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INTELLIGENT SYSTEM FOR THE AUTOMATIC DETECTION AND CONTROL OF ACCIDENTS ON THE ROAD IN REAL TIME

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ABSTRACT

Accidents remain a serious public health problem nationally and globally. Our contribution is part of the development of an on-board system to identify accident sites in real time and provide assistance to people who have been exposed to a vehicle accident. This work is interested in the design and realization of a management and control system of road accidents based on IOT (Internet of Things) in the form of an on-board WEB server more efficient in terms of calculation created physically by an FPGA card (Field Programmable Gate Array) and an intelligent system installed in each vehicle based on Raspberry Pi allowing the following detection of sensors and alerting the server by SMS of accidents in real time. The latter transmits a request to the nearest ambulance or service concerned at that location in order to minimize the time required for the process of moving the ambulance (or the firefighter). It automatically and intelligently controls the traffic signal to facilitate the process of moving the ambulance and getting the ambulance to its destination in a short period of time.

Keywords: *Smart Car, Raspberry Pi, FPGA, Embedded System, Internet Of Things, Connected Systems, Embedded Web Server, NIOSII, GPS*

1. INTRODUCTION:

The number of accidents in the world is increasing due to the increase in the number of cars on the road, road bends, fog or heavy rain, which contributes to serious accidents daily. So many accidents contribute to the loss of many lives. Growing countries are especially the most targeted by daily road accidents. In the event of a vehicle accident, a person should actively seek help, calling emergency services, etc. There is no automatic notification to the police, ambulance, firefighter, friends or family on anything in areas that have no residents (eg in mountains, forests ...). This article describes equipping a vehicle with technology capable of detecting an accident, the state of health of people in the car and immediately alerting the relevant authorities to save human life more quickly. Each vehicle is equipped with an integrated electronic map, sensors, GSM card and a GPS (Global Positioning System) system which allows the exact position of the vehicle exposed to the risk of accident to be determined with an accuracy of a few feet. Cellular telephony technology (GSM, UMTS, etc.) is integrated into the embedded electronic card in order to be able to send notifications on the driver's position and state of health by SMS to

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the authorities concerned and to the suggested telephone numbers (family members, friends, etc.) and initially recorded in the card by the driver who had the accident. In the envisaged system, intelligent sensors will be integrated into the vehicle and are linked directly to the embedded electronic card. An on-board processor controls and coordinates all the sensors installed in the vehicle and during an accident the sensors are triggered to take the necessary measures and provide the card with the information and measures collected.

So that the driver of the accident can obtain rapid treatment, the on-board card sends a message to the server materially created by the FPGA specifying the location of the accident and the latter sends a request to the nearest ambulance (or firefighter) to this location in order to minimize the time required for the process of moving the ambulance (or the firefighter). If the driver is not seriously injured and does not need medical treatment, he has the option of deactivating the sending of the message to the medical assistance center by pressing a switch dedicated to this operation or of canceling the message. request for help after the automatic sending of the message (sent after a given time of the accident). If the driver needs medical treatment and the deactivation of the sending of emergency message is not done, the server sends a notification to the available ambulance (or firefighter) closest to the accident location. It also controls the traffic signal in an automatic and intelligent way to facilitate the process of moving the ambulance and getting the ambulance to the destination in a short period of time. The web server also monitors the traffic signs installed in the roads in order to also avoid secondary accidents and traffic jams created by the accident. So, our subject is to solve the problem of the delay of the arrival of ambulances (or firefighters) at the places of vehicle accidents by the use of an intelligent system based on the technology of the Internet of Things (IoT). Its vision arose to reach unexpected limits in today's computing world. It is a concept that can not only have an impact on human life, but also on their functioning [1]. The IoT can be used to produce automatic notification and rapid response to the scene. Our Web server created by FPGA (Cyclone2, device EP2C70F896C6) is connected to the network by an Ethernet connector. It allows remote control of sensors and intelligent cars in real time or remote transmission of data through the Internet. it replaces traditional web servers. In this work we have presented the advantage of using this reprogrammable web server creation technology (in terms of energy consumption, speed, size, etc.).

2. WORK LITERATURE REVIEW

In this area [2], Zhao examines the potential impact of mobile phones on future intelligent transport systems, including telematics and public transport systems. It deals with the location of mobile phones which is becoming a hot topic. In the near future, if every mobile phone is able to determine its location, advancements in our current transportation systems become inevitable.

Also, Peng Chen et al. [3] discusses the communication process and data transmission between the server and the client via TCP / IP and UDP for the vehicle monitoring application.

S.P. Bhumkar et al. [4] provide a solution in which the driver should have to move his cell phone in the road. If the driver does not, ARM begins to operate. If road accidents have occurred, this project sends an emergency message to rescue teams and surrounding people to save the lives of the victims [5].

S. Denasi et al. [6] describe a system for planning the trajectory of a vehicle traveling in a structured environment in real time which was developed within the framework of the European project EUREKA PROMETHEUS. The limits of the road are detected by highlighting the large homogeneous region which is at the bottom of the image, in front of the vehicle. Techniques of edge detection, local thresholding and morphological filtering are used to define this region.

The proposed technique of Angel D. Sappa et al. [7] is intended to be used on a driver assistance system for applications such as the detection of obstacles or pedestrians. A robust technique for real-time estimation of the pose position and orientation of the camera. A commercial stereo vision system is used.

J. Langheim et al. [8] describe the development of a sensor system whose aim is to provide sufficient information about the low-speed automotive environment to aid low-speed driving in complex (urban) environments. The main objectives of the program remain the improvement of individual sensors and the fusion of information from these sensors in a fusion unit.

Akriti S. et al. [9] and Dhanlakshmi et al. [34] found many compromises when working with the accident management system such as high cost, non-portability, wrong delivery, etc. The system encountered many shortcomings due to lack of Resources. In this technique, the severity scale was used to measure the impact of an accident. This reduced load on the cloud server by 30%. [10] A framework was designed which has two components. The first is the accident detection and warning system. The second is traffic management for the ambulance. The efficient routing algorithm is used to route the ambulance. The technique is feasible for the road at junctions with signals. However, it is not applicable to segments without signals.

In Vikas J. Desai et al. work [11], an electronic card in the form of a wireless black box based on a MEMS accelerometer and a GPS tracking system is developed for accidental monitoring. The method consists of cooperative components of an accelerometer, GPS device, microcontroller and GSM module. In the event of an accident, this wireless device will send a short massage to the mobile phone indicating the vehicle position by the GPS system.

Ali and Alwan [12] proposed a multi-case system for detecting low speed and high-speed car crashes. The first parameter used to ensure that the user is inside the vehicle is the high speed of the vehicle (i.e., high speed of). For example, if the speed of the vehicle (as well as that of the smartphone) is greater than the speed threshold value (24 km / h), this would indicate that the user (as well as the smartphone) is inside the car. At the same time, any acceleration event encountered by the smartphone exceeds an acceleration threshold value (4G); it is interpreted as a sign of an accident, this leads to triggering of false alarms in some cases.

Sarika B. Kale et al. [13] describes the development of a management system for a moving emergency vehicle. they used GSM, GPS, ARM tools to provide an empty path for the ambulance. they based on the cheaper ARM processors and they are small in size, they are widely used. Two RFID systems are also used. An RFID tag, a heart rate sensor and a temperature sensor are placed in the ambulance, they monitor the patient's health and send SMS to the mobile using the GSM module. Two RFID readers are placed at intersections to detect the density of traffic on the roads.

Jyoti Tamak [14] proposed a system composed of two parts: traffic light control system and congestion avoidance system. The design of this system is based on the Arduino "ATMEGA" board which is a 328-family based microcontroller. IR, Arduino, xbee proximity sensors are mounted on either side of the roads and the emergency vehicle.

