named Sensordrone [3]are used to obtain values of various physical parameters related to vehicle motion. convenient.

Android smartphones contain a number of built-in sensors, like accelerometer, gyroscope, etc., those sensors can be used to determine speed, direction, rotation and g-force etc. of the vehicle. Sensordrone is attached to a smartphone via a Bluetooth connection to send data to the smartphone. Most of the processing is handled by the smartphone. The processing in smartphones greatly reduces the usage of internet resources by transmitting only relevant details like location, name, nature of the accident, etc. to the IoT server. The IoT server provides emergency alerts to various emergency services like EMS, local police station and fire service as well as other recipients like relatives, insurance companies, towing services , etc., after assessing the situation.

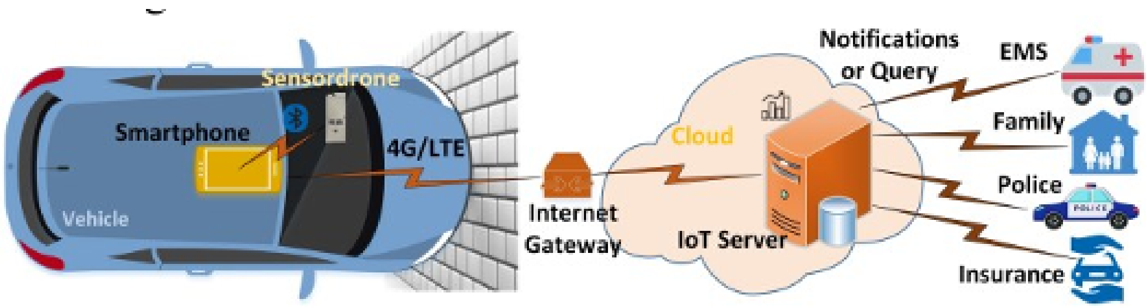

Fig 2.1 Architecture of proposed IoT system.

[3]

2.2 Workflow Diagram

The operational flow chart of the proposed ADC system is shown in Figure 2.2. The general operating procedure of the classification model includes five parameters, namely speed, ALA, pitch change, pitch and roll, to detect and classify a vehicular crash. Initially, the sensors measure the corresponding value of each sensor, then through a few data processing transformations, we obtain the corresponding parameters: The manometer corresponds to the altitude; gyroscope, magnetometer and accelerometer for pitch, roll and ALA respectively; finally, the GPS corresponds to the speed of the fingerprint.

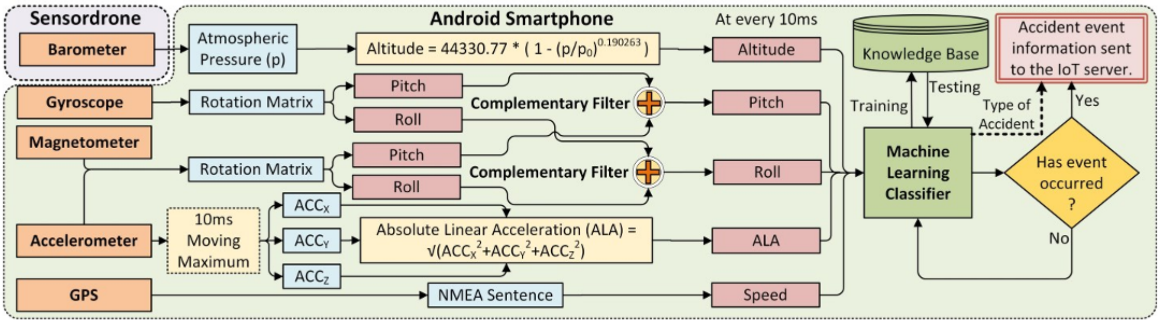

Fig 2.2 Workflow diagram of accident classification system

[3]

2.3 Model Variables

2.3.1 Speed

The smartphone's GPS was used to measure the vehicle's speed. Each GPS device receives an NMEA (National Marine Electronics Association) sentence from a satellite containing information regarding the device's position, velocity, and time [27]. For this paper, speed is meaningful, because after an accident, the speed of the vehicles is all zero, so when using GPS with NMEA, it is possible to both show the location and judge. predict the accident. Each type of GPS device has its own NMEA sentence. The most common NMEA sentence used by most Android devices is *GPRMC*.

2.3.2 Absolute Linear Acceleration(ALA)

ALA exhibits an acceleration characteristic parallel to the direction of impact. This absolute quantity is a resulting vector of the deceleration components X, Y and Z.

