COMENIUS UNIVERSITY IN BRATISLAVA
FACULTY OF MATHEMATICS, PHYSICS AND
INFORMATICS

INTERNET OF THINGS IN AUTOMOTIVE INDUSTRY

Bachelor's thesis

2016 **Dávid Kőszeghy**

COMENIUS UNIVERSITY IN BRATISLAVA
FACULTY OF MATHEMATICS, PHYSICS AND INFORMATICS

INTERNET OF THINGS IN AUTOMOTIVE INDUSTRY

Bachelor's thesis

Study Programme:	Applied Computer Science
Field of Study:	9.2.9. Applied Informatics
Department:	Department of Applied Informatics
Supervisor:	RNDr. Jozef Šiška, mgr?
Advisor:	Mgr. Anton Pytel

Bratislava 2016 **Dávid Kőszeghy**

Univerzita Komenského v Bratislave
Fakulta matematiky, fyziky a informatiky

ZADANIE ZÁVEREČNEJ PRÁCE

Meno a priezvisko študenta:
Študijný program: aplikovaná informatika (Jednoodborové štúdium, magisterský II. st., denná forma)
Študijný odbor: 9.2.9. aplikovaná informatika
Typ záverečnej práce: diplomová
Jazyk záverečnej práce: slovenský

Názov:

Cieľ:

Anotácia:

Vedúci:
Katedra:
Dátum zadania:

Dátum schválenia:

.....
študent

.....
vedúci práce

Declaration of Authorship

I confirm that this Bachelor's thesis is my own work and I have documented all sources and material used.

Bratislava May 26, 2015 .....

Acknowledgements

I would like to thank my supervisor...

Abstrakt

Tu je text slovenskej verzie abstraktu

Kľúčové slová: *slovo1, slovo2, slovo3, slovo4*

Abstract

In this bachelor thesis we will show you the possibilities of connected cars, options in what advanced services a connected vehicle can provide and how you can do it in the first place. After a thoughtful study of our work anybody with computer science background will be able to build a device which will be capable of advandced services based on his/her needs.

Keywords: *Automotive industry, IoT, Big Data, Embedded device*

Obsah

Introduction

Most of us who watched Knight Rider as a kid expected that by 2015 we would be driving self-aware cars like KITT - cars that would drive us without problems from point A to point B while entertaining us. However we can resort to that this is only partially true, we have successful tries at completely autonomous cars(e.g Google's car) but for ordinary costumer they are not available. What is available is connected cars. Connected cars provide the possibility of internet-based transfer of information. This can be obtained either with embedded devices in car or smartphone. Multiple car manufacturers sell connected cars where different OEM(Original Equipment Manufacturer) devices or applications. These OEMs offer various services which are provided to you when you purchase their car, but there is a small problem. If you are not satisfied with services provided by your manafacturer, the only option you have is to buy someone else product which comes with predefined services. You can not configrue them to the extent as smartphones have apps. It is either you will get used to your OEM solution or go and buy whole solution from somebody else, nothing else. It is like we are stuck in the 90, where software offered to you had come on this particular hardware and you could not choose otherwise. It is 2015 where you can obtain music,movies,applications from various sources that does not limit you to specific hardware, so why on earth we should accept solutions offered by car manufacturers? Imagine you would buy smartphone with predifined set of applications and you could not change them or add new. Today in connected cars what is missing is operating system which would allow costumers to configure their Info-attainment system.So in my thesis I would like to solve problem where when you have car which has no connection or has connection with software you do not like, you could follow my thesis to gain insight into how to connect car and what possible services you can obtain for yourself. In first chapter I will establish some common ground on which we can build foundations of this thesis. Next we can describe the specification of problem which we need to solve and after that show implementation methods and solution to this given task.

1. Overview

1.1 Solutions available

1.1.1 Automatic

The Automatic car adapter plugs into just about any car's standard diagnostics (OBD-II) port. It unlocks the data in your car's on-board computer and connects it to your phone via Bluetooth wireless.

