Self-Driving car using Stereo Vision

I. Team:

Team Leader Name

Mahmoud Ahmed

Team Leader Email

mahmoud1611910@miuegypt.edu.eg

2nd Team Member Name

Sarah Fouad

2nd Team Member Email

Sara1603573@miuegypt.edu.eg

3rd Team Member Name

Nada Ashraf

3rd Team Member Email

nada1607602@miuegypt.edu.eg

4th Team Member Name

Omar Ismail

4th Team Member Email

omar1609905@miuegypt.edu.eg

Faculty Advisor Name:

- Ayman Nabil

Faculty Advisor Email:

- Ayman.nabil@miuegypt.edu.eg

Faculty Advisor University Job Title:

- Assistant Professor

How many male team members?

- 2

How many female team members?

- 2

University:

- Misr International University

Country of Residence:

- Egypt

II. Project:

Project Title:

- Self-driving car using stereo vision.

Which sector does your project tackle?

- Well-Being

Which Technology area are you using to tackle the addressed problem?

- Internet of Things (IOT)
- Artificial intelligence (AI)

1-What is the main problem that you are solving?

Self-driving cars are on their way of being legally used on the streets, however the self-driving car engineers are doing the best effort to reach the highest safety of the self-driving cars as it's a risky development. This is what we are trying to reach, we are focusing on reaching more safety in the self-driving cars development using new different algorithms and mechanisms including Stereo-Vision depth calculation and accurate anomalies detection algorithm that helps the self-driving car to take different normal decisions more safely. Also we are developing a mobile application that receives the live updates of the actions that the car will do right before it happens to notify the driver in the car.

2-What is the importance of this problem?

Self-driving technology in general is becoming increasingly common and could transform our transportation system, also self-driving cars are on their way of being legal in more countries. Therefore, safety in these self-driving cars is highly needed to avoid any kind of accidents that could occur and cause some serious damages like the famous accident of the Waymo car that occurred in 2018 where the driver took the manual control of the car suddenly in the self-driving mode and caused in the death of the driver.

3-What are the current solutions?

Lately there have been many solutions to increase the safety as:
Some people tend to use Convolutional Neural Network and test on their own road images then the car drive itself on small road lanes around oval-shaped and 8-shaped, but there is camera latency that takes a long time to recognize the scene and much time for the computer to read the data so this slow down the decision making process.
Another solution is Create automated vehicle whose destination is dynamic so the target vehicle which have a GPS, Arduino, etc. in it will be followed by another vehicle and the followed vehicle is familiar with the first vehicle destination by continuously receiving its location and gets the route and move in this path. But the drawback is that this solution is wasting of hardware resources.

4-How will your solution solve the problem? What is new?

Our solution is a self-driving car using stereovision disparity map to detect obstacles on road and measure the distance between our car and other obstacles, road lane detection algorithm using stereovision cameras & road anomalies detection algorithm. Also we develop an android mobile application that will help us achieve more safety for the car driver as it will send the updates of the car action right before it happens to the driver on the mobile phone.
We are using stereovision disparity map algorithm to measure the distance between our car and other obstacles or cars as it's definitely more accurate than other algorithms of detecting obstacles and as it will help the car detect the obstacles earlier and take more accurate decisions. Also we are using accurate road lane detection algorithms and anomalies detection algorithms to help the car take more accurate decisions based on road conditions.

5-What is the expected impact of your solution from varies perspectives (social, commercial, environmental, etc.)?

- Technologically, people will not need for the driver anymore, they will just interact with a smart system in an easy way and they can do any other activity while the car drive them, also they won't be stressed from driving and traffic jam so by this way people can be more productive.
- Environmentally, Autonomies cars are eco-friendly as it saves fuel so the driver will pay less, and there will be fewer accident so people may save the money that spends on repairing also the self-driving car have lesser negative impact on the environment.
- Medically, it will not help in the medical field for sure but this product can be useful for the disabled people who can't drive for themselves, so by this system they can easily go anywhere without need to order uber or any taxi.

6-Give a high level functional description of your solution. How will it be used?

