ECE PARIS
ÉCOLE D'INGÉNIEURS
INSEEC U.

SWITCHEYE

System Requirements Specification for SwitchEye

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1 Purpose

In this document, you will find the System Requirements Specification (SRS) of the project **digitizing an ordinary car** made by the group PPE no1848. It has been made before the product's realization and will contain a description of all functions needed and constraints to resolve problems that were found. The aim of our project is to give the opportunity for everyone to have a smart car.
The SRS is a formalization of what the team will work on during realization phase, and help them understand the purpose of every function.
Functions will be organized according to their importance. They will be divided between : what the project absolutely need ; what he should have ; what will be nice to have. Furthermore, in this document, we will make a reasoning on humans and material means needed. With this analysis, we will be sure to obtain the most valuable product at the end of the project. The SRS is a document that can be edited during the development phase.

2 Documentation and terminology

2.1 Reference documents

Document	Application	Link/ Number reference
The RearVision Camera Solution	**Existing product:** An existing rear-camera and some characteristics of the products. It also explain how the user should install and use it.	Rear Vision Link Here
Pearl Tips: RearVision and Solar Charging	**Existing product:** An interesting sum up of the way the Pearl camera is powered.	Solar Charging for Rear Vision Link Here
Rear Vision: the only wireless backup camera and alert system	**Existing product:** datasheet of the Pearl Rear Vision	Link Here
Wifi back-up camera	**Existing product:** All specifications concerning the Rand McNall camera and a video to install the moduless	Rand Mac Nally Link Here
Android Auto	**Existing product:** Technical aspect of the OS Android Auto	Android Auto Link Here
Driving mode app	**Existing product:** Presentation of an application which prevents accident by reducing the dangerous behaviour of drivers on the road	Link Here
Statistics on car accidents in France	Evolution of car accidents and death through the years	Link Here
A method to save of “moving picture” in car blackbox	**Patent:** An image storage method of a black box for vehicle is provided to automatically control the focus of a camera at an accident predicted position.	Link: KR20130031016
Rear accident Protection	**Patent:** A backward accident protection (BAP) system includes a video camera attached to the rear windshield of a vehicle.	Link: US2017259815
Impact system is prevented to vehicle based on video range finding	**Patent:** A system with collision sensors, a display to give informations to the driver and a rear display to alert the car coming from the back	Link: CN206426927
Car managing system using Smartphone	**Patent:** The present invention relates to a system and a method for managing driving information using a smartphone which inspect various states of an automobile to notify a driver of the states, and provide running statistics information.	Link: KR20180077831

2.2 Glossary

2.3 Acronyms

Acronym	Meaning
SRS	Cahier Des Charges / System Requirements Specification
INPI	Institut National de la Propriété Intellectuelle
MVP	Most Valuable Product
PMBOK	Project Management Body of Knowledge

3 System justification and valorisation

In the following subsections, we describe the role and the use of the system, and place it in its enclosing context.

3.1 Initial justification

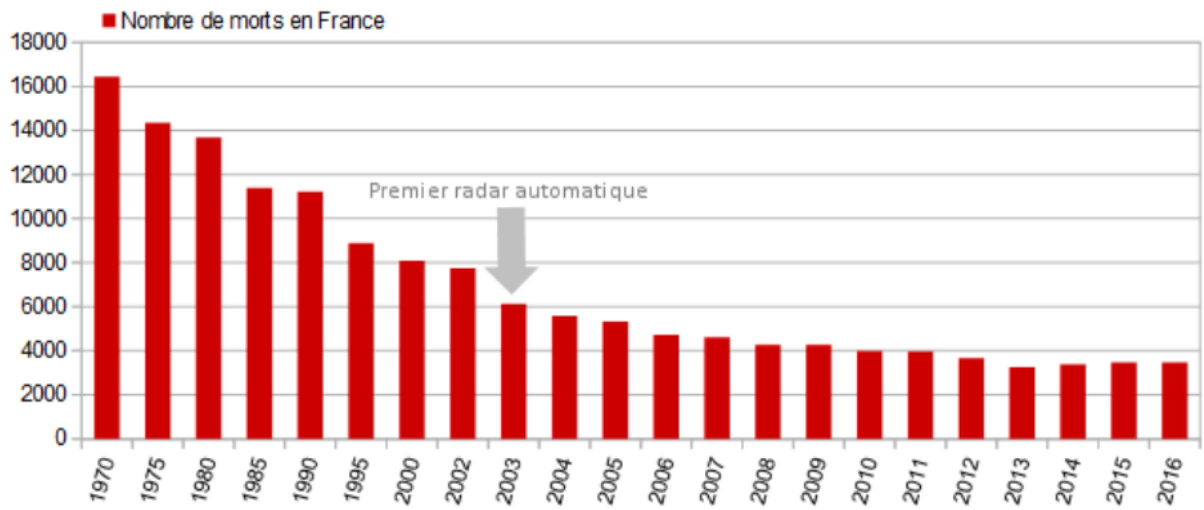


Figure 1: Nombre de morts sur la route en France chaque année

Since 2013 the road accident rate remains quite high and constant, approximately 2500 deaths per year. That's why it is necessary to find new ways to decrease the number of accidents and provide more safety for drivers. Today, we see the appearance of smart cars on the automotive market equipped with new technological advances that provide support to the driver and aim to avoid or reduce accidents.
However, the french fleet car turnover (parc automobile français) is quite slow due to the important cost of investment for a new car. The average age of a car in France is 9 years old and it keeps increasing. It means that many drivers can't have access to new interesting and secured functionalities which are only available on new cars. Some solutions already exist but are expensive and sometimes incomplete. Our goal is to propose a more suitable solution for these drivers. Our system will be composed of sensors placed on a car communicating with an app on the driver's smartphone to alert him when there's a dangerous situation. It will be useful for the security of every drivers who have an ordinary car and their passengers during every travel.

For the next decade, the fleet car turnover will continue and more smart cars will be bought and used. Despite that aspect, actually lots of people don't want to invest in an expensive car just to have additional functionalities so we are convinced that this turnover will take some time. In this context, our system should interest a lot of potential customers and more features could be integrated thereafter to better match the consumer's demand.

3.2 State of the art

In this part, we are going to provide a description of systems existing and patents already registered. At the end, a summary table will allow us to explain the added values of each existing product and to display our added value and potential patent system.

3.2.1 Pearl Rear Vision

This system was created by former engineers from Apple. The device is provided with a camera disposed around the license plate of the car. It is connected to the driver's smartphone and displays the video stream picked up by the camera when the car is moving backward. The device is wireless and easy to install. Finally, the camera is powered by photovoltaic systems and is commercialized only in the US since 2017 and cost almost 500€. The system is composed of two wide perspective HD cameras, CMOS sensor, 3-axis accelerometer and a lithium ion battery all mounted on an aluminum frame.

Positive aspects of this setup are that the app is regularly updated ; the system is theft-resistant thanks to a special screwdriver, there is no wiring needed, it's simple to install and it has a night mode. On the other hand this device is really expensive at a retail price of almost 500€, also requires a recent phone.

Figure 2: Pear Rear Vision

3.2.2 Rand McNally Wireless Backup Camera

Datasheet/Information about the product: This wireless backup camera is mounted to the license plate of a car and displays automatically the video stream from the camera when the driver parks his car. The camera has a Wi-Fi transmitter with an antenna to send pictures to the device screen on the dashboard of the vehicle. It works with the driver's smartphone and the Rand McNally GPS.

1. Technical information:
This system provides a camera fixed on a License Plate bracket. The camera is powered with a car charger. It is also constituted with a WIFI transmitter with an antenna which allows the latter to communicate with the driver's phone. Videos are transmitted to the phone via a mobile application.
The product also has a G sensor whose aim is to protect the recording files of the camera. Indeed, it sends an order to the camera to lock and save all recordings when the car receives an important shock. It also protects data from being deleted when the memory card is full.