- The adapter's accelerometer measures your car's 3D orientation a hundred times per second and uses signal processing algorithms to detect a serious collision. That's how Automatic knows to send help in a crash.
- The adapter protects all wireless data using 128-bit AES encryption. Each adapter gets a unique key to prevent unauthorized access to your vehicle's systems.
- The adapter has unique audio capabilities. It uses special tones to confirm a connection, give you driving feedback, or let you know that help is on the way in an accident.
- We build our hardware and the software together to deliver a seamless experience. Free over-the-air firmware updates allow us to add features and improve performance, making your car as upgradable as your phone.
- Hardware Specs
  - OBD-II (conforms to J1962 standard), works with most cars since '96
  - Weight and Dimensions: 1.65 1.96 0.78in (42 50 20mm) 0.84oz (23.75g)
  - Temperature Tolerance: Operating: -40F (-40C) to 158F (70C), Resting: -40F (-40C) to 185F (85C)
  - Wireless: Bluetooth 4.0 Dual Mode (EDR and BLE), Made for iPhone (MFi) Certified
  - Accelerometer: Frequency: 100Hz, Precision: 0.012G

- Security: Wireless encryption: 128-bit AES, Signed binary enforcement: 1024-bit RSA
- Built-in GPS: GNSS engine for GPS/QZSS, Logs trip routes with no phone present
- Audio Capabilities: Volume: 80db at 10cm at 2.5kHz
- Firmware: Over-the-air updates via smartphone

1.1.2 VI Monitor

The VI Monitor installs in seconds and works by reading the data stream straight form your vehicles electronics via the On-Board Diagnostics (OBDII) port. Not only is it a multi-function engine monitoring device complete with a 3.5”touch screen display and G-sensor, the VI Monitor has an advanced diagnostics tool with the ability to view and reset engine fault codes and comes with sophisticated comparision software in the box

- Monitor parameters such as RPM, Speed, Throttle Position, Intake Manifold Pressure, Water Temperature, Air Fuel Ratios (lambda), Air Flow Rate, Ignition Advance Fuel Pressure, and many more.
- Perform braking and acceleration tests such as 0-60, 1/4 mile and 0-60-0 to measure your car’s true performance. Most tests can be G-triggered for unparrelled acuracy. Each test is recorded for future comparision.
- Avoid putting points on your license with adjustable speed warnings. Use the RPM warnings in conjunction with the adjustable Shift Light feature to get the most from your engines performance.
- Highly accurate G-Sensor with built-in damping monitors acceleration, brakiung and cornering G-Forces. Also records maximum G-readings.
- Record over 500 hours of engine and performance data on any parameters for review. Then upload the data to your computer for comparison. Ideal for measuring the effectiveness of modifications and recording drivers performance.
- Got a Engine Warning Light, but dont know why? - VI gives you the fault code number and a description of the problem, giving you more information to take to your garage or tuner.
- Simple stop/start timing feature allows you to record your times for later comparison on a computer.

- VI allows you to reset fault codes yourself, It also maintains a complete MIL stats history, including time and distance since the engine warning light was activated or rest.

- Using a Built-in Virtual Dynamomter, VI can test your vehicles true net horsepower in real world conditions.

1.2 Internet of Things

1.2.1 General Information

The Internet of Things (IoT) is a global infrastructure for further informatization of society, enabling advanced services by interconnecting things based on available technologies. Through identification, data capture, communication and processing capabilities, the IoT makes full use of things to offer services to all kinds of applications. Whilst IoT is a hot topic in the industry it is not a new concept. It was initially put forward by Mark Weiser in the early 1990s. This concept is opening up huge opportunities for both the society and individuals. However, it also involves risks and undoubtedly represents an immense technical and social challenge.[2]
“Things”, in the Interten of Things refer to a various devices. From hardware level they are all designed to do different things, collect data from various enviroments and sources. Howewer, in software aspect they behave more generally, in simplistic from its a thing which can report data and act upon them. Objectification is important, because then you can combine many things to work together and communicate between them. Current market example could be the smart thermostat systems combinating washer/dryers that use Wi-Fi for remote access.