The proposed system contains a variety of sensors to perceive the surroundings areas, lanes and objects to be able to identify appropriate navigation paths that allows the vehicle to drive by itself and make the right decision including turning left, right, backward, forward and slowing down when detecting road anomalies. The system is responsible for collecting the data and calculate the depth map between the vehicle and the other vehicles surrounded. Then according to the collected data of the road anomalies the system is responsible for deciding the action to be applied, the path to be taken and highlight the road anomalies detected and saves its location then upload it to Cloud server. The system is able to alert the driver while driving (manually) with any anomalies that are not seen and alert to slow down the vehicle if a high speed or an abnormal behavior was detected.

7- Give a high level technical description of your solution: architecture, technology, integration, innovative components, etc.

The proposed system software integrates with the vehicle's inner system and a mobile application to keep the driver alerted in case of manually driving.

□ Hardware: Stereo-Vision Cameras (dual cameras), Ultra-Sonic Sensor, Accelerometer, GPS, Gyroscope, Raspberry-Pi 3, motor
and a buzzer.
□ Software: Support Vector Machine algorithm, CNN, Cloud server.
□ Programming Languages: Python, Android and Laravel.

The system consists of three main stages Processing, Pre-processing and Output. The first stage consists of Stereo-Vision Cameras, Ultra-Sonic Sensor and the Cloud. In this stage the Stereo-Vision and Ultra-Sonic are responsible for capturing, detecting and collecting the data set (speed pumps, potholes, etc..) and save its location then upload it on the Cloud. The Stereo-Vision Cameras (dual cameras) also used to help the car to know the depth map between the vehicles in front of it. The second stage consists of Accelerometer, GPS and Gyroscope. The Accelerometer is responsible for measuring the acceleration of the car while driving which will help us when alerting the driver to slow down his speed. The Gyroscope is responsible for measuring or maintaining orientation and angular velocity (x, y, z) which will help us when collecting data about the road anomalies. The GPS is used to highlight the road anomaly detected

and save its location to alert the vehicles that will pass on this location later. Finally, the last stage is the output which contains the motor and a buzzer. The whole system is controlled by A Raspberry-Pi 3 which runs by Support Vector Machine algorithm that classify the readings of the road conditions from the sensors and a CNN algorithm that is also used to classify the images of the road lanes.

8- Give a high level description of your solution development environment, platform, tools, etc.