2. Advantages/Added Values:
This product provides a high-quality digital video that can be taken at night or in a low light environment. A wireless transmission, WIFI in this case, is an efficient way to transmit data between the phone and the application. Another advantage is the fact that the mobile application is compatible with Android and IOS. Finally, the saving system with the G sensor is a real added value which allows to detect collisions efficiently.

3. Disadvantages/Problems:
On the contrary to what the brand is saying, this system is really difficult to set up. To fix the camera of your car you have to unmount the license plate and for the power supply you have to unmount your taillights. Furthermore, it is not self-sufficient in energy because you have to plug the charger of the camera into the car's power port (OBD). Finally, a reverse light wiring has to be added manually to the dispositive for the night detection. Thus, we can say this project has a lot of interesting functionalities, but the system is really complex to install, especially for inexperienced users.

Figure 3: Rand McNally Wireless Backup Camera

3.2.3 Android Auto

Android Auto is an application that has been designed to be integrated into the car dashboard. To work, the user must have an Android device and a vehicle that implements the Android Auto system. By connecting his device to the vehicle via a USB cable or Bluetooth, the user can then find his apps on the dashboard.

This device can make visual and audible alert in case of danger. It's easy to use and the app is free on the playstore. It also integrates vocal commands through Google Now which can allow the user to keep looking at the road while using the device, which is a good way to promote safety. We can note that the system is only compatible with a select amount of modern cars.

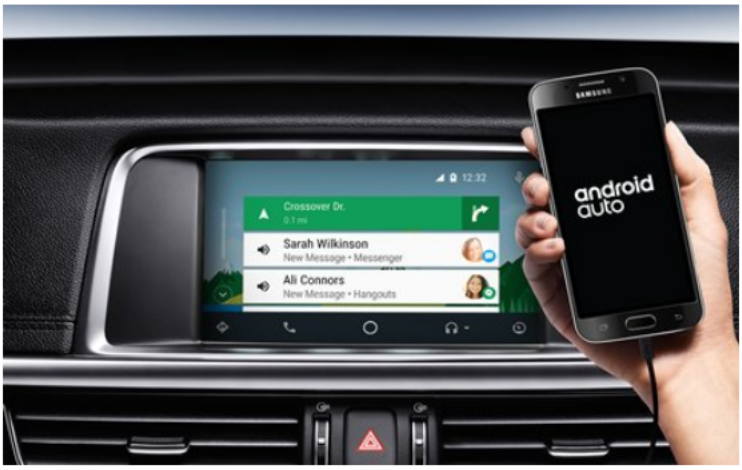


Figure 4: Android Auto

3.2.4 Driver mode application

Road safety application:
This application allows to block incoming calls and SMS notifications and sends automatically an unavailability message to inform the caller that the person is still driving.
This application allows to block incoming calls and SMS notifications and sends automatically an unavailability message to inform the emitter that the person is still driving.

Driver mode application:
"With Drivemode, you can manage calls, messages, music, directions, and more without taking your eyes of the road".
This application has a voice function that automatically reads the new messages to you and gives you a chance to reply. It also announces when you have a call.

Summary Table:

	Pearl Rear Vision	Rand McNally camera	Android Auto	Driver mode Application	Our Project
Proximity sensors	V	V			V
Camera	V	V			V
Wireless	V				V
Video back-up	V				V
Driver Mode				V	V
Alerts in case of danger	V		V	V	V
Automatic switch between the app and the camera					V

3.3 Valorisation strategy

While doing a project, it's not enough to have a well-built system if nobody knows about it. The goal of an engineer is to contribute to the society by resolving technical problems with his knowledge in various domains such as science, economy. To valorize the contribution of our system, we have decided to get a patent because we are working on a product different from what already exist. A patent is a title to intellectual property. In France it's delivered by the INPI, it gives the holder the exclusivity to make or sell his invention for 20 years after the day he made his demand. For this, it is essential to make a state of the art to be sure that the solution we're thinking of doesn't already exist.

With our research, we were able to find patents about the general theme of our projet, making cars smart :

3.3.1 A Method for saving of moving picture in a car blackbox

This patent was delivered on Mars 2013 in Korea, the applicant is the company Midong Electronic Telecom Co, LTD.
The system that was patented is formed by a camera and a blackbox. The camera is taking pictures and transmitting to the blackbox which will process the pictures to detect a moving car from behind and keep the focus by adjusting the setting or the angle of the camera without using other sensors. If there is an accident, the blackbox will save those pictures. It will help to understand the causes of the accident.

3.3.2 Rear Accident protection

On September 2017, the company TRW Automotive US LLC has succeeded in having a patent for its concept of a rear accident protection.
The concept patented includes a video camera in the back of the vehicle. By analyzing the video, if there's a potential impact actions will be taken to avoid the severity of the impact.
In this patent, the applicant took the example of an existing car from 2010, the Audi A8 which has a function called "Pre-Sense Rear". It uses a radar to sense the risk of a rear collision, then the system automatically reacts by tightening the seat belts, closing the windows, and adjusting the rear seats.
The difference with the Audi is the usage of a camera instead of radar. A microcomputer will process the

data from the camera and an interface is present to show informations about subsystems (window control, safety system...). There will be a visual or an audio warning if there is an imminent risk and actions will be taken to reduce the severity of the impact such as closing windows, flashing tail lights to grab the attention of the tailing vehicle's driver.

3.3.3 Impact system is prevented to vehicle based on video range finding

This patent was made in China on August 2017 by a society called Henan Huierxun intelligent Tech Co, LTD.
The system has two cameras, one on the front and another one on the back of the car. There are also two displays : one inside the vehicle for the driver that will display a message if the driver is too close of a car in front of him or if someone is too close to his vehicle ; the second one will be placed on the rear side of the vehicle, it will show alerts for the driver of the vehicle driving behind such as a warning sign of danger, explosion. This system can work on every vehicle but it will benefit more for trucks because it can alert the driver if there is an obstacle on his blind spots and those are more numerous on big vehicles. The main goal is to reduce accidents by providing instructions to the driver so that he can take measure and adopt a safer behavior.

3.3.4 Car Managing System Using Smart Phone

Here is an other patent from Korea, made by Netcombine Inc on November 2018.
The system allows to display and analyze in real time informations concerning the current state of the different car's components. It allows the driver to compare these data with the information of his driving. The smartphone receives data from a Bluetooth terminal and displays information about the functioning of the vehicle and the driving conditions.
The next step of our strategy is to find a technological feature that can be patented, to make a product that is unique. Then we will be able to write a technical memorandum before asking the INPI for a patent. If we succeed, it will be an indisputable argument that our project has a real added value and we will be able to foreclose the market, sell licences or maybe sell the patent.

	A method for saving of moving picture in car black box	**Rear accident protection**	**Impact system is prevented to vehicle based on video range finding**	**Car Managing System Using Smart Phone**	**Our Project**
Transmission of data from a camera to a black box	V				V
Warning sign of danger		V	V		V
Information about the functioning of the vehicule				V	V
Save pictures in case of accident	V				V

4 System requirements

4.1 System Lifecycle

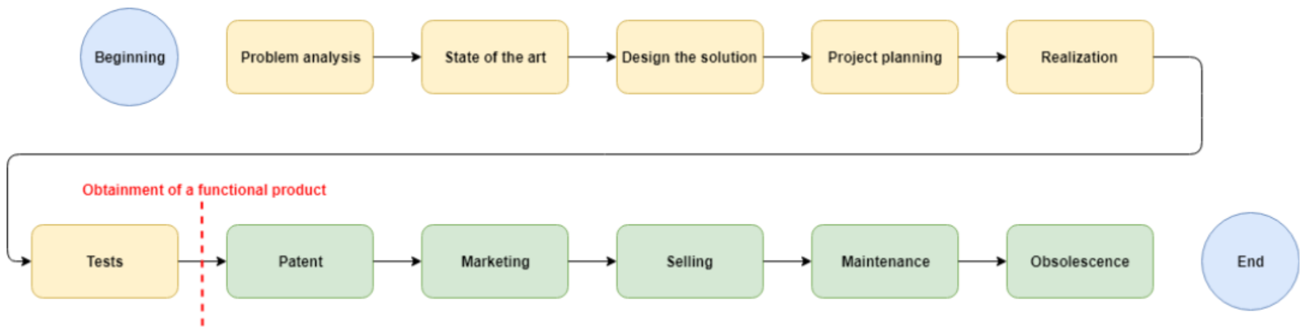


Figure 5: System Lifecycle of our product

A project can be defined as “a temporary endeavor with a beginning and an end and it must be used to create a unique product, service or result” (PMBOK). So we can say that the system is considered to exist when the group starts working on the project.