1.2.2 Benefits

IoT is generating a lot of interest in a wide range of industries. Here are a few examples of some significant early adopters:
• In the healthcare field, medical device manufacturer Varian Medical Systems is seeing a 50 percent reduction in mean time to repair their connected devices.[5] With IoT, Varian reduced customer service costs by $2,000 for each problem resolved remotely, with 20 percent fewer technician dispatches worldwide.
• Tire maker Pirelli is using IoT to gain valuable insights about the performance of its products in nearreal time. The company is using an analytics platform to manage the huge amounts of data gathered directly from sensors embedded in the tires in its Cyber Tyre range. The system allows the pressure, temperature, and mileage of each tire to be monitored

remotely. By keeping these factors in range, fleet managers can have a significant impact on fuel economy and safety. In a trial covering nearly 10 million miles, Cyber Tyres saved the equivalent of $1,500 per truck per year.

• Ford Motor Company's Connected Car Dashboards program collects and analyzes data from vehicles in order to gain insights about driving patterns and vehicle performance. The data is analyzed and then visualized graphically using a big data platform. Among the goals are better vehicle design and improved safety for occupants.

• In the public service sector, the Boston police department operates a "real-time crime center" that receives dozens of feeds from street cameras and other sensors around the city. The resulting data gives researchers the ability to analyze and match videos from incidents to help identify suspects, mobilize resources, and even map evacuation routes during emergencies

IoT has the potential to transform the way companies make products, track goods and assets in the supply chain, monitor the performance of systems in the field, provide security for employees and facilities, and provide services to customers. Clearly, it's enabling transformation in both the private and public sectors. "I firmly believe that there is not a single industry that won't benefit from IoT," Turner said. IoT is also changing the way businesses impact society and the environment. "Overall, the world needs better and more sustainable ways to live," said Stephen Miles, research affiliate at the Center for Biomedical Innovation at the Massachusetts Institute of Technology. "To accomplish this, companies need better, more holistic models that capture a complete picture of what is happening so that they can better access and optimize these systems."

1.2.3 Why is it important?

In my thesis I will connect a thing(car) to the internet so following principles which was set by IoT field will allow me to build better and more secure solution[7].

1.3 Big Data

1.3.1 General Information

The rise of digital and mobile communication has made the world become more connected, networked, and traceable and has typically lead to the availability of such large scale data sets that the traditional data processing applications are insufficient. As the result new field trying to deal with this problem, have been created which scientists and computer engineers have coined 'Big Data'.

1.3.2 Concept

1.3.3 Benefits

1.3.4 Why is it important?

When we will have connected car, we will need to collect information, e.g. data. With Big Data approach our solution will be scaleable without need for adaptation if a very big number of devices would be connected.

1.4 Single-board computer

1.4.1 General Information

A single-board computer(SBC) is complete functional computer built on single circuit board. It has microprocessor, memory, input/output and other features depending on the model and manufacturer. Single-board computers are used for educational purposes, embedded solutions and development research/systems.

1.4.2 Why is it important?

Since we will be building embedded device which will allow us to gather data and send them to the Internet, it is necessary to choose a single-board computer which will fit fulfill our needs.

1.5 OBD-II port

1.5.1 General Information

OBD II is an acronym for On-Board Diagnostics II, the second generation of on-board self-diagnostic equipment. On-board diagnostic capabilities are incorporated into the hardware and software of a vehicle's on-board computer to monitor virtually every component in the car. Each component is checked by a diagnostic routine to verify that it is functioning properly. If a problem or malfunction is detected, the OBD II system will alert the driver that something is wrong. The system will also store important information about any detected malfunction so that a repair technician can accurately find and fix the problem.