Bhagya Lakshmi V. [15] develops a system to track the position of any vehicle and send an automated message to the pre-programmed number. The owner of vehicle, police to clear traffic, ambulance to save people can be informed by this device. FPGA controls and co-ordinate all parts used in system. With the help of accelerometer sensor, we can tell the exact position of the vehicle. We can predict whether the vehicle is in normal position or upside down.

KA Khaliq et al. [16], Discussed techniques to detect the accident using some sensors and other equipment, then verified the generated results. In their approach, they verified the severity of an accident.

Zing Xu et al., discuss a location-based communication protocol between two vehicles, in which each vehicle generates emergency messages at a constant rate. Message transfer can help the warning message reach vehicles beyond the radio transmission range. The authors propose a multi-hop broadcast protocol based on the reservation of MAC slots. Two protocols to reduce the quantity of transfer messages have been proposed [17].

Nirav Thakor et al. described a real-time online safety prototype that controls the vehicle speed

under driver fatigue [18].
Reddy and Rao [19] developed a system to detect disasters such as fires in the car. The proposed methodology offers good security. This results in warnings that can be triggered to trigger preventive measures in the event of such incidents.
This system proposed by S. Boopathi et al. [20] which detects any accident in the vehicle and communicates the preprogrammed numbers such as the owner of the vehicle, the ambulance, the police, etc. GSM technology is used to send the vehicle position as an SMS to these numbers and the vehicle position can be obtained by the vehicle owner.
ying-wen et al. [21] and Steve Furber [22] created a vehicle tracking system, this system ensures the safety and security of the vehicle by tracking its position and sending it to the owner or to any person at all times.
Kim and Jeong [23] proposed an algorithm to detect collisions using collision probability data. The proposed algorithm showed an improvement over the Mote-Carlo simulation which gave efficient results of their model.
Chen, H. Chiang et al [24], The GPS / GSM based system is one of the most important systems that integrate GSM and GPS technologies. It is necessary because of the many applications of GSM and GPS systems and their wide use by millions of people around the world.
The application of an Internet of Things intelligent network as an enabling technology for SG has been presented in R. Kappagantu et al. work [25]. Y. Zhang et al. detailed review of the security challenges and issues for IoT -based SG, and a summary of the main challenges for IoT-based SG and potential solutions are presented. A study of communications and infrastructure for the energy sector and SG is presented by Zhang team [26].
The work published by Priyal R. et al. [27] proposed a call notification system consisting of an XBee WiFi network. Module, XBee Shield, GPS Module and Seeeduino. The accident is only detected using the crash sensors, which is why the results are less precise.
The idea of Manasi patil et al. [28] is to provide an intelligent traffic light system, which would help the ambulance to reach the destination in the shortest possible time by providing an adequate passage route. Along with this, a controller installed on the vehicles, which would contribute to the fully automatic detection of the occurrence of an accident and the location of the vehicle.

3. METHOD AND MATERIALS

3.1. Road Accident Control and Management System:

The aim of this article is to create a fast, Internet of Things-based on web server that helps detect car crashes, notify them immediately, automatically turn the traffic light green on the ambulance route (or firefighter) so that it can reach the place at some point and human life can be saved. It also controls the traffic signs installed in the roads in order to also avoid secondary accidents and traffic jams created by the accident. This can be achieved by integrating smart sensors into an electronic board, based on a microprocessor in the car, which can be triggered during an accident. We implemented this system by designing a car based on the Adafruit IO is an easy-to-use and powerful enterprise IoT platform designed to help quick and secure building of complex systems [29]. Adafruit IO uses open communication standards like MQTT to provide connectivity from one to millions of devices.
Figure 1 represents the operating principle of our system:

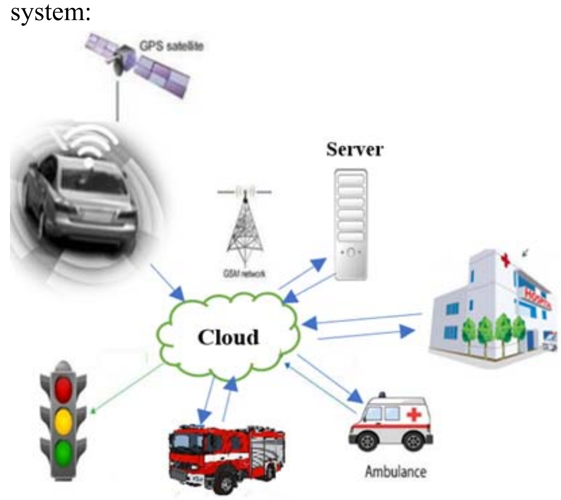

Figure1: accident detection and navigation system

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3.2. Management and Control Modules:

A-Vehicle / Ambulance Modules: These systems are equipped with a pressure sensor, a fire sensor, an accelerometer, a heart rate sensor and a GPS / GSM module integrated into the car. Whenever an accident occurs, the GPS tracks the current position and sent them to the cloud and via SMS to the server. Emergency vehicles detect the current position of the accident vehicle via the data received by the server, which is the accident location and the driver's state of health, the server also sends the accident information to the nearest hospital (e.g contact details of injured driver and details of the ambulance reserved for the accident). He also informs the ambulance on information the hospital is ready to treat the injured.

B-Control and data storage server: All information in the web server, on the accident, the nearest available ambulance to the accident, the patient as well as the current traffic density of each junction are stored in the cloud. The server then communicates with the other servers installed between the accident area and the hospital. It plays a controlling role in an intelligent way in the traffic monitoring system and emergency response to correlate the data collected from the GPS in order to reach the destination in a short period of time. Once the server receives the information on the accident, it searches for an available ambulance near the accident, it sends information received by vehicle module then it controls using IoT and SMS the traffic signal automatically according to the distance calculated by GPS between the ambulance and the vehicle in accident and at the same time it sends a message to the road signs, installed in the roads in order to avoid secondary accidents and traffic jams created by the accident. The servers check each time, according to a calculation algorithm, that the emergency vehicle is approaching the traffic light, the latter turns green via SMS communication between an algorithm installed in the FPGA server and the automatic red light based on the Arduino board (see figure 2 and figure 5). The intelligent traffic light controller introduced, reduces the waiting time and avoids the traffic load. With on-board network sensor technology, the congestion route is detected and managed accordingly by remote controllers [30] or by traffic signs and display. These are controlled by our Web server created by an embedded NIOSII processor in the FPGA circuit.

The following figure represents our web server Created by FPGA DE2-70:

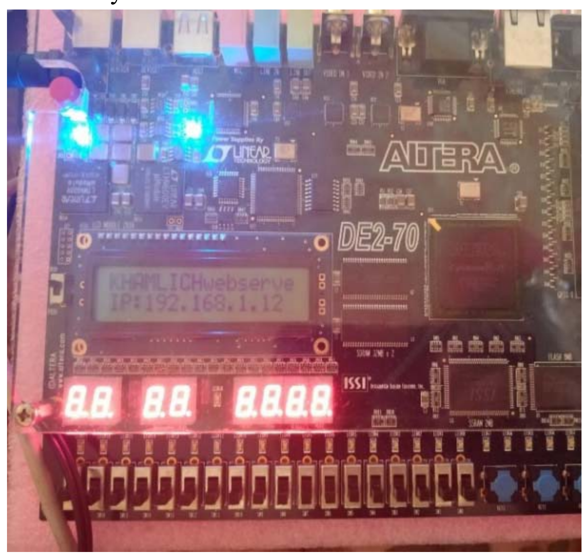

Figure2: Web server created by the FPGA card

C-Red light module and Traffic signs: play an important role:

They make it possible first of all to ensure safety, by sharing over time the use of the same space between conflicting flows, by the choice of the durations of each color (green, red) and by the synchronization of the lights between them. They also allow the flow to be managed remotely by on-board electronic systems. The red light and the automatic signaling displays are based on the Arduino board which communicates with the web server by IoT technology and by SMS, the latter turns green by a remote command following an algorithm installed in the web server.