At the beginning, a product is just an idea and there are many phases before it becomes physical, something that we can interact with. It starts with the **problem analysis**, to make every group member understand the situation, what has to be solved. After that it’s important to do a **state of the art**, it’s studying existing products to be able to **design our own solution** which should be unique. The next step is to make a **planning** that must be followed to finish the system in time and see critical steps (phases where a delay will affect the entire project). Then there is the **realization** and **tests** of the prototype to obtain a functional product.

At the end of the 2nd semester, we might be able to patent our idea. If we decide to continue this project, we’ll have to keep developing our project until having a final product and do **marketing** to promote it to a targeted demographic, ordinary car drivers. Then there’s the phase of **selling** with the **maintenance** of the system to keep it viable till it becomes **obsolete**, when it’s overtaken by other products on the market. When the product arrives at the end of its life, we can do another project to develop another system that will replace the previous one.

4.2 System Environment

The system is formed by the app and sensors that the driver will place on his car. It’s environment will be influenced by users and external elements. Here, users will be the driver that will interact with the system by using the application. The external environment corresponds not only to other road users but also to other factors such as weather, temperature, etc. . .
The system must interact with its external environment in an optimized way according to the following requirements:

- External sensors must withstand all types of weather and extreme temperatures, for example in rainy conditions or when it is cold
- Sensors must be perfectly fixed on the car to prevent them from falling or being stolen.

- Collecting information can use a lot of energy, that's why sensors should have a good battery. We also thought as an optional feature to add solar panels that would allow to partially recharge the batteries.
- When the product becomes obsolete, a recycling system could be used to give a second life to those components or they can be recycled individually.