1.5.2 Concept

The OBD-II standard specifies the type of the connector and its pinout, the messaging format and electrical signalling protocols available. OBD-II also provides a list of vehicle accessible parameters for monitoring tohether with how to encode the data for each. One of the pin in the connector provides power to the connected unit, so it could run from the vehicle battery, which simplify use of scantools, because you do not need auxiliary power. On the other hand, sometimes auxiliary power is needed, because of car malfunction which could shutdown the scan tool and lead to loss of diagnostic data. Finally, the OBD-II standard provides an extensible list of DTCs(Diagnostic trouble codes). As a result of this standardization, a single device can query the on-board computer(s) in any vehicle. OBD-II standardization was prompted by emissions requirements, and though only emission-related codes and data are required to be transmitted through it, most manufacturers have made the OBD-II Data Link Connector the only one in the vehicle through which all systems are diagnosed and programmed. OBD-II Diagnostic Trouble Codes are 4-digit, preceded by a letter: P for engine and transmission (powertrain), B for body, C for chassis, and U for network. [6]

1.5.3 Why is it important?

One of the main sources of information in my thesis will be data from OBD-II diagnostic port. This data will be accessible later in the database and we can preform logical deduction on them.

1.6 Accelerometer

1.6.1 General Information

An accelerometer measures proper acceleration which is the acceleration it experiences relative to freefall, and is the acceleration that is felt by people and objects. Put another way, at any point in spacetime the equivalence principle guarantees the existence of a local inertial frame, and an accelerometer measures the acceleration relative to that frame.[3]As a consequence an accelerometer at rest relative to the Earth's surface will indicate approximately 1 g upwards, because any point on the earth's surface is accelerating upwards relative to a local inertial frame. To obtain the acceleration due to motion with respect to the earth, this "gravity offset"should be subtracted.
The reason for the appearance of a gravitational offset is Einstein's equivalence principle[4], which states that the effects of gravity on an object are indistinguishable from acceleration of the reference frame. When held fixed in a gravitational field by, for example, applying

a ground reaction force or an equivalent upward thrust, the reference frame for an accelerometer (its own casing) accelerates upwards with respect to a free-falling reference frame. The effect of this reference frame acceleration is indistinguishable from any other acceleration experienced by the instrument. An accelerometer will read zero during free fall. This includes use in a spaceship orbiting earth, but not a (non-free) fall with air resistance where drag forces reduce the acceleration until terminal velocity is reached, at which point the device would once again indicate 1 g acceleration upwards.

1.6.2 Why is it important?

For accident detection we will use accelerometer to determine if accident occured[1]. Application will proactively monitor the occurrence of accident using accelerometer sensor. When the accelerometer sensor values exceedes the threshold value, system can act upon it.

2. Specification

2.1 Requirements

2.1.1 Hardware

Develop an embedded device which will be running operating system of your preference. Integrate this device with needed addons to operate properly such as Internet, Wi-Fi, GPS and additional sensors. Figure out how to connect your device to the vehicle's OBD-II service port. Make sure device and sensors are connected correctly so you would not get errorous data. Test your hardware for correct measurments/information, to be sure it is not defect.

2.1.2 System

Configure operating system to every sensoric input so you can communicate with them. Use any protocol for communication which will suit your solution. Develop a main application server which will be responsible for reading input information, parsing this data to objects and storing them into database. This server will have modular capabilities of connecting various sources of information. Develop a protocol which will enable to configure comunication between server and inputs. Your server should accept data in predefined format which will be provided by input functions. Create an interface where user can configure this input functions to increase adaptivity of your system. Figure out how to storage parsed data, keep in mind that this database will need to be compact as you do not have unlimited space on your device. For accessing information from the Internet and WiFi, create RESTful web application which will enable authorized user to access your web app. In web application add a configuration webpage where user can easily configure your system. Add behavior modes which will enable user to set prefered methods of communicating over the Internet. e.g. you are connected not on your home network so roaming charges apply, add setting which will enable or disable reporting of choosen data-sets based on preference of the user. Parameters which user should be able to configure are: rate of collecting information from various inputs, SMS contact numbers and text which should be send in case of accident, POST medthods to supplied url addresses of choosen data sets.