3.3. Proposed Method for Material Design:

Real-time processing of information requires the use of fast, reconfigurable electronic circuits capable of processing large amounts of information generated by the sensors. Figure 3 illustrates the communication between the Control Server and the other modules.

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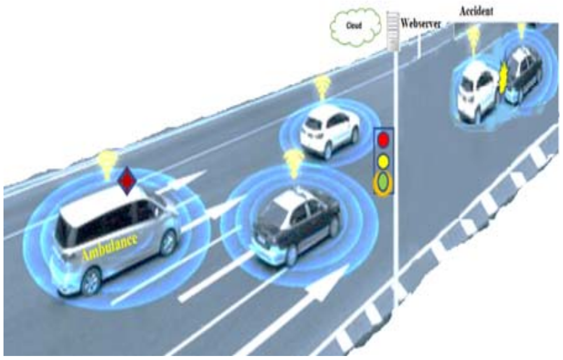

Figure3: communication between the Control Server and the other modules

Figure 4 shows the block diagram of our complete system (web server, Ambulance module, vehicle module, red light module and traffic sign). This system consists of an electronic board that resides in every ordinary car or ambulance, and it is called Raspberry Pi3 B+. This electronic map identifies the severity of the accident using several sensors connected to it and determines the location of the accident by GPS, so it sends SMS to the web server. The latter is an electronic card called FPGA equipped with the Internet and the communication chip, and inside is a program based on an algorithm that works intelligently and perfectly to manage a group of electronic boards remotely. And the last system is the automatic high beam consisting of an electronic board called Arduino which receives signals from the server via SMS or operates normally.

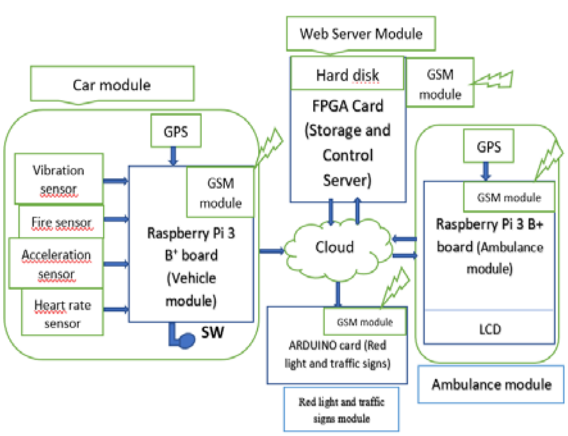

Figure4: Intelligent accident detection and navigation system

In the event of an accident, a signal comes from a GPS sensor linked to a Raspberry PI electronic card installed in the car, thanks to this card, an alert message and information on the accident are automatically sent to the web server (for example the seriousness of the accident and the GPS location, the date of the accident, health status and driver name...). The ambulance will use GPS coordinates to quickly get to the scene. If the victim is not seriously injured, he can manually disable the sending of messages by a switch linked with Raspberry PI. After the design, production and installation of the electronic card in the car and the installation in the server of a traffic light management system to facilitate the movement of ambulances, we carried out tests for different conditions in order to get results. For this setup, the algorithm uses the data collected by the sensors: heart rate, vibration, fire, acceleration and GPS modules. These sensors have their configurations and their threshold range. The heart rate sensor is essential since it can track the driver's heartbeat during the journey. Normally, a person's heart rate is between 75 and 170 beats per minute for the 20 to 50 age group [31]. Proximity sensors are used in binary mode. In this case, the signal amplitude can only have two levels (high and low), depending on whether the object is present near the inductive sensor or not. The acceleration sensor input range can be from 2g to 200g (negative and positive) and can vary even more [32] (1g approximately 9.81 m / s2). While the vibration sensor has only two states, low and high. It is low for normal cases. When the environment is subjected to a large impact force, it becomes high [33]. When smoke particles enter it, they pick up some of the alpha rays, causing the current to decrease, and then the fire sensor going into alarm [32]. The GPS module consists of an electronic circuit connected with a Raspberry pi board. When the occurrence of the accident is detected, the data obtained by the GPS are transmitted to the server. The following part represents the components of the three modules (server module, car / ambulance module and red light / traffic sign module).

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4. MATERIAL AND SOFTWARE COMPONENTS OF THE SYSTEM:

The overall model consists of the following components:

4.1. Web Server Modules:

When an accident is detected, the central server is immediately informed. It is responsible for locating nearby ambulances that can reach the scene of the accident. During this study we used the cyclone version 2EP70F896C6 FPGA board to create the web server, which is a product designed by the Altera company. It has the necessary components for various real-world applications (examples: image processing, speech processing, networks and telecom etc.). This board includes a reconfigurable, modern and very complex processor. It is called NIOS II, this processor is reconfigurable, i.e. that we can reprogram it several times following the modification of the FPGA circuit by the hardware programming languages. In our case we configured the FPGA circuit to create the hardware NIOSII processor intended for the web server application. We have added a GSM module linked with the card by the USB port and a communication controller with the RJ45 port of the FPGA card to control electronic cards remotely or to receive information in the form of SMS or by internet.

When we finish building the system in the SOPC-builder tool, we switch to the Quartus II software to connect the inputs/outputs of this NIOSII processor with the external inputs/outputs of the FPGA circuit. Same software is used for the simulation of our NIOS II processor. When the software completes the simulation without errors, the result is a ".sof" extension file that defines the NIOSII hardware processor. The role of this file is to modify the internal structure of their FPGA reprogrammable circuitry of the implementation.

After the creation of the HW processor (see figure 5), we move on to the programming part by C and C ++ programming languages of this processor and the algorithms for the management and controls of electronic modules installed in vehicles, ambulances, lights red / traffic signs.

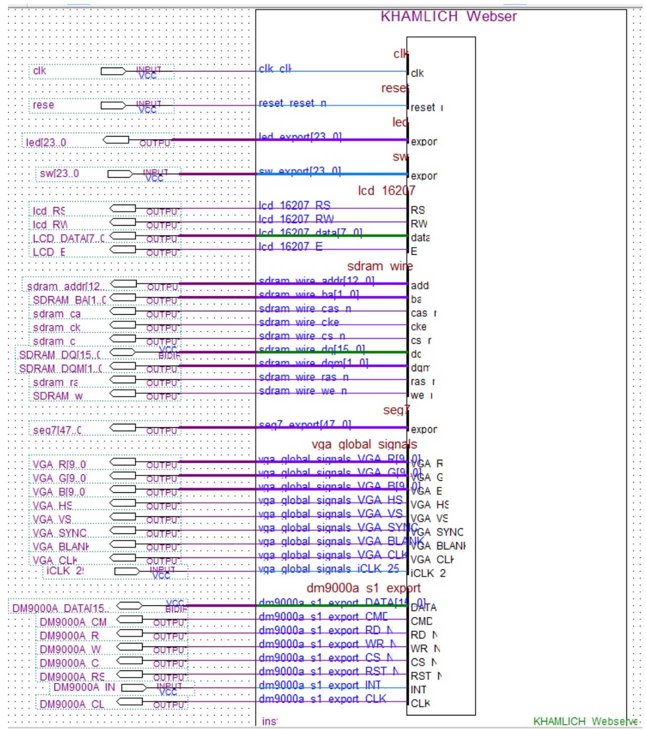

Figure5: NIOSII Hardware processor created by Qsys and QUARTUSII software

The creation of new project in the Eclipse programming software based on the file (KHAMLICH_Webserver.sopcinfo) in the directory KHAMLICH_HW / SW, this file is created after the simulation and compilation of HW processor. The program files as well as the libraries of the Soft part in the software folder are shown in figure 6:

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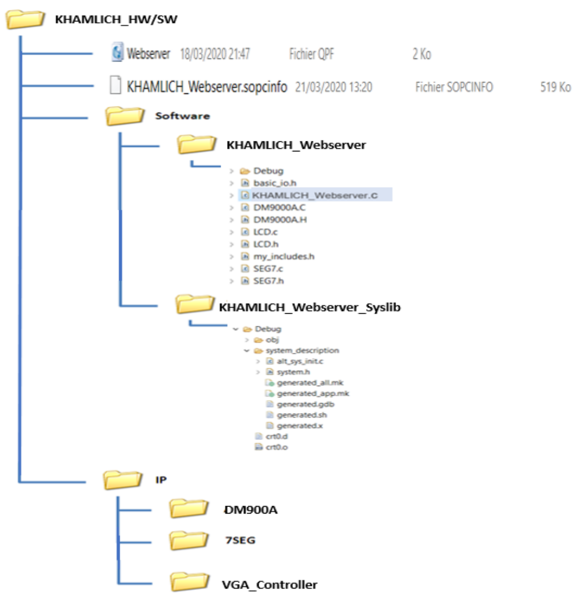

Figure6: program files created by the NIOSII IDE tool (Eclipse)

After the design and production of our NIOS II processor, created for the WEB Server application by the development tools, we obtained a good result, either in terms of material reservation, energy consumption, size, processing speed and communication (Figure 7a and 7b), or at the level of simplicity of soft and hard configuration.

Family	Cyclone II
Device	EP2C70F896C6
Power Models	Final
Total Thermal Power Dissipation	259.94 mW
Core Dynamic Thermal Power Dissipation	1.00 mW
Core Static Thermal Power Dissipation	155.18 mW
I/O Thermal Power Dissipation	103.76 mW
Power Estimation Confidence	Low: user provided insufficient toggle rate data

Figure7.a: Power result of our NIOSII Hardware

Family	Cyclone II
Device	EP2C70F896C6
Timing Models	Final
Met timing requirements	No
Total logic elements	6,607 / 68,416 (10 %)
Total combinational functions	5,230 / 68,416 (8 %)
Dedicated logic registers	4,151 / 68,416 (6 %)
Total registers	4289
Total pins	249 / 622 (40 %)
Total virtual pins	0
Total memory bits	472,128 / 1,152,000 (41 %)
Embedded Multiplier 9-bit elements	4 / 300 (1 %)
Total PLLs	1 / 4 (25 %)

7.b- material reservation of our NIOSII on the FPGA

circuit

So, this processor version is modifiable and we can share this dynamic processor on CD-ROM or on a USB key with researchers and developers in electronics and computer science (the internal architecture can be modified and flexible).

Server operation: The information of the person's status and their vehicle obtained by the Raspberry Pi card installed in the car, are sent by internet or by SMS to the central server and to the telephone numbers stored in the card memory (family, police...). Thanks to the integrated sensor network technology, the central ambulance server is immediately informed of an accident and its location. It then controls traffic signs and traffic lights via SMS to reduce waiting time and avoid traffic load. The driver of nearby ambulances could thus easily reach the scene of the accident.

4.2. Car and Ambulance Modules:

4.2.1. Raspberry pi card and GSM module:

In our case we used a pi3 B + board with a 1.4 GHz 64-bit quad-core processor, dual band wireless LAN and GPIO pins. This board controls the flow of information between the sensors, It is a development processor that provides the flexibility to write programs in python for the sensors, GSM module and GPS module, which can then be deployed in the flash memory of Raspberry pi to check the operation of the sensors. Figure 8 shows the flowchart which summarizes the car module program in the 2 cases (static case and dynamic case).

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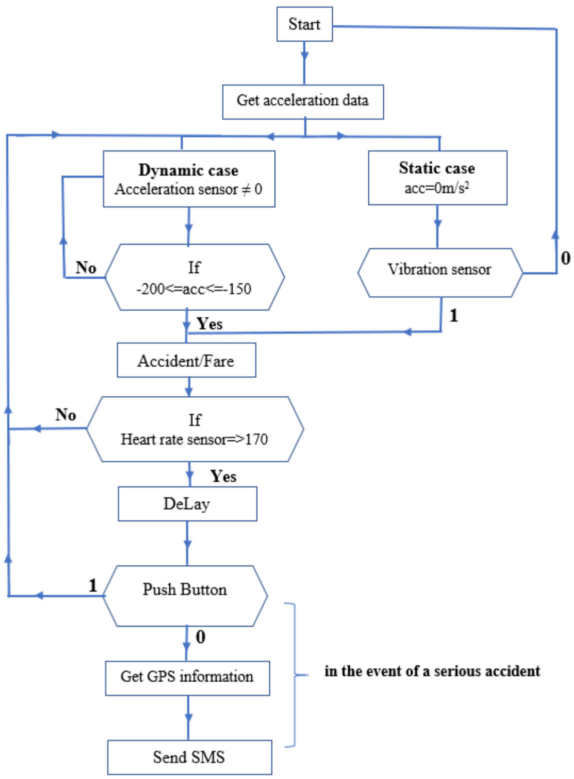

Figure8: the static and dynamic system flowchart

In the static case there are two possibilities:
1st Case: If the accident detected by the sensors is very normal or if the driver has hit the wall in certain situations such as parking, the driver will press the stop push button linked with the card. This will inform the Raspberry Pi board that this is a very normal crash. **2nd Case:** if the driver is unable to press the push button or if the accident is really a major accident, the driver will not press the button. Then the Raspberry Pi board will get the coordinates of the GPS modem then it will send this information to the GSM modem or by internet, the GSM modem is used to send this information by SMS. An SMS will be sent to the driver family member, so that he can take immediate action to help the people suffering from this accident and another SMS and internet message will be sent to the web server, they contain the driver information, sensor data linked with the RPi map, GPS latitude and longitude….

We have used in this application the **SIM808EVB-V3.2.4 GSM / GPS** module, It is a module contains two blocks (see figure 9), the first (GSM block) used for mobile to mobile communication, It is loaded send SMS to the desired number or make a call whenever requested. The second for satellite communication (GPS block), It has 24 satellites, it will transmit coded information. The GPS sensor is a receiver that gives information about the position, speed and timing of an object. When installing this sensor, any device can be tracked to locate its position. There are three different segments in GPS:

A. Spatial segment.
B. Control segment.
C. User segment.

The GPS module uses the standard NMEA protocol to transmit the position via the serial port [27]. The module antenna must be in a horizontal position. A clear sky without any obstruction allows the GPS module to provide accurate information. When a GPS receiver begins to operate, it first downloads the orbit information of each satellite to download this information, it will take about 12.5 minutes. Once this information is completely downloaded, it will be stored in the receivers in order to continue to use it. The GPS knows the exact location of the satellite, but it still needs to know the exact distance between the satellite and the receiver [35]. This distance can be calculated by the receiver, by multiplying the time taken by the signal to reach the receiver and the speed of the transmitted signal. But the receiver already knows the speed which is 18,600 miles / sec.

Figure 9 and table 1 illustrate the cabling between pins: 8, 10 and 3.3V of the Raspberry pi card and the RX and TX serial ports of the GSM / GPS card.