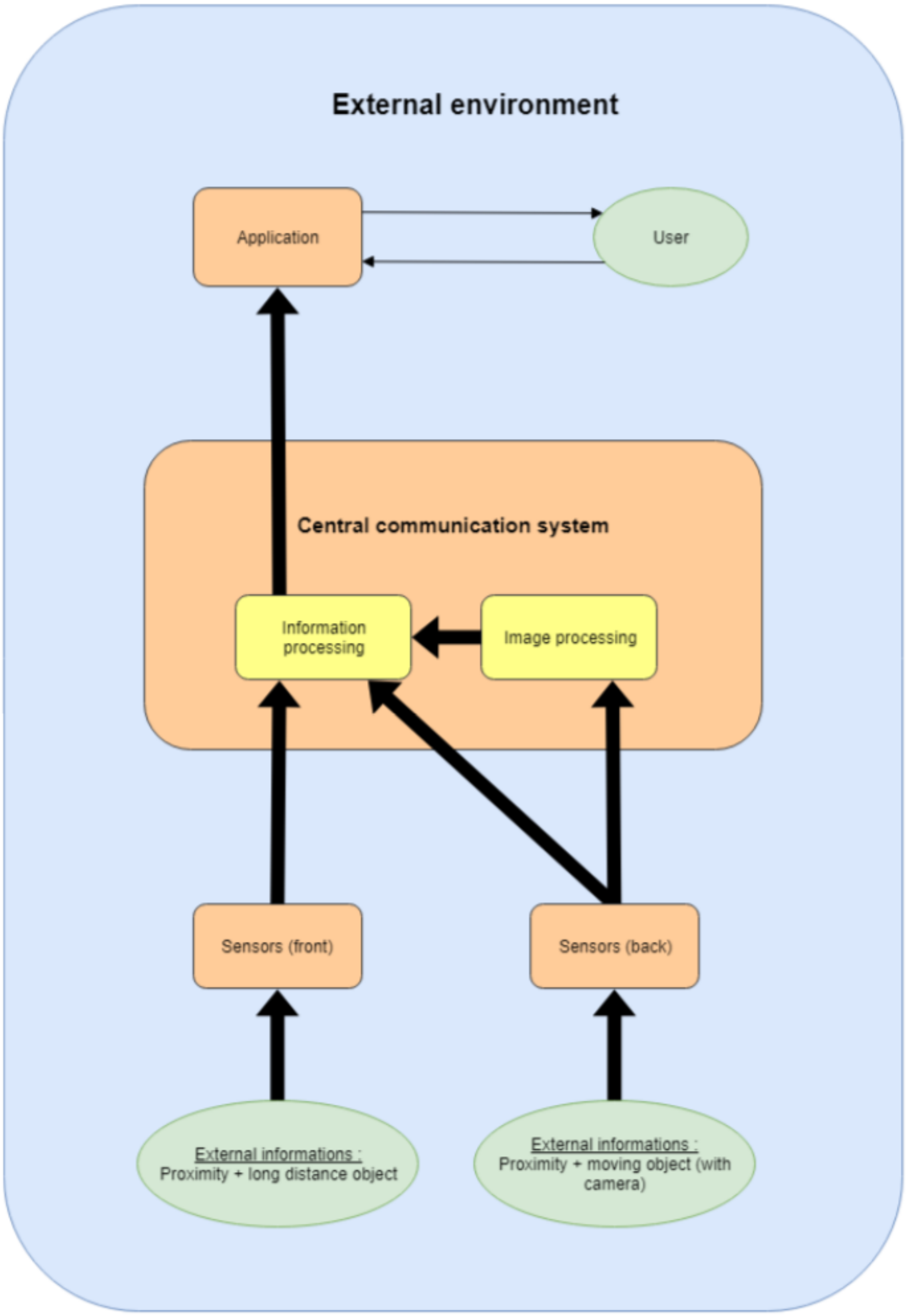


Figure 6: External environment of the project

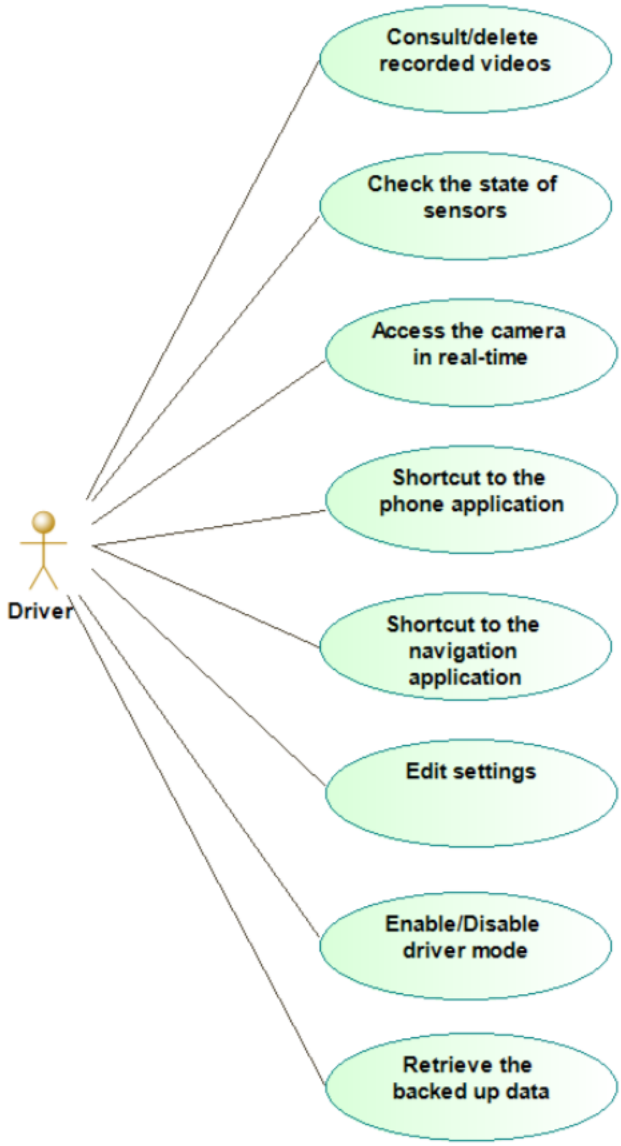


Figure 7: System environment of the project

4.3 System Functions

4.3.1 Function F1: Mobile application

Our system includes a complete application with a menu providing six different modules. This application acts as an interface between the user and the data transmission system.
Moreover, most of these modules display 2 navigation bars: a first one at the top contains the title of the application and a second one which will propose shortcuts to the other modules and a switch button to enable or disable "the driver mode" which is described in one of the subfunctions below.

1. Subfunction F1.1: Gallery

   This module launches a gallery where the user can watch all videos recorded by the camera. The most recent or important videos are sent to the application.

2. Subfunction F1.2: Sensors

   This menu will give information on the states of the components of the system. For example, if a sensor or the raspberry is malfunctioning or out of power, the user will receive a notification and will be invited to check this menu.

3. Subfunction F1.3: The Switch of the Camera

   The application will display information from the short distance sensors placed at the back of the car. As shown in the wireframe (part 4.4), we are thinking of displaying these information in the corner of the smartphone using colors to indicate if the obstacle is close or far. In addition, there will be an audible signal in case of imminent danger, the user can still disable this sound in the settings. Indeed, the camera will automatically be displayed if a danger is detected. This function is a real added-value on which we are going to focus on: besides, this function is the part of the system that we want to patent. You can see at the end of this part a diagram showing the overall operation of the application switch.

4. Subfunction F1.4: Map

   This module simply launches a navigation application like Google Maps or Waze. It will require the connexion of the smartphone to Internet (4G).

5. Subfunction F1.5: Phone

   This module simply launches the application Phone.

6. Subfunction F1.6: Settings

   This module provides some settings such as sound adjustments and maybe others proper to the application.

7. Subfunction F1.7: Driver mode

   When this functionality is enabled, the driver will only have access to some predefined applications : The Phone, the Map and our application with the automatic switch of the camera. If the driver This mode is already available in smart cars and it's seems important to us to provide a same level of security for the ordinary cars.

8. Subfunction F1.8: Voice Recognition

   An additional feature for the app could be the addition of a voice recognition system to launch different functionalities when the driver is saying some words such as "camera", "gallery"... With that, the driver doesn't have to touch his smartphone and can be fully concentrated on the road. It's a difficult part, not really indispensable for this project but it can be an added value for the safety of the driver.

9. Subfunction F1.9: Image Processing

   Another additional feature for the app is the creation of an image processing software to analyze the image stream of the camera and give an alert to the driver if a car is coming too close to the back of the vehicle. It's also a difficult part that we rank in the "Nice to Have" section.

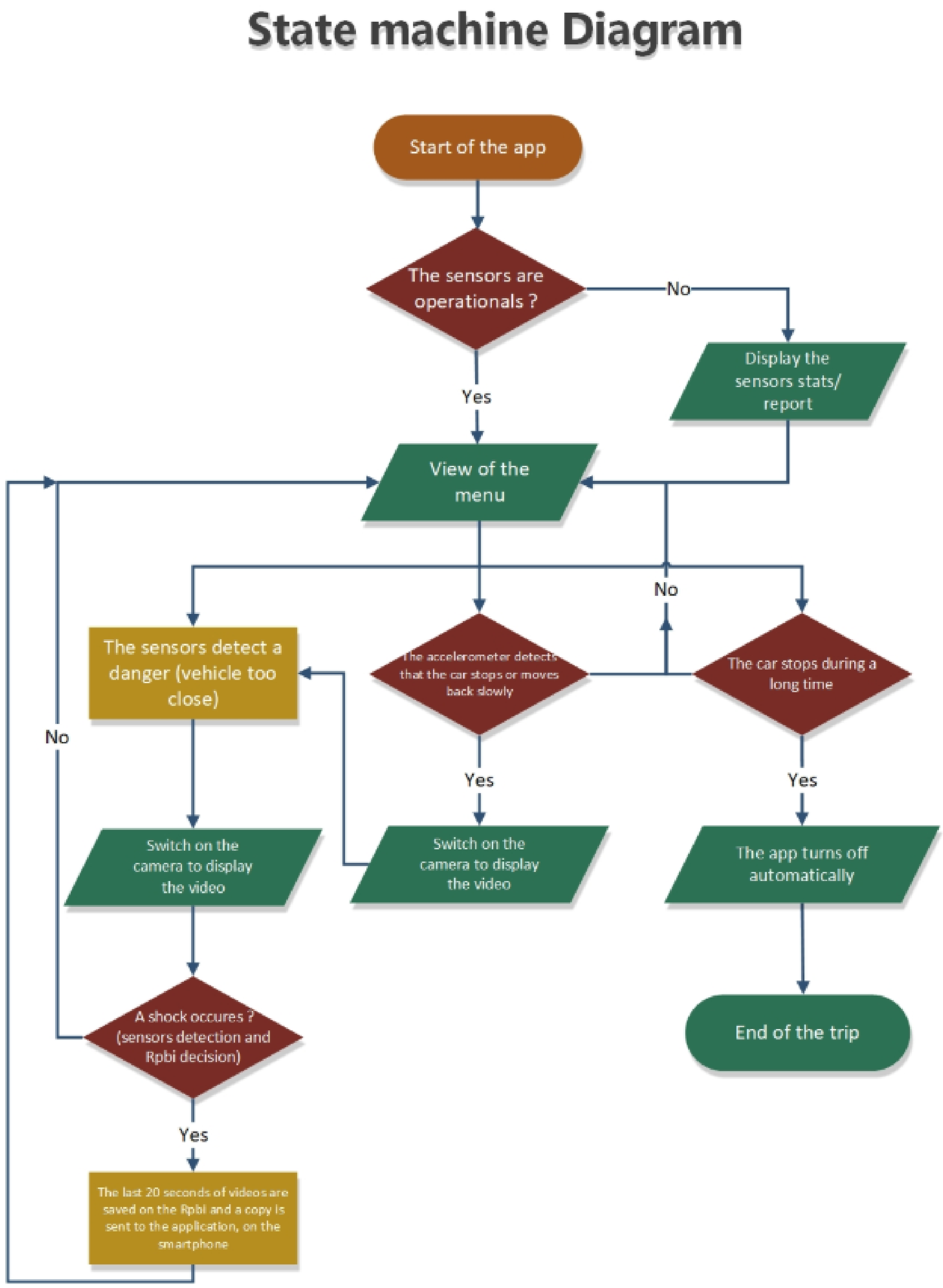


Figure 8: State machine diagram

4.3.2 Function F2: Short-range detection system

All the information of distance are provided by a set of sensors disposed in the front and the back of the car. This system is called short-distance detection system. Its role is to detect obstacles close from the car.

1. Subfunction F2.1: The two ultrasonic sensors To detect obstacles close from the car, we are going to use ultrasonic sensors. We will explain in details the functioning of these sensors in the technical part at the end of this report. Therefore, this part send distance information to the central computer to be analyzed.