Whenever a moving vehicle falls from above, the vehicle's direction will not be the same as it was on the road before the fall. In such a case, the vehicle cannot remain parallel to the gravitational axes (X, Y and Z) and deceleration due to impact may be distributed along multiple axes. Therefore, it is difficult to judge the exact value of the deceleration. To solve this problem, ALA (or Signal Strength Vector [4]) is calculated with the help of deceleration components X, Y and Z. ALA is defined as:

$$\text{ALA}=\sqrt{(DEC_x)+(DEC_y)+(DEC_z)} \quad (2.1)$$

where DEC_x, DEC_y and DEC_z, respectively is the deceleration in the X, Y and Z axis.

2.3.3 Change in Altitudein One Second

Usually when a vehicle is moving normally, if there is a change in altitude, the collapse of the vehicle can be predicted. During the fall, the height of the vehicle is the most characteristic feature that represents the fall of the object, the height of the vehicle changes significantly.

Although, in theory, GPS can also be used to determine altitude, but GPS cannot determine altitude if the position of the object remains constant while the altitude changes. Therefore, the quantity ALA is proposed to calculate the height of the object

For this work, altitude was determined using a Sensordrone barometer to measure pressure P. In this paper, considering P0 as the reference pressure recorded at sea level, then the final altitude calculation formula will be provided by Haibo Ye [5]

Altitude=4430.77* $\left(1-(\frac{P}{P_0})^{0.190263}\right)$ (2.2)

2.3.4 Roll, Pitch

[3] With the analysis of the rotational motion of the object, there are quantities of rolling and pitch, showing the level of balance of the vehicle. The rotations of an object around the X and Y axes are called roll and pitch, respectively. Roll and pitch are determined by combining rotation information provided by the gyroscope, accelerometer, and magnetometer using an additional filter. The rotation matrix rotates Euclidean space counterclockwise around the center of the Cartesian coordinate system by an angle θ. We've noticed that if the roll or slope is greater than 90^o, rollover occurs. The vertical axis is always treated as the X axis and the lateral axis is always considered the Y axis (Figure 2.3(left))

By incorporating the sensor using an additional filter, the vehicle's direction can be determined by pitch, roll and azimuth (deviation). The longitudinal, transverse and longitudinal axes of the vehicle body are indicated by X, Y and Z respectively. Roll, pitch and azimuth (yaw) are rotation angles around the X-, Y- and Z-axis, respectively (Figure 2.3 (left)). Three inertial sensors, viz., gyroscope, accelerometer, magnetometer were used to determine the vehicle's orientation. At high frequencies, short-term estimates of the accelerometer and magnetometer combination are imprecise due to a number of minor external factors, with the exception of the g-force. A low-pass filter (which generates only a low frequency signal from 0 Hz up to its threshold level- f_c) is required for correction because the combination of both these inertial sensors works well at low frequencies. Another sensor that can calculate angular momentum in terms of X -, Y and Z Axes is the gyroscope, but it also has a strong drift. The gyroscope works well at high speeds, so high-pass filtering is required (allowing only high-frequency signals from its threshold frequency) to correct the results because the measurements start to drift in long time. In this study, additional filters [32] are used, including both a low-pass filter and a high-pass filter (Figure 2.3 (right)). If Agyro, Pgyro, and Rgyro are the azimuth, pitch, and roll provided by the high-pass filter, respectively, and $Aacc_m ag$, $Pacc_m ag$ and $Racc_m agare$ are the azimuth, pitch, and roll provided by the low-pass filter, respectively, then resulting azimuth, pitch and roll are determined by the additional filter as follows:

Azimuth=$\alpha * A_{gyro} + (1-\alpha) * A_{acc_m ag}$ (2.3)

Pitch=$\alpha * P_{gyro} + (1-\alpha) * P_{acc_m ag}$ (2.4)

Roll=$\alpha * R_{gyro} + (1-\alpha) * R_{acc_m ag}$ (2.5)