Table 1: connections between RPi3 B+ and GSM / GPS module:

Raspbery Pi	GSM/GPS
Pin 8 (TX)	RX
Pin 10 (RX)	TX (GSM)
Pin 34 (GND)	GND

Note: the RX of the Raspberry pi board is linked with a 4148 diode and a 10K resistor in parallel with TX of GSM / GPS module.

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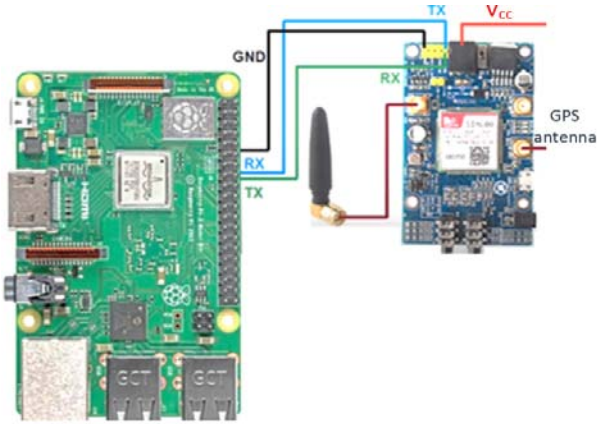

Figure9: GPS / SIM system installed in the car and test ambulance

Before programming and wiring the modules with the Raspberry Pi board, we make them configured. In the linux operating system installed in Rpi, we used the GSM / GPS configuration by the following commands:

Reference AT Commands:
AT+CMGF=1 -configure SIM to TEXT mode
AT+CGNSPWR=1 -Turn on GPS(GNSS - Global Navigation Satellite System)
AT+CGNSSEQ=RMC -configure GPS settings
AT+CGPSSTATUS? - check if GPS fix is already available (should be either 2d or 3d fixed location)
AT+CGNSINF - get the GPS location
AT+CMGS="phone number" -Send message. Followed by the message. Terminated/ended by a special symbol from Notepad++.
The following code represents part of main program in GSM / GPS module python in this program there is also an example phone number for the test:

```
import RPi.GPIO as GPIO
import serial
import os
import time, sys

SERIAL_PORT= "/dev/ttys0"
Ser = serial.serial (SERIAL_PORT, baudrate
= 9600, timeout = 5)
Ser.write ( "AT+CMGF=1\r")
Print ("activate text mode …")
Time.sleep(3)
Ser.write ('AT+CMGS=  "+212676770571" \r')
Msg= "test the RPI card …"
Print (" sending message …")
Time.sleep(3)
Ser.write(msg+chr (26))
Time.sleep(3)
Print("message sent…")
. . . . .
# Main program loop:
while True:
    line = ser.readline()
    if "$GPRMC" in line:
# This will exclude other NMEA sentences
the GPS unit provides.
        gpsData = parse_GPRMC(line)
# Turn a GPRMC sentence into a Python
dictionary called gpsData
      if gpsData['validity'] == "A":
# If the sentence shows that there's a
fix, then we can log the line
        if firstFixFlag is False:
# If we haven't found a fix before, then
set the filename prefix with GPS date &
time.
           firstFixDate =
gpsData['fix_date'] + "-"
gpsData['fix_time']
           firstFixFlag = True
            else:
# write the data to a simple log file and
then the raw data as well:
with open("/home/pi/gps_experimentation/"
+ firstFixDate +"-simple-log.txt", "a") as
myfile:

myfile.write(gpsData['fix_date'] + "," +
gpsData['fix_time'] + "," +
str(gpsData['decimal_latitude']) + "," +
str(gpsData['decimal_longitude']) +"\n")
with open("/home/pi/gps_experimentation/"
+ firstFixDate +"-gprmc-raw-log.txt", "a")
as myfile:
   myfile.write(line)
```

4.2.2. Raspberry pi board and heart rate sensor:

The VMA340 heart rate sensor is based on the principle of photoplethysmography. It is designed to measure changes in blood volume. It keeps track of the person's heart rate. The VMA340 sensor has two sides, on one side the DEL is placed with an ambient light sensor and on the other side we have electronic circuits. These circuits are responsible for amplification and noise cancellation work. The DEL on the front of the sensor is placed on a vein in our human body. It can be your fingertip or ear tips, but it should be placed directly over a vein.
Now the DEL emits a light which will fall directly on the vein. The veins will have blood flow inside only when the heart is pumping, so if we monitor the blood flow, we can also monitor the heartbeat. If blood flow is detected the ambient light sensor will pick up lighter as it will be reflected by the blood, this minor change in the light received is analyzed over time to determine our heartbeat. In this project, the pulse sensor works as a heart rate sensor for Raspberry Pi.

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There are three wires coming out of the sensor which are signal (S), Vcc (3 - 5 V) and GND. The signal wire is shown in purple (or white), red and black respectively. In our project, the sensor will be powered by the 3.3V pin and the signal pin will be connected to Raspberry pi through the ADS115 ADC module because Raspberry Pi by default cannot read analog voltage. The components needed to create our own patient monitoring system using Raspberry Pi are:

1. Raspberry Pi
2. Pulse Sensor
3. ADS1115 ADC module
4. Jumper wire
5. Power supply or power bank

The circuit block diagram of the conductor beat monitoring system using Raspberry Pi is shown below.

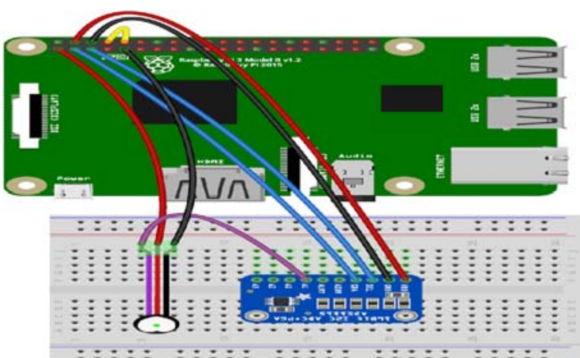

Figure10: Heart rate sensor system installed in the test car

We used ADS115 ADC module with pulse sensor. The pulse sensor is connected to Pi via I2C communication, so that we can measure heart rate on Raspberry Pi. The wiring of our system is shown in table 2 and in figure 10:

Table 2: connections between RPi3 B + card, heart rate sensor and ADS115 module:

Raspbery Pi	Pulse sensor	ADS115
-----	S (Purple)	A0
Pin 1 (3,3 V)	Vcc (Red)	-----
Pin 25 (GND)	GND (Black)	-----
Pin 4 (5 V)	-----	VCC
Pin 6 (GND)	-----	GND
Pin 3 (SDA)	-----	SDA
Pin 5 (SCL)	-----	SCL

Since the ADC module communicates in I2C and we use UART for serial communication, we need to enable UART and I2C of raspberry pi using in linux shell mode the command **sudo raspi-config**, then we install i2c packages by the use of the following commands:

sudo apt-get install -y python-smbus
sudo apt-get install -y i2c-tools

After the I2C installation, we proceed to the installation of the python ads115 library for the ADC module by the following commands:

sudo apt-get update
sudo apt-get install build-essential python-dev python-smbus git
cd ~
git clone https://github.com/adafruit/Adafruit_Python_ADS1x15.git
cd Adafruit_Python_ADS1x15
sudo python setup.py install

We have now interfaced an ADC module via I2C communication to get the analog output of the pulse sensor. After getting the raw analog output from the pulse sensor, we find the upper peak and the lower peak. And then find the time difference between two peak points, then convert them to heart rate (Fc), expressed in beats per minute (Bpm). We send the raw analog output and BPM to the serial port which is read from the processing IDE for further process.