2.1.3 Application

Provide an application which will utilize information collected from connected vehilce. The application needs to preform logic deduction from accessed data and act upon it. First application will be accident detection/prevention. This application will access statistical database of accidents, look up how many of accidents happened in the location where vehicle is. Get an statistical average of accidents happening in nearby area, compare this results and if vehicle is passing trough area which has higher chance of beiing in a accident, infrom driver of hazardous conditions. Design a system which will detect if accident happend, by active monitoring accelerometer data. Figure out threshold value which needs to be triggered for correct detecting of accident. Simulate this events. After accident is detected, send an SMS/email to recepient depending on the settings in a system aplication, with contact information of the driver and car's location. Second application will create statistical map of cars running on low fuel. Devlop a way how to get/compute fuel level in fuel tank, monitor this level and after certain threshold, report GPS position of car to the statistical map.ars which has low fuel. Add to the statistical map a real-time data for reporting cars which have low fuel level in fuel tank. This real-time map will be used to monitor behaviour of drivers with low fuel, where they tend to fuel up and how long they kept fuel on low level. Log this data and analyze it.

2.1.4 Output

Output of your bachelor thesis should be application which upon correct instalation on embedded device is capable of monitoring various inputs of sensoric data, log them and make them accessible for different services through Internet, reaserch what is more suitable, store collected information on embedded device which provides user of control over what is shared and what is not or store it on cloud based service where the provider collecting this data can make better data analysis on gathered information and use it.

3. Implementation

farby a dalsie klucove slova na zvyraznenie sa daju urcit v definicii lstset ktora je v main.tex nasleduje nieco ako JQuery....

```
(new MojObj());        //vytvorenie
MojObj = function() {
  var prem1 = [];
  var bool = 0;
  var construct = function() {
    var prem1 = $('#id').find('div');
    prem1.each(function() {
      prem1.push(new obj(this));
    });
    $(document).click(nejakaFunkcia);
  }
  var funkcia = function() {
    for (var i in prem1) {
      if ( bool ) { //tak nieco sprav
      }
    }
    bool = !bool;
  }
  $(document).ready(construct);
};
```

Momentalne je lstset nastaveny na jazyk PHP, tak automaticky zvyrazni syntax aj bez pridavania klucovych slov
ukazka php kodu

```
<?php
function randomcode() {   //komentarik
  $var = "abcdefghijkmnopqrstuvwxyz0123456789";
  srand((double)microtime()*1000000);
  $i = 0;
  while ($i <= 7) {
    $num = rand() % 33;
    $tmp = substr($var, $num, 1);
    if (isset($code))  {
      $code = $code . $tmp;
    }
```

```
    $i++;
  }
  return $code;
  }
?>
```

4. Záver

Cieľom diplomovej práce bolo...

V práci som.....

Ďalší možný rozvoj....

Zdroje

[1] AMIT.V.KACHAVIMATH, Nagaraj.C, "Vehicle accident detection and reporting system using accelerometer", *JIJSRD*, vol. 3, no. 4, 2015, ISSN: 2321-0613.

[2] DR. OVIDIU VERMESAN, Dr. Peter Friess 2013. *Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems* : River Publishers, 2013. . ISBN: 9788792982964.

[3] EINSTEIN, Albert 1920. *Relativity: The Special and General Theory* : New York: Henry Holt, 1920. . ISBN: 1587340925.

[4] PENROSE, Roger 2014. *The Principle of Equivalence* : Knopf, 2014. . ISBN: 0470085789.

[5] PTC. 2015. *Reducing Mean Time to Repair by 50 Percent with SmartConnect^{TM}*. [online]. : http://www.ptc.com/, 2015. [cit. 8.4.2013]. Dostupné na internete: `http://www.ptc.com/internet-of-things/customer-success/varian-medical-systems/thank-you`.

[6] STANDARDIZATION, International Organization. 2014. *Road vehicles – Diagnostic communication over Controller Area Network*. [online]. : http://www.iso.org/, 2014. [cit. 8.4.2013]. Dostupné na internete: `http://www.iso.org/iso/home/store/catalogue_ics/catalogue_detail_ics.htm?csnumber=46045`.

[7] WOOD, Alex. 2015. *The internet of things is revolutionising our lives, but standards are a must*. [online]. : http://www.theguardian.com/, 2015. [cit. 8.4.2013]. Dostupné na internete: `http://www.theguardian.com/media-network/2015/mar/31/the-internet-of-things-is-revolutionising-our-lives-but-standards-are-a-must`.

Prílohy

CD obsahujúce:

- Elektronickú verziu
- Zdrojáky
- atď