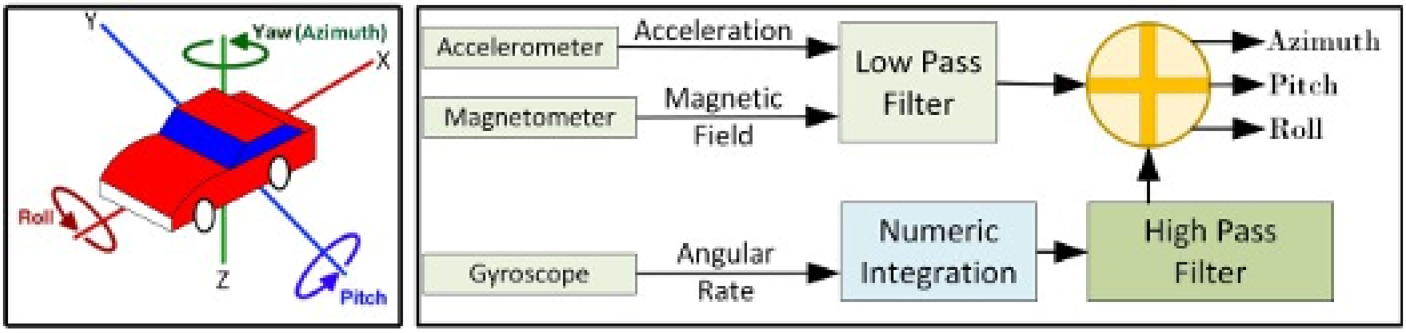

Fig 2.3 (left) yaw, pitch and roll; (right) complementary filter.

3 HARDWARE AND SOFTWARE SETUP OF THE SYSTEMHARDWARE AND SOFTWARE SETUP OF THE SYSTEM

3.1 Hardware Setup

3.1.1 SAMSUNGGalaxy S8 AndroidSmartphone

In this, a complete hardware setup includes a SAMSUNG Galaxy S8 Android smartphone, a Sensor Drone, and a 1:12 scale RC car. In this study, besides external sensors, SAMSUNGGalaxy S8Android smartphone with inertial sensor and GPS sensor was used. The inertial sensor, with measuring ranges of ± 179 and $\pm 16g$, is used to measure pitch, roll and deceleration, and the GPS sensor is used to determine the vehicle's speed and position. The Exynos 8895 processor's 1.9GHz clock speed and 4GB of RAM make it a decent computing device for tests.

3.1.2 Sensordrone

The sensor drone is a small sensor hub consisting of seven separate internal sensors that evaluate twelve different environmental variables, such as temperature, humidity, CO, barometric pressure , light, proximity, etc. In this study, only Sensordrone's barometric altimeter (measuring range: 26kPa to 126kPa) was used to determine vehicle altitude.

3.2 Software Setup

Two Android applications, SNUSense and SNUAlertApp have been developed to send and receive emergency notifications. The phone needs to have SNUSense installed in order to collect and process the data sent from the sensor. All processing methods such as ALA calculation, additional filter (sensor combination) are programmed in the SNUSense app. As for SNUAAlertApp, for the purpose of receiving emergency notifications, this application is required to be installed on the Android smartphone of the accident rescue force to be able to start the rescue operation in time after determining the location.

3.2.1 SNUSense Android App

SNUSense is an android application developed to collect and process various parameters such as rotation angle (roll, pitch and azimuth), vehicle speed, deceleration in different axes, pressure atmosphere, altitude, temperature, latitude, longitude etc. using Android smartphone sensors and Sensor Drones (Figure 3.4 (left)). It continuously processes transmitted data coming from the Sensordrone and smartphone sensors and makes an estimate based on five vehicle characteristics. After detecting an accident event, SNUSense sends the name victim, type, and location of the vehicle crash to the SNUSense IoT server (Google Firebase) using a 4G internet connection. We can see in the user console that in the event of a false alarm, the victim can cancel the message by pressing the STOP button (Figure 3.4 (middle)). The IoT server will send additional notifications (using the Firebase CloudMessaging service) to the intended recipients

3.2.2 SNUAlertApp Android Application

Another Android application, SNUAlertApp, was created to receive crash alerts as shown in Figure 3.4 (right). When there is an announcement, the information about the coordinates of the accident, the name of the driver, the type of accident. A simple tap on the notification launches Google Maps with a tracking icon on it so rescuers can conveniently locate the accident.