4.2.3. Raspberry pi board and the acceleration, vibration and fire sensors:

An accelerometer is a sensor which, attached to a mobile or any other object, makes it possible to measure the linear acceleration of the latter. We speak of an accelerometer even when it is in fact 3 accelerometers which calculate linear accelerations along 3 orthogonal axes [35]. It is a type of sensor designed to measure acceleration accurately. Acceleration is measured in three axes which are the x direction, the y direction and the z direction. The x-axis of the accelerometer gives the measure of positive acceleration, the Y-axis

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shows the measure of negative acceleration (deceleration), and the z-axis shows the angle of rotation of the device in which he's installed. Figure 11.a shows the sensor that is used in our application.

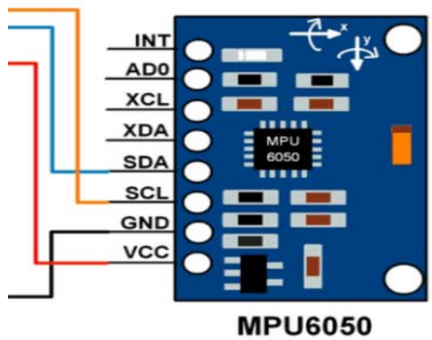
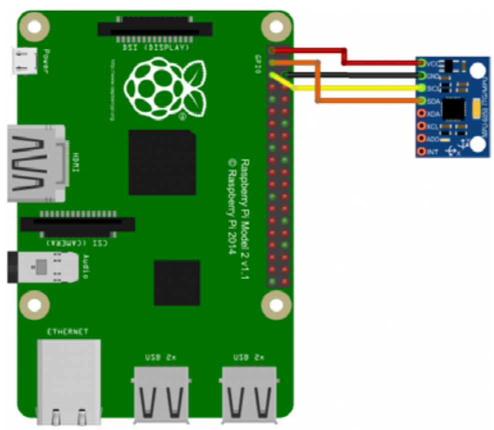


Figure11.a: Accelerometer Sensor MPU6050



11.b: accelerometer sensor system and RPi card

The MPU6050 sensor module is a motion tracking device. It combines a 3-axis gyroscope, a 3-axis accelerometer, and a digital motion processor in a small package. It has an I2C bus interface to communicate with the Raspberry Pi host controller.

The MPU6050 has 8 pins as mentioned below.

- VCC: DC + 5 V supply pin
- GND: ground pin
- SCL: serial clock pin
- SDA: serial data pin
- XDA: auxiliary serial data pin
- XCL: auxiliary serial clock pin
- AD0: slave address selection pin.
- INT: interrupt pin

The practicality of I2C is that very few pins are used. On the eight pins of the sensor, it is enough to connect the 4 upper ones (See figure 11.b and the table and above).

Table 3: connections between RPi3 B + and MPU 6050 module:

Raspbery Pi	MPU 6050
Pin 17 (3,3 V)	VCC
Pin 3 (SDA)	SDA
Pin 5 (SCL)	SCL
Pin 34 (GND)	GND

Operation of the MPU6050 acceleration sensor used in our work able to find different physical changes such as "tilt", "tap", "jerk" etc. The advantage of this sensor is that it can detect physical conditions in all three directions (i.e. 3 axes), Figure 12 shows the 3 directions of the accelerometer tilt.

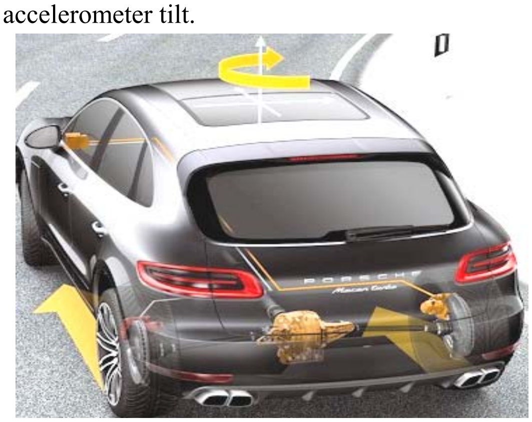


Figure12: When vehicle position is in x-axis, y-axis and z-axis

The gyroscope is correctly connected, we saw a display of the addresses of the connected I2C modules, in hexadecimal after the following command:

sudo i2cdetect -y 1

We have created a class for the mpu6050 which summarizes all the functions that will be required to get readings and set the parameters of the mpu6050. This class is a tool for developing various applications using the mpu6050. Probably the most convenient way to read the acceleration sensor is Python.

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Running it will print the accelerometer and gyroscope value along all three axes once every 500ms on the terminal. Now we will see an output containing all the captured data, see the following figure:

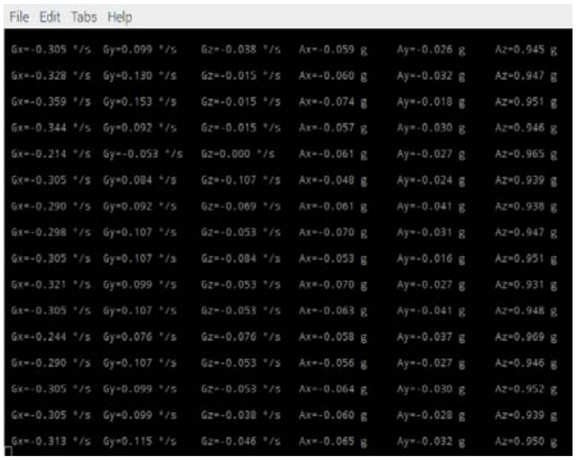

Figure13: acceleration sensor test

The output window will show all the values mentioned below

Gx = gyroscope X axis data in degrees / seconds
Gy = gyroscope Y axis data in degrees / seconds
Gz = Gyroscope Z axis data in degrees / seconds
Ax = Accelerometer X axis data in g
Ay = Accelerometer Y axis data in g
Az = Accelerometer Z axis data in g

Vibration sensor: This sensor can recognize vibrations in a given area. It has two values: low and high (0 or 1 in computing). Usually, it remains low for scenarios where the impact of vibration is not as strong. It acquires a high value when it receives strong vibrations from the environment.

Fire Sensor: Sensor that detects gas or smoke at concentrations from 300 ppm to 10,000 ppm. After calibration, the MQ-2 can detect different gases such as LPG (LPG), butane, propane, methane, alcohol, hydrogen as well as fumes. It is designed for indoor use at room temperature. In our case, we used smoke detection.

4.3. Red Light Module and Traffic Sign:

We used in this application the Arduino board with the 800L SIM module to control the red-light module. The figure below illustrates the connection:

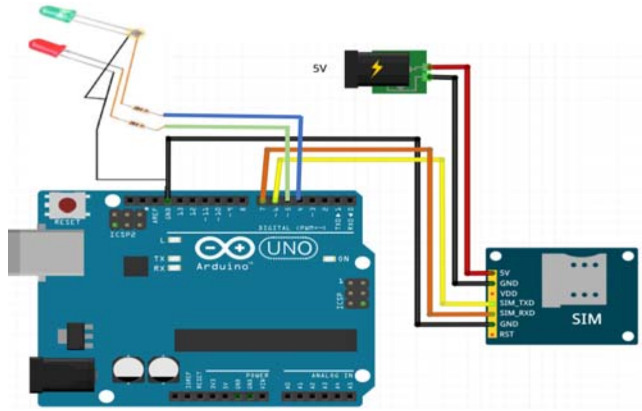

Figure14: Arduino and SIM800L card

We plugged in the 800L SIM module with the SIM card and two red and green DELs in pins 4 and 5 of the card in order to test our program. If the ambulance is in the road and near a red light, in this case the web server will command the red dipped light, it turns on the green DEL in the direction of the ambulance and at the same time it turns on the red DEL in the other directions. The following program represents an infinite loop of testing the messages received by another SIM module linked with the server to control the two DELs plugged into pins 4 and 5.

```
Void loop()
{
        while (MySim.available() )
        {
Message=MySim.readString() ;
Serial.println(message) ;
If (message.indexof("green_ON")>=0) {
    digitalWrite(4, HIGH);
    digitalWrite(5, HIGH);}
If (message.indexof("green_OFF")>=0) {
     digitalWrite(4, LOW);
     digitalWrite(5, LOW);}
          delay (1000);


      }
}
```

If the message received is green_ON, in this case the Arduino board turns on the green DEL in the direction of the ambulance and it turns on the red DEL in the other directions.