2. Subfunction F2.2: The camera

   The system at the back will be completed by a camera to retrieve video data.

4.3.3 Function F3: Long-range detection system=

Moreover, we want to add a long-range detection system at the front of the car. It would allow the detection of distant obstacles and it could help the driver to anticipate a potential collision.

4.3.4 Function F4: Video storage function

This function allows to save the recorded videos on the nanocomputer, the latter will be used both to transmit videos from the sensors to the application and to save them. The most recent/important video will be sent from the raspberry to the phone, it will allow the user to have an easy access to it, for example after an accident.

4.3.5 Function F5: Solar panel as power supply

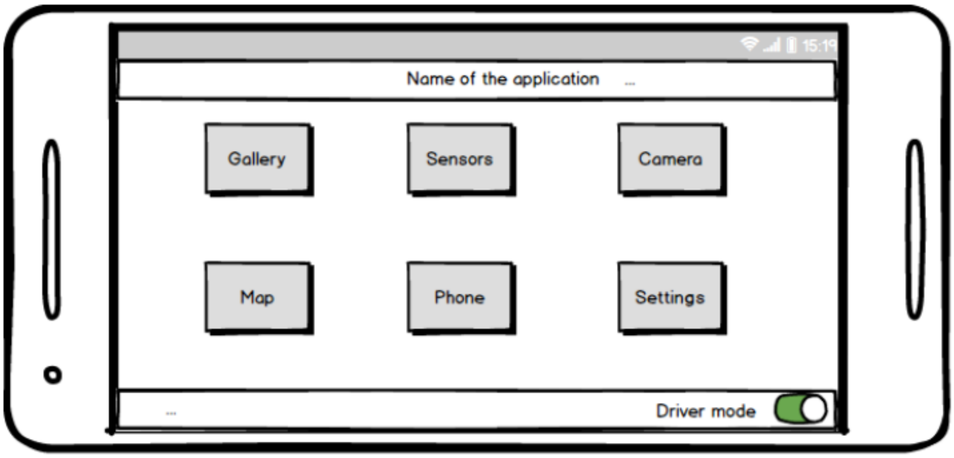
Finally, an additional function should be the use of a solar panel power supply to power the nanocomputers and the sensors. It could replace classic lithium batteries, that pollute a lot and need to be recharged frequently. With this function, the prototype could be more autonomous.

4.4 Wireframes

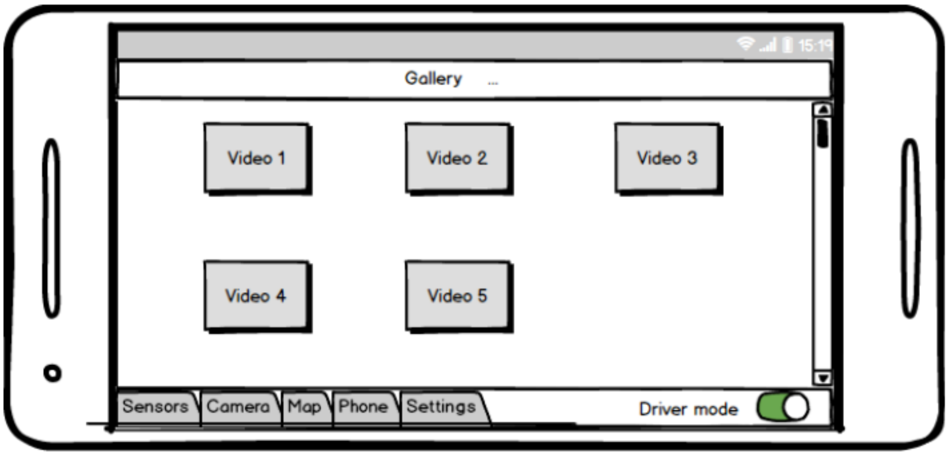
The main menu is used to access the different functions of the app :

- The video gallery
- The state of sensor
- The rear camera
- The rode map with Waze
- The phone
- The settings

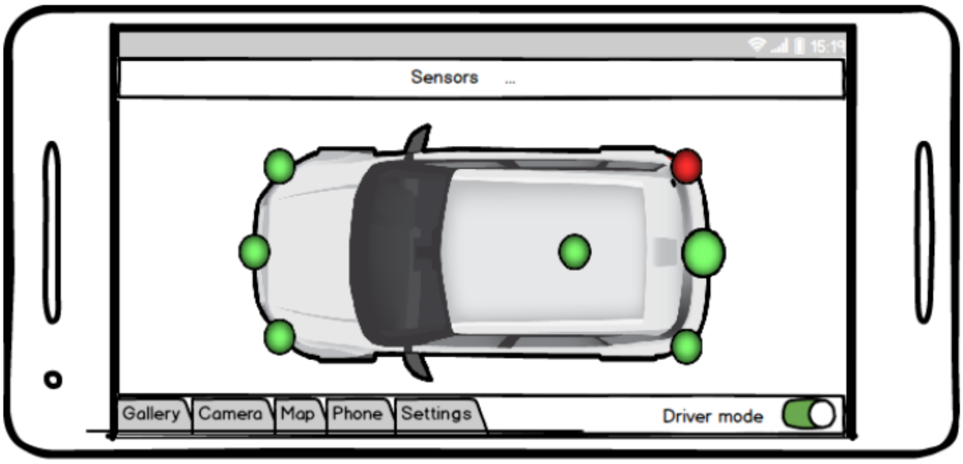
You can see the global structure of the application on the wireframes below:



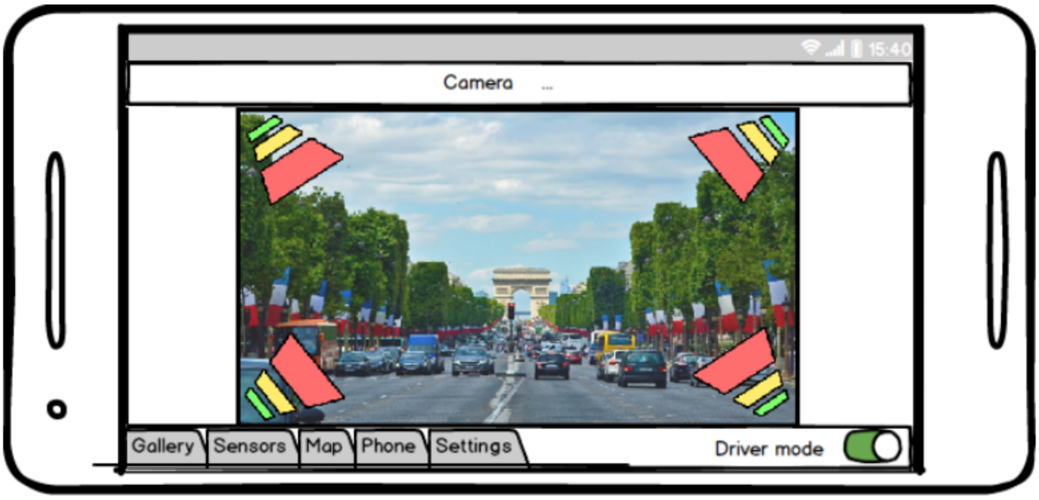
Main menu : displays the 6 main features of the application as well as the driver mode at the bottom right of the screen.