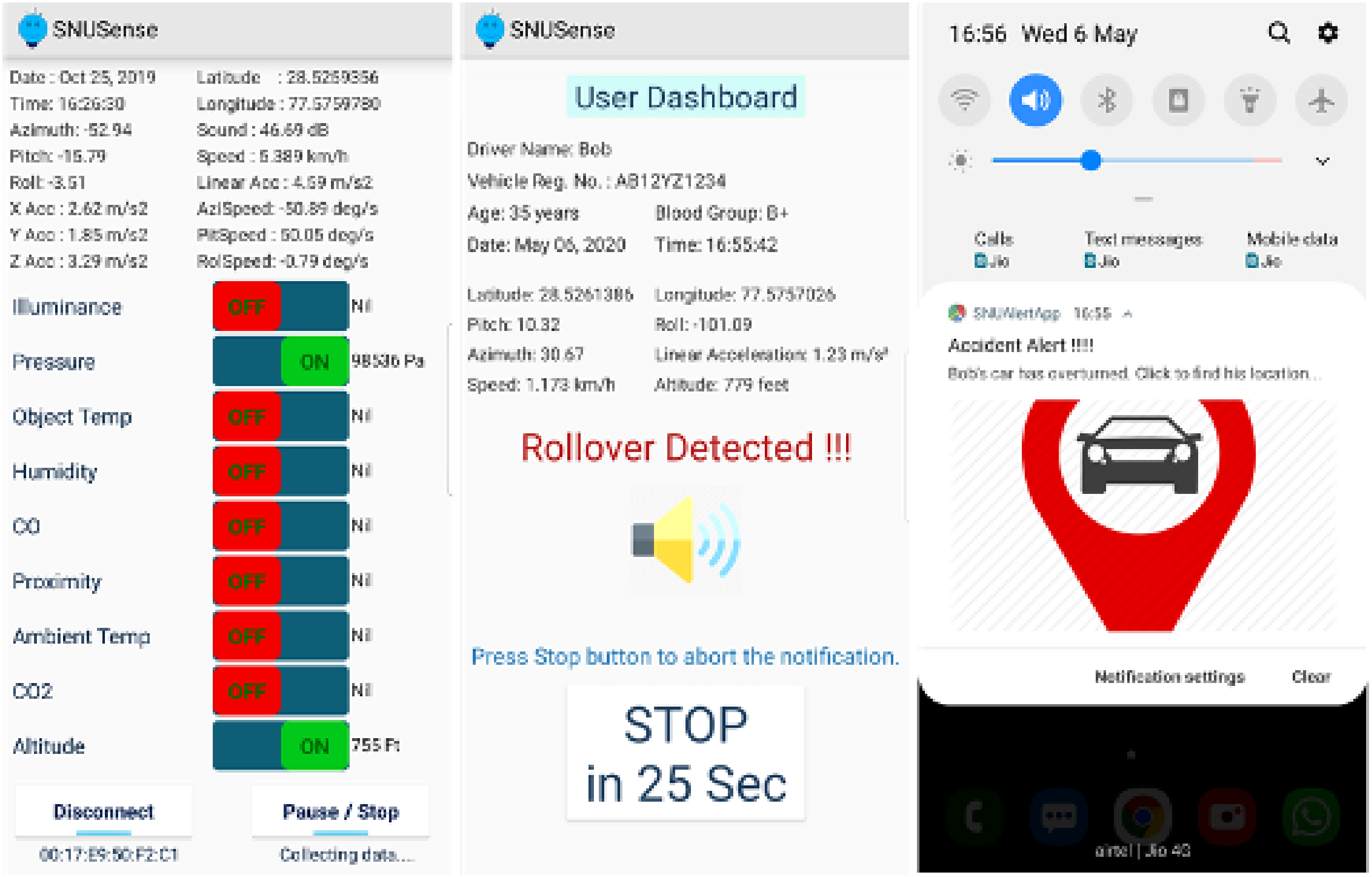

Fig 3.4 (left) Data collection; (center) user dashboard; (right) notification [3]

4 Conclusion

The recommended detection system works regularly whether there is an accident or not and reports the incident to predefined emergency services and the family in the event of an accident. The system relies on processing 5 basic quantities thereby classifying accidents into four categories i.e. collision, overturning, falling and no accident so that the best possible rescue operations can be carried out. . Five training variables namely pitch change, pitch, roll, speed and ALA were used as input variables for training and testing the system. The proposed ADC system uses smartphone sensors and sensors

Sensordrone is used to measure the value of model variables. The system can be retrofitted on any type of vehicle. According to [6], there are more than 5.22 billion smartphone users in the world in 2021. Therefore, the smartphone and its built-in sensors are suggested for use in this work. In addition to a smartphone, only a barometric altimeter and 4G internet connection are required to deploy the system. In the future, it is possible to add another type of accident, i.e. fire/explosion, to the current ADC model.

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