4.4. Necessary Elements and the Proposed algorithm:

4.4.1. Items required for each module:

To generate the expected results, the following elements are taken into account:

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Car and ambulance module:

- In our case, we used a single robot that acts as a car. But it is necessary to install the electronic cards with the sensors in each car.
- The algorithm only works for the area which has strong networks.
- This only applies to cars.
- Only possible crash cases are taken into account.
- The driver must put the sensor in the grip on his finger when in the car (the heart rate sensor being integrated into the safety grip). In our future work we will be using another heart rate sensor installed in the belt. The driver in this case will have to wear the seat belt every time to register the heartbeat.

In designing the algorithm, keep in mind the maximum values of the accelerometer and heart rate sensor. According to the sensor data sheets, the maximum value for the heart rate sensor is 170 beats per minute and above. The maximum value of the accelerometer is between -150 and -200 in case of delay. Table 4 describes the above cases.

Server module:

- To increase the processing speed and to solve the problem of communication with cars / ambulances and red lights, it is necessary to install several web servers connected with GSM modules and strong networks.

Red light module / traffic signs:

- To make it easier to move the ambulance on the road, especially in the event of an accident. It is necessary to install in each crossing, traffic signs and automatic red lights, based on the Arduino board and a GSM module.

4.4.2. Proposed algorithm:

The cases considered for an accident and its chances (see figure 8 in the form of a flowchart which represents the possible cases):

1st Case: when the car is stationary. This case represents a scenario of a possible accident when the car is at rest. The driver inside the car could be injured depending on the value given by the heart rate sensor.

2nd Case: when the car is stationary and the driver is not inside. This case represents a situation where the car is at rest, but the driver is not inside. If there is an accident, in such cases emergency services do not need to be notified.

3rd Case: when the car is moving. In this case, the driver is alerted in the event of overspeed. Warning message to avoid accidents.

4th Case: This is the most common case when a moving car is struck by another vehicle. In such situations, emergency services should be encouraged to provide assistance. Tables 4 and 5 show the cases mentioned above using the values given by each detector in the car.

5. RESULT AND DISCUSSION

The proposed system is mainly based on the generalized accident detection and notification algorithm, which takes into account different signals received by the sensors and generates useful results to determine the state of the proposed system. This on-board solution (see figure 15) will also contribute to the secondary accident limit (when there is an accident in the road and the road is full, fast or foggy, in which case other secondary accidents may take place due to primary accident).

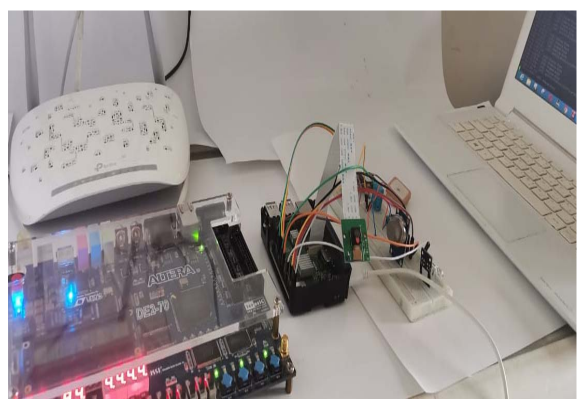

Figure15 : intelligent accident detection and navigation system

To detect an accident, to immediately alert the authorities concerned and to save human life more quickly. This system must be installed in the road and on board each vehicle.

5.1. Static Car Crash:

In this case, there may be a risk of an accident when the car is stationary and the driver is inside. The accelerometer will give low values or mainly 0m/s^2. The vibration sensors will go from

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weakest to strongest the moment it experiences a crash with greater impact. Table 4 describes the numerical values responsible for an accident.

Table. 4: Sensor states for a car accident at rest

Heart rate sensor	Vibration sensor	Fire sensor	Acceleration sensor	Car condition
=>170	0	0	0	Worry
=>170	0	1	0	Fire
=>170	1	0	0	Accident
=>170	1	1	0	Accident / fire
0	0	1	0	Accident
0	1	0	0	Crash
0	1	1	0	Crash/Fire

From Table 4 and figure 8, it can be deduced that the heart rate sensor gives a maximum value for the heartbeat when the acceleration is 0. This means that the driver is not healthy or the car is running. fire. Likewise, when the sensor gives the value 0, it means that the driver is not in the car and that the heart rate sensor is therefore 0, in this case the car state is either in crash or in fire.

5.2. Moving Car Accident:

This is a specific case described for a moving car. When the car encounters an accident, the accelerometer experiences a certain delay (negative acceleration). At this time, the vibration sensors go from low to high. In some situations, the driver is injured as a result of the impact of a collision. In the event of a fire, the driver is injured due to the effect of the burns on the body, resulting in a drastic change in the driver's heart rate in both cases (accident and fire). Table 5 and figure 8 represents the scenario shown above.

Table.5: Sensor states for a moving car accident

Heart rate sensor	Vibration sensor	Fire sensor	Acceleration sensor	Car condition
>=170	1	0	=>-200 and <=-150	Accident
>=170	1	1	=>-200 and <=-150	Accident / Fire
<170	0	0	>120	Over speed
>=170	0	1	>0	Fire

When the car is seriously delayed due to a collision (the value of the accelerometer is between -150 and -200 in case of delay), the driver's heartbeat is dramatically awakened, indicating the cause of an injury. This situation calls for immediate assistance for an ambulance.

Note that the heart rate sensor values vary depending on a person's age and that it was not used for simulation. Only vibration sensors and accelerometers were taken into account for the tests. However, in both tables, only cases requiring a warning to the driver or an emergency call to the ambulance are described.

In this work we have carried out a large part, for example the communication between the electronic cards, the location of accidents, control of red lights and control of traffic signs etc but there are still parts not carried out for example the automatic calculation of the distance between the ambulance and the accident and communication between the servers, but we are still preparing this part with my authors.

6.CONCLUSIONS

Human life worth more than anything else. In accidents, people lose their lives as a result of delayed ambulances.

Our accident detection system, with sensors installed in the car, is helping us to avoid the increase in many fatalities. Whether it is the people who committed the accident, by not delaying them in the rescue operation, or the road users by facilitating their movements during the accident. And all of this is done using web server technology that relies on Internet of Things (IOT) technology, to find nearby ambulances, and clear the way for them to easily move to the locations of accident and towards the hospital, by remotely controlling the main beam headlights near the ambulance. It also informs road users of the location of the accident by means of information screens to exercise caution and change course if necessary. This can reduce the occurrence of other accidents due to the accident that is on the road, especially during fog, darkness, rain, slopes and traffic jams on the road. All this is designed with fast, high quality and affordable electronic systems in relation to accidental damage (death, car damage, traffic congestion ...). he also informs relatives and friends of the occurrence of the accident and its location by SMS.

Future research

This system can also be developed. We will then use a camera interconnecting to the Raspberry Pi system following the CSI Port which takes photos of the accident site, which facilitates the monitoring and detection of the accident by an image recognition algorithm automatic.
We will also add communication technology between vehicles to facilitate the process of passage in fog or in the winter season, as well as to overtake heavy trucks on slopes and in corners without accidents.