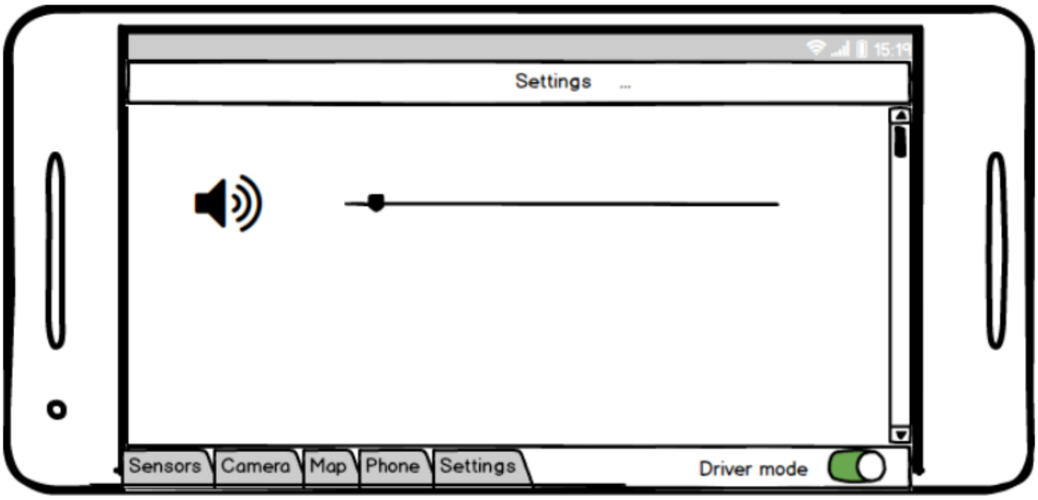
Gallery : the gallery allows to display the different videos recorded by the camera.



Sensors : this module allows you to consult the status of sensors. It warns the driver of a possible malfunction on one or several sensors.



Camera : this module allows you to display the recording of the camera in real time. At the 4 corners of the screen, you can see warning lights indicating the proximity of obstacles around the car.



Settings : this module displays the different parameters of the application such as sound.

Driver mode : a slider button at the bottom right of the screen, present to activate the driver mode. This button is in each module of the application.

4.5 System Constraints

Our first prototype will have some constraints.

4.5.1 Design constraints

In the design part, the user will have some obligations. First, he must install a frame at the back and the front of the car on which the components will be fixed. Those two frames have to be securely locked so that they will not fall while driving or get stolen. They also have to be discrete and small. Our system will be suitable for all cars and be easy to install with a base plate or magnets.

4.5.2 Organizational constraints

The production of the prototype will last three months, therefore our team has to work efficiently and quickly in order to have a final product that responds to the requirements and constraints developed in this document.
We have to think about how we will organize the project team, knowing that certains functionalities will

only be available to work after other tasks are completed. We will all work on the application until we receive the components and then split into a software and hardware team. We have allocated the last 3 weeks of the project to test the prototype and resolve different bugs or errors that may arise.

4.5.3 Logistical constraints

The costumer must own a functional smartphone running on Android OS, with a certain amount of free storage to keep a copy of a recorded video. Indeed, the nanocomputer that we will use is going to send the essential data to the smartphone.
One other problem could be the video storage. In fact, the camera will film continuously. It is necessary to have a sufficient storage space. Furthermore, the transmission of sensors data will have to be done quickly enough to avoid any latency.
Moreover, we are going to create a system that works in real time and that will monitor, respond and control the external environment. This system must be **reactive** according to the different informations given by sensors. Indeed, we will pay a special attention to the amount of data that will transit between the smartphone, the nanocomputer and the technology we will choose to transmit the data.

4.6 Acceptance criteria

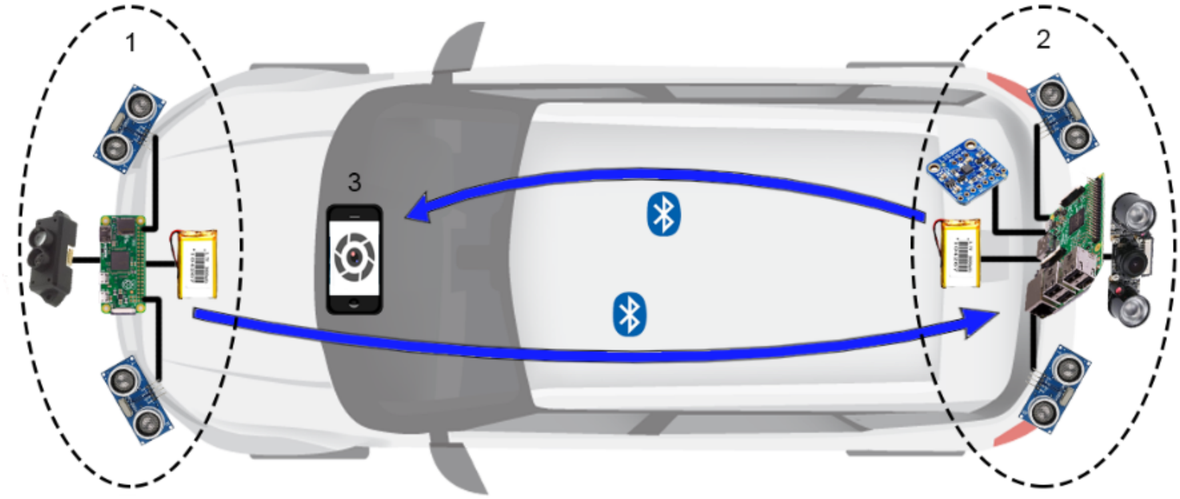
In order to complete our project, we have decided to divide it in different parts to organize the functionalities according to their importance. The first group of functionalities is forming the **Must Have part** (high priority) : it regroups all functions that are essential to have a complete project with an added value. Then, the second group : the **Should Have part** (medium priority) gathers the functionalities that can be interesting for the project and that can bring other added values to it. Therefore, those functionalities are not essential and will be implemented only if the Must Have parts are fully completed. Finally, the last part is the **Nice to Have** (low priority). These functionalities are not essential for the project and for the model we are going to create this year.

Here, you can find a summary of the different functionalities of the project and their order of priority, from 1 to 14:

Actor	Number	Requirement	Priority	Task Ranking
Software team	F 1	Android application with a menu that links the different functionalities in an ergonomic way.	Must Have	6
Software team	F 1.1	Mobile Application part: the Gallery displays the videos recorded by the camera.	Should Have	7
Software team	F 1.2	The sensor states display give information on the components of the device	Should Have	8
The whole team	F 1.3	The Switch of the Camera	Must Have	1
Software team	F 1.4	The possibility to launch the Map app	Should Have	9
Software team	F 1.5	The possibility to launch the Phone app	Should Have	10
Software team	F 1.6	Settings part for the volume for example	Should Have	11
Software team	F 1.7	The driver mode to reduce the number of application available.	Must Have	2
Software team	F 1.8	Voice recognition system to switch between the different if the app when the driver is saying some words.	Nice to Have	14
Software team	F 1.9	Creation of an image processing software to analyze the image stream of the camera and give an alert to the driver	Should Have	12
Hardware team	F 2.1 et 2.2	Retrieve the data from the ultrasonic sensor and the video stream from the camera.	Must Have	3
Hardware team	F 3	Long-range detection system. Retrieve the data from the Lidar.	Must Have	4
Software team	F 4	System that save the recorded videos on the nanocomputer.	Must Have	5
Hardware team	F 5	Solar panel use to power the sensors and raspberry.	Nice to Have	13

5 Technical specification

Functional schematic



Our system will have 3 parts:

- 1: 1 LIDAR + 2 ultrasonic sensors + 1 Raspberry Pi Zero W + Power Supply
- 2: 1 camera + 2 ultrasonic sensors + 1 Raspberry Pi 3 B+ + Power Supply
- 3: A mobile app

5.1 Wireless Connection

In parts 2 and 3, elements are connected to each other with wires.
The wireless connection between the different parts will be just as shown on the schematic above. The transmission between part 1 and part 2 will be done in **bluetooth** to recover the data from sensors. For parts 2 and 3, we will also use a bluetooth connection because if we link the phone to the Raspberry Pi using Wifi, then the phone won't be able to have an internet connection which is important in order to use a navigation map.