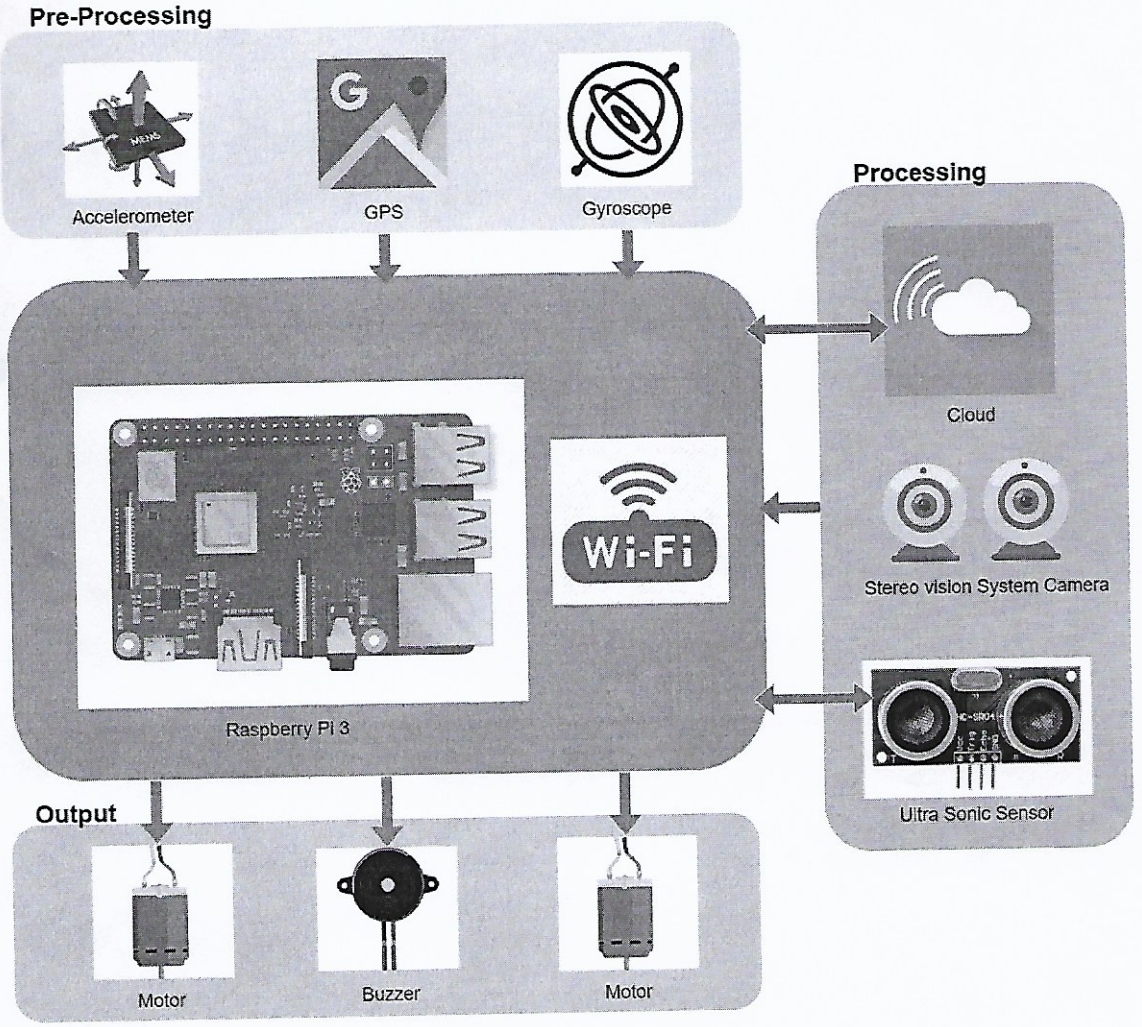
- The whole development and implementation of the proposed system including the process of retrieving our data and testing our classification algorithms is being done in an ordinary lab environment, which will be our own designed track that will suit the car.
- Our proposed system will be designed and implemented for only mobile applications as we are focusing on notifying the driver through the system's mobile application.
- The hardware tools in this project includes:
    - Stereo Vision camera: Dual cameras for disparity map measurement.
    - Ultra Sonic sensor: To help in calculating distance.
    - MPU-6050 sensor: To read the data of the accelerometer and Gyroscope.
    - GPS module: To store anomalies location.
    - Raspberry Pi: Where the whole system implantation takes place.
    - DC motors: To move and control the 2WD car.

9-How will you manage your product development cycle, your quality assurance process, your solution deployment logistics, etc.?

- Quality assurance which is to develop the functional requirements and especially the nonfunctional requirements and following the Engineering standards.
- All the product we use are friendly and sufficient to fulfill all the driver's requirements to be relaxed and safe.
- we plan on make our own road and test it with differ obstacles, obstacles sizes, speed, modes (night/morning) and in many different environments to cover all the impossible cases that can occur while driving.
- Quality control is one of the most important part in our process as we will test/validate each test case scenario according to the test design techniques and test each process individually as it is related to people lives not just an easy thing to make any small mistake in the prediction or in anything. Things could not possibly go wrong as we have to keep people in the car safe.