REFERENCES

[1] Sonali D. T., "Cloud Computing and Software-Based Internet of Things," International Journal of Advanced Research in Computer Science and Software Engineering, vol/issue: 6(4), Apr 2014.

[2] Zhao, Mobile Phone Location Determination and its Impact on Intelligent Transportation Systems, IEEE Transactions, 2000, pp 55-64.

[3] Peng Chen, Shuang Liu, Intelligent Vehicle Monitoring System Based on GPS, GSM and GIS, WASE International Conference on Information Engineering, 2010.

[4] S.P. Bhumkar, V.V. Deotare, R.V.Babar, " Intelligent Car System for Accident Prevention Using ARM-7", International Journal of Emerging Technology and Advanced engineering ISSN 2250-2459, Volume 2, Issue 4, April 2012

[5] Abhay P. Bagade, "Cell Phone Usage While Driving Avoidance with GSM-RF Based Accident Emergency Alert System", ISSN (Print) : 2319-5940 ISSN (Online) : 2278-1021, Vol. 2, Issue 5, May 2013 International Journal of Advanced Research in Computer and Communication Engineering.

[6] S. Denasi, C. Lanzone, P. Martinese, G. Pettiti, G. Quaglia, L. Viglione, "Realtime system for road following and obstacle detection", in: Proceedings of the SPIE on Machine Vision Applications, Architectures, and Systems Integration III, pp. 70–79, October 1994.

[7] Angel D. Sappa, David Ger´onimo, Fadi Dornaika, and Antonio L´opez « Real Time Vehicle Pose Using On-Board Stereo Vision System » : ICIAR 2006, LNCS 4142, pp. 205–216, 2006.

[8] J. Langheim, "CARSENSE – New environment sensing for advanced driver assitance systems", IEEE Intelligent Vehicles Symposium, National Institute of Informatics, Tokyo, Japan, May 2001.

[9] Akriti S., et al., "Intelligent Accident Management System using IoT and Cloud Computing," 2nd International Conference on Next Generation Computing Technologies, Oct 2016.

[10] C. Chatrapathi and N. R. Venkatesakumar, "VANET based Integrated Framework for Smart Accident Management System," International Conference on Soft-Computing and Network Security, Feb 2015.

[11] Vikas J. Desai, Swati P. Nawale, and Sachin R.Kokane "Design and Implementation of GSM and GPS Based Vehicle Accident Detection System" International Journal of Technology and Science, ISSN (Online) 2350-1111, (Print) 2350-1103 Volume 1, Issue 2, 2014 pp. 8-11

[12] H. M. Ali and Z. S. Alwan, "Car Accident Detection and Notification System Using Smartphone," International Journal of Computer Science and Mobile Computing, vol/issue: 4(4), pp. 620-635, Apr 2015.

[13] Sarika B. Kale, Gajanan P. Dhok "Embedded System for intelligent ambulance and traffic control management" International journal vol.2issue2, April2013.

[14] Jyoti Tamak "Smart Traffic Light Control and Congestion Avoidance System during Emergencies Using Arduino and ZigBee" International Journal Volume3, Issue6, June2013.

[15] Bhagya Lakshmi V, Savitha Hiremath, Sanjeev Mhamane "FPGA Based Vehicle Tracking and Accident Warning using GPS" International Volume 5, Issue 2, February-2014.

[16] KA Khaliq, A Qayyum, J Pannek, "Prototype of Automatic Accident Detection and Management in Vehicular Environment Using VANET and IoT," 11th International Conference on Software, Knowledge, Information Management and Applications, 2017.

[17] Zing Xu: V-V location Based broadcast communication, Automated crash notification via the wireless web: system

design and validation", vol. 19, no. 6, ipp. 1048-1059, 2011.

[18] Nirav Thakor, Tanmay Vyas, Divyang Shah, "Automatic Vehicle Accident Detection System Based on ARM &GPS", International Journal for Research in Technological Studies ISSN: - Applied (Online) Vol-1, Issue - 1, Dec 2013.

[19] Sarishma R. and K. Raghav, "Fire Accident Detection and Prevention monitoring System using Wireless Sensor Network enabled Android Application," Indian Journal of Science and Technology, vol/issue: 9(17), May 2016.

[20] S.Boopathi , K.Govindaraju , M.Sangeetha, M.Jagadeeshraja ,M.Dhanasu, REAL TIME BASED SMART VEHICLE MONITORING AND ALERT USING GSM, International Journal of Advanced Research in Computer and Communication Engineering Vol. 3, Issue 11, November 2014.

[21] ying-wen bai.siao-cianwu, cherig-lung tsai; "Design and implementation of a fall monitor system by using a 3-axis accelerometer in a smart phone", IEEE– Nov. 2012.

[22] ying-wen et al. and Steve Furber, ARM system-on-chip architecture, second edition, Pearson Education Limited,2000.

[23] Taewung K. and Hyun Y. J., "A Novel Algorithm for Crash Detection Under General Road Scenes Using Crash Probabilities and an Interactive Multiple Model Particle Filter," 2014 IEEE Transactions on Intelligent Transport Systems, vol. 15, Dec 2014.

[24] Chen, H., Chiang, Y. Chang, F., H. Wang, H. (2010). Toward RealTime Precise Point Positioning: Differential GPS Based on IGS Ultra Rapid Product, SICE Annual Conference, The Grand Hotel, Taipei, Taiwan August 18-21.

[25] R. Kappagantu, S.A. Daniel, "Challenges and issues of smart grid implementation: A case of Indian scenario," Journal of Electrical Systems and Information Technology, vol. 5, no. 3, pp. 453-467, Dec. 2018.

[26] Y. Zhang, W. Chen, W. Gao, "A survey on the development status and challenges of smart grids in main driver countries," Renewable and Sustainable Energy Reviews, vol. 79, pp. 137-147, Nov. 2017.

[27] Priyal R, Vanthana S ''Car Accident Notification System based on Internet of Things'' International Journal of Computer Applications (0975 – 8887) Volume 107 – No 17, December 2014.

[28] Manasi patil, Aanchal Rawat, Prateek Singh, Srishtie dixit "Accident Detection and Ambulance Control using Intelligent Traffic Control System" International Journal of Engineering Trends and Technology (IJETT) – Volume 34 Number 8- April 2016.

[29] Bharat Naresh Bansal, Vivek Garg , "Development of Message Queuing Telemetry Transport (MQTT) based Vehicle Accident Notification System" International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-9 Issue-2, December, 2019.

[30] Shivani S, Shoney S « IoT based car accident detection and notification algorithm for general road accidents » International Journal of Electrical and Computer Engineering (IJECE) Vol. 9, No. 5, October 2019.

[31] Shu Y., et al., "A Pressure Sensing System for Heart Rate Monitoring with Polymer-Based Pressure Sensors and an Anti-Interference Post Processing Circuit," IEEE Sensor Journal, 2015.

[32] D. S. Dima and D. Covaciu, "Solutions for acceleration measurement in vehicle crash tests," IOP Conference Series:Materials Science and Engineering, Mar 2017.

[33] Himanshu C., "Recent Trends of Measurement and Development of Vibration Sensors," IEEE Sensor Journal, 2016.

[34] Dhanlakshmi and Ezil S. L., "Instance Vehicle Monitoring and Tracking with Internet of Things using Arduino," International Journal on Smart Sensing and Intelligent Systems, Sep 2017.

[35] Kavya K, Dr. Geetha C R ''Accident Detect ion and Ambulance Rescue using Raspberry Pi'' International Journal of Engineering and Techniques - Volume 2 Issue 3, May – June 2016.