We thought about connecting the Raspberry Pi to internet and share the connection with the phone but it would involve to send internet data and a real time video at the same time which could create an additional transmission delay.
Furthermore, in the state of the art, we found that the Pearl RearVision project is using bluetooth to transmit a video from a camera to the phone. **The fact that a company has already used this method shows us that the Bluetooth solution is sustainable**.

5.2 The Ultrasonic sensors

In order to detect close obstacles, we are going to use ultrasonic sensors: two at the back of the car and maybe two in front. We have chosen the model **HC-SR04** because there are efficient and very simple to use. Moreover, there are small (45mm * 20mm * 15mm) and can be easily placed at the back of the car, wired to the Raspberry Pi Zero. These sensors will give us a precise distance of obstacles. Finally, they are precise enough and their power consumption is low.

Figure 9: Ultrasonic Sensor

5.3 The Camera

The main component of our project is the camera. We have chosen the Raspberry Pi Camera Fisheye of Unistorm. It supports 1080p, 720p and 480p. We will certainly use the 480p mode to avoid a huge latency during the bluetooth transfer of the video stream. Moreover, it has a wide angle mode (130 degrees) which will allow the driver to have a good visibility and a night mode to collect data in the dark. The camera will be wired to the Raspberry Pi 3 B+ placed at the back of the car.

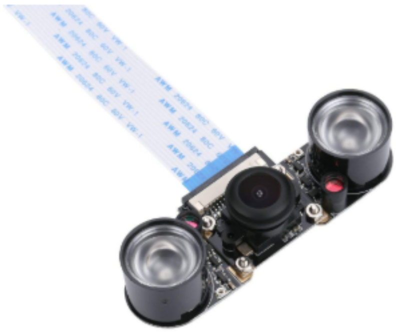


Figure 10: Camera

5.4 A Laser sensor : the LIDAR

A Lidar is a Laser sensor. We will place it in the front of the car. The goal is to detect **cars ahead**. If the radar detects that the distance between the front of the car and the obstacle has decreased significantly in a very short time, the application will warn the user of a collision risk.

To power this sensor, we need **5V** and a maximal current of **100 milliamps**. It will be supplied by the Raspberry Pi Zero directly connected with wires to the Lidar. We have chosen this model because it is relatively cheap for a high efficiency and a low power consumption (an average of **0,12W**).

We hesitated between the LIDAR Mini and another LIDAR. We found a LIDAR which can detect objects up to 40 meters and the Mini version up to 12 meters. For a first prototype, a LIDAR Mini is sufficient to prove that our concept is working.

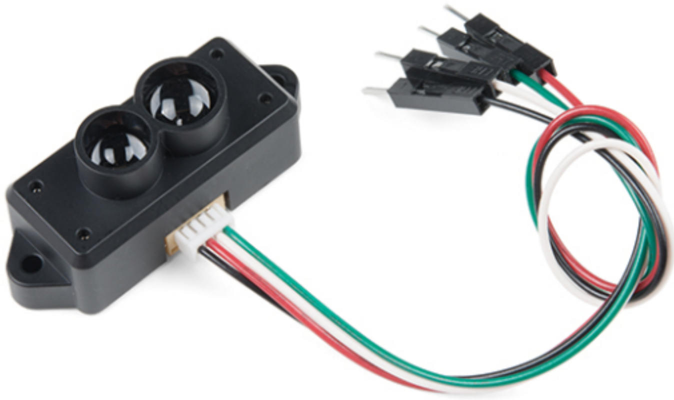


Figure 11: Lidar

5.5 Raspberry Pi Zero W

In order to recover the data from the sensors in the front of the car (ultrasonic sensors and lidar), we have decided to use a Raspberry Pi Zero. The sensors are connected directly with wires to this nanocomputer. Data will be stored on a micro SD card. Then, the data will be sent to the Raspberry Pi 3. We will use the **Bluetooth integrated module** of the Raspberry Pi Zero to send the data.

To power the Raspberry Pi Zero W, we have chosen to use a power module with a **Lithium bat-**

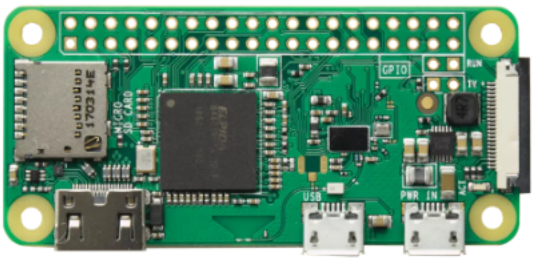


Figure 12: Raspberry Pi Zero

tery of 3800 milliamps. This small module is fixed on the Raspberry Pi Zero and supply **5V** and a maximum of **2 Amps** that will be enough for the sensors used in our project.

5.6 Raspberry Pi 3 B+

To collect the data, we need to use a Raspberry Pi 3. This Raspberry Pi will be the main nanocomputer of our project. It retrieves all the data (video stream and distance data) from the back of the car and also collects the data sent by bluetooth from the Raspberry Pi Zero and stores it in the storage memory (micro SD card). Then, the data will be analyzed to check if there's a danger and then send the resultant information to the mobile application via bluetooth.

To power this Raspberry Pi 3 B+, we have chosen to use the same power module and **Lithium battery** as for the Raspberry Pi Zero W.

Remark: To implement our system, we decided to use a Raspberry pi (zero and 3B+) instead of microcontrollers because Raspberry are powerful nano computers which already have integrated Bluetooth and Wifi modules (it is not the case of the microcontrollers Arduino Uno or Nano). In our opinion, it is the best solution to implement a communication between the different elements of our system and process data from the camera and the lidar.

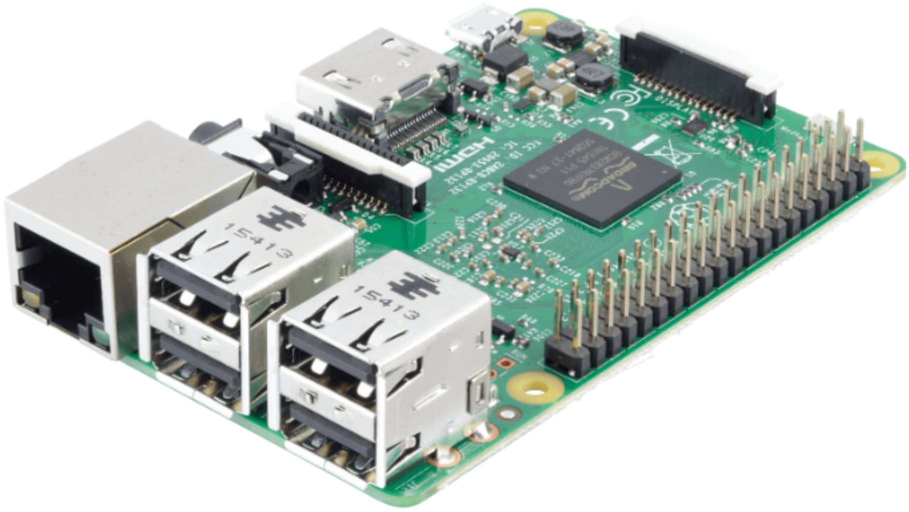


Figure 13: Raspberry Pi 3

5.7 Acceletometer

In order to trigger the video stream on the screen of the smartphone, we use an accelerometer. This device will be connected to the Raspberry Pi 3 B+ and give data about the acceleration of the vehicle. We have chosen a **digital accelerometer**, which means it generates a PWM output signal that can be analyzed by the Raspberry Pi 3 B+ to detect some situations (for example when the car moves backwards, . . .) and ask the smartphone to display the video stream on the screen.

