Internet-Of-Things Accident Detection System, Using Arduino And The Cloud

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Aims and Objectives

Aim:

To develop and evaluate an IoT device's capabilities in vehicle hazard detection, and further analyse the collected results.

Objectives:

1. Continue to conduct a systematic examination of the problem through analysis of currently published sources. The literature considers research from the comparative fields of networking, cloud, and IoT technologies.

2. Develop a suitable IoT device using microcontroller boards.

3. Develop a Cloud solution through an iterative software development process that meets the project's requirements.

4. Collect quantitative data from the IoT device through controlled environment scenarios, then test/plot the data for valuable information.

5. Evaluate the data against existing data provided by the government.

6. Analyse the results and collate key insights

Introduction

According to the Department of Transport Statistics, in 2018 there were 122,635 total reported accidents across all roads, with 1,671 of these reported accidents resulting in fatalities (Department for Transport, 2019). This project aims to understand if it is possible that networking and cloud technologies are a potential solution in reducing these statistics.

The number of connected IoT devices was predicted to reach 50 billion by 2020, although now current experts predict this value to be between 17-30 billion devices (IEEE Spectrum, 2016), this is broken down further per device in figure 1. Likewise, IoT has been recognised to have had an impact on the quality of life and businesses (Buyya and Dastjerdi, 2016, 7). This project aims to understand what similar impacts IoT can have through the addition of IoT based features in cars. Furthermore, the infrastructure would be required to make this idea feasible.

This project will simulate a small-scale car using an Arduino board as a miniature Electronic Control Unit (ECU), "a device that controls one or more electrical systems in a vehicle…The ECU provides instructions for various electrical systems, instructing them on what to do and how to operate." (Computer Hope, 2017). The Arduino board will be connected to multiple sensors that will record; the speed of the car, the distance from an object, and the GPS coordinates of the car. These features together will allow the car to be capable of detecting when it is about to crash and, with an additional Wi-Fi shield, record the data to the cloud.

Methodologies to be Used

Extreme Programming: An agile software engineering methodology that avoids the development of functions that are not currently needed and aims at creating a final product with no regard for frequent changes in requirements. This is the methodology is used for developing the Arduino artefact.

Quantitative Data Collection: Using a dataset provided by Her Majesty's Government (HMG) Department for Transport. Dataset features all recorded traffic accidents which occurred in the year 2018, these details include; location, severity, type of road, etc.

Literature Review

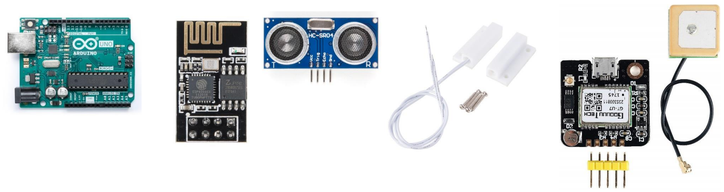
To understand the requirements and capabilities of the project, an abundant amount of research needed to be undertaken in the following fields; IoT, Cloud computing, and Networking.

Many academics have researched the concept of a connected car, a car that is able to access the internet via mobile phone networks (Kawtar and Tomader, 2019). Häberle et al describes a prototype platform for the connected car with application templates that provide the architecture for telematics application prototypes. The architecture used is a modified three-tier architecture purposed around enabling user-vehicle interaction. This journal is built from Christoph Fehling's design process that utilises patterns, "structured textual documents that describe abstract problem-solution pairs to design problems recurring in a specific context." (Fehling, 2014).

These patterns are designed to cover the problems cloud developers come across when designing, building, and managing applications that are based in the cloud. Häberle et al were able to successfully develop their platform for research and development groups. Furthermore, they found that these patterns offered reusable functionality which aided with the speed of development and also served as a guideline based on how the patterns reference each other. Häberle and his colleagues also pointed out how Fehling's design process is limited in that "the patterns cover how to use cloud offerings but not how to actually build a cloud. This is because they target application developers and not cloud providers" (Häberle et al, 2015).

To understand the technology required to make the project idea feasible, Networks Basics Companion Guide by Cisco Networking Academy provides examples of hardware, protocols, and services involved in networks. One of the important aspect of the artefact is connecting to networks and sharing data which is underpinned in this book. The information provided by this book will outline the technology that can work in co-operation with the artefact and explain the technology required to make the idea both scalable and consequently feasible.

Components

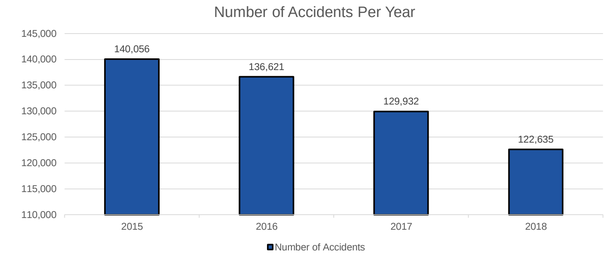


From left to right: Arduino Uno, ESP8266 WiFi Module, HC-SR04 Ultrasonic Sensor, Magnetic Door Switch, MakerHawk GPS Module 51 Microcontroller GPS.

Data / Observations

- 140,056 total reported accidents in 2015
- 136,621 total reported accidents in 2016
- 129,932 total reported accidents in 2017
- 122,635 total reported accidents in 2018
- 1,671 resulted in deaths in 2018

- Number of traffic accidents has stayed relatively high despite the amount decreasing per year.



Interim Conclusions

The project is ahead of schedule, the Arduino components and RC car were scheduled to be obtained in December. Instead, this objective has been completed within September and November. The work in progress document itself is coming along faster than anticipated, the first draft was expected to be finished by mid-November but is instead weeks ahead in schedule and should be expected to be done before the second week of November.

Through personal research, the cloud vendor has been narrowed down between Google Cloud Platform (GCP) and Microsoft's Azure.

Many methods of representing both the dataset, and test data have been identified, such as using machine learning as a tool, however, significant drawbacks have been spotted, and so further research needs to be undertaken. Fortunately, another method of representing the data has been identified using Google Maps, which allows users to plot the data based on longitude and latitude coordinate values. This method will not only act as a way to visualise the data but will also help pinpoint where accidents occur in the UK.

References

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