Figure 14: Accelorometer

6 Project roadmap

6.1 Actors

This project is going to be realized by seven engineering students. Five of us come from ECE Paris and two are exchange students from Mexico. We will be helped and supervised by our mentor : **Mr Rafik Zitouni**, professor in ECE Paris and researcher in wireless networks and signal processing. As an embedded-system that communicate with the smartphone of the user, our project belongs to the cluster: “Communicating Systems” directed by **Mr Frank Bietrix**. In addition, we decided that the most valuable valorisation for our project is “Patent”. Our “patent” coach is **Mr Cornuéjols**, he will advise us during the “sprint week” and help us to define precisely the patentable system. Finally, we are going to order some components to realize the prototype and will need to interact with **Mr Daniel Buruian** from the Fablab.

Here, is a sum up of the contact details for each actors (for the team : see next paragraph):

Last Name	First Name	Position	Phone Number	Mail
ZITOUNI	Rafik	Mentor	01 44 39 10 39	rafik.zitouni@ece.fr
BIETRIX	Frank	Cluster Director		bietrix@ece.fr
CORNUEJOLS	Georges	Valorization Coach	06 22 13 14 33	georges.cornuejols@cassiopi.com
BURIAN	Daniel	Component Supplier		daniel.buruian@ece.fr

The team is really interested in embedded systems and in the automobile field. Moreover, some of us aspired to plan a career in automobile companies or their suppliers. This project is an interesting way to learn about the different embedded-systems currently available in cars and to meet professionals of this industry. Indeed, we have chosen this subject because we think we can improve our hard skills such as in computer science, electronic but also soft skills thanks to the pitches, the valorisation and team work. We are expecting to provide a complete prototype with a real added value : the automatic switch between the application and the camera in case of danger or accident. We are convinced that our product can be useful for many drivers and can improve security on the road and save lives.

The mentor and the cluster director will seek a rigorous work from the team: this involves frequent meetings and the realisation of a consistent prototype with the Project Requirements Specification (CDC) which must meet the client’s expectations. Finally, Mr Cornuéjols will help us to follow the right steps to obtain a patentable system.

6.2 Team

Seven engineering students are involved in this project. We both are in fourth year in ECE Paris, except two exchange students from Mexico.

The Team Leader is **Alexandre Tavernier**, student in “Information System”. He will be the intermediary between the group of student and the mentor or the “patent” coach. He will check the involvement of each member of the team, be sure that the group will respect the different deadlines as the agile method (Scrumaster).

Matthieu Colin de Verdière is a student in the major "Information Systems". He will work on the realization of the electronic system composed with the different sensors and on the programming of the Raspberry pi for the wireless communication between the different components of the system.

Nicolas Baralle and **Léo Remurier** are two students from the major Embedded Systems. They are going to manage the Hardware part of the project, working on the different sensor, the communication between them and the nanocomputers. Then, we will join the software team to help the improvement of the app.

Karl Léveillé is a student is the major Health & Technologies. He will work on the application because he already has experience on developing android apps.

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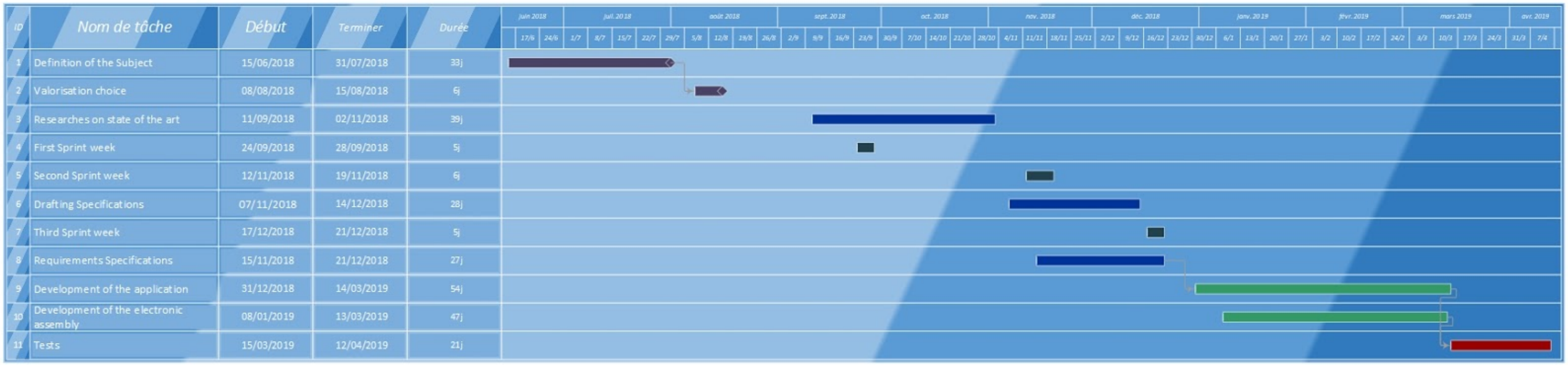
Matthieu Colin de Verdière	Léo Remurier
matthieu.colin-de-verdiere@edu.ece.fr	leo.remurier@edu.ece.fr
06 95 26 37 16	06 67 05 05 53
	

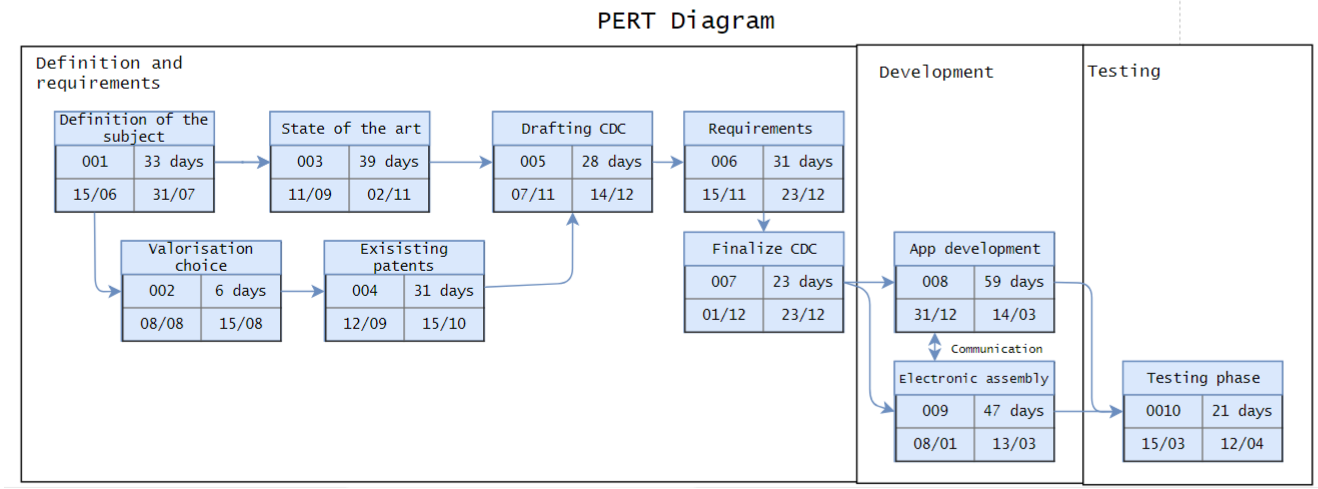
The team will split into two groups: a first subgroup will handle the creation of the application to display the video and all other important information in an ergonomic way. The second will deal with the sensors (camera, ultrasound and lidar) and the nanocomputer (Raspberry Pi 3 and Pi 0). There must be a regular and clear communication between the two groups in order to make the different components work efficiently together and minimize bugs and errors.

Role	**Responsibilities**	**Team members**
Project Manager	Task planning and allocation, progress monitoring and reporting, primary interface with mentor and partner.	Alexandre Tavernier
Application developer	Java coding and unit-testing.	Karl Léveillé, Alexandre Tavernier
Electronic (Sensor and Raspberry Pi part)	Sensor power supply. Communication between the Raspberry and the app. Collection and analysis of the data by the Raspberry.	Léo Remurier, Nicolas Baralle, Matthieu Colin de Verdière

6.3 Milestones

Milestones of the project





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