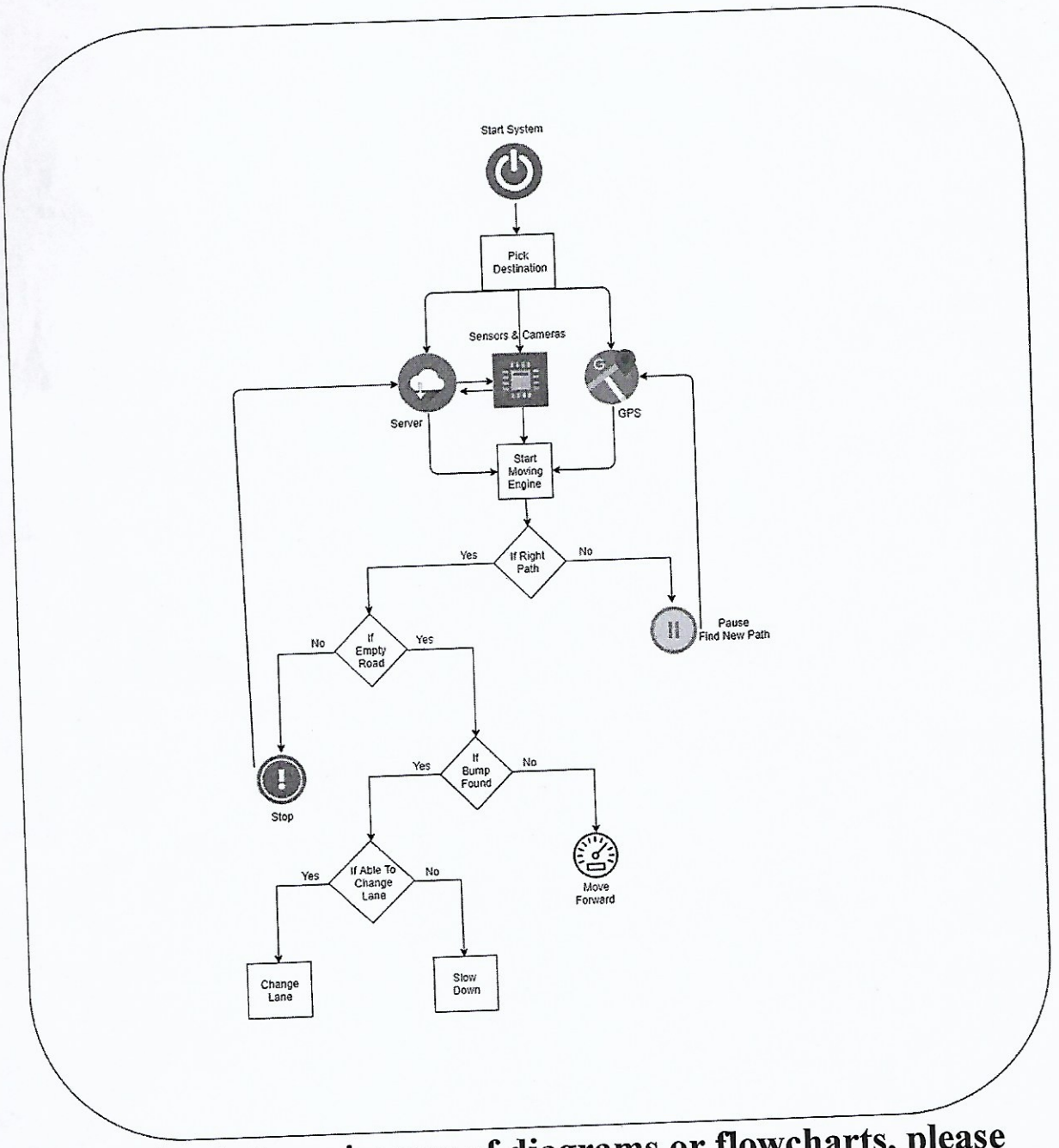
Kindly upload images of diagrams or flowcharts which explain better your idea.

A) System Overview



B) State Diagram

Misr International University
MIU
جامعة مصر الدولية



10-If you uploaded any images of diagrams or flowcharts, please provide a description for each image.

The images we have uploaded have two diagrams. System overview diagram and state diagram that shows how the car will act in different situations.

- **System Overview**: Our system passes through three phases: Preprocessing, Processing & Output phase.

Preprocessing phase:

The first phase of the system where we:

- Get sensor readings from our sensors (Accelerometer, Gyroscope, GPS & ultrasonic)
- Filter the readings from each sensor to remove and avoid any kind of noises.
- Getting video frames from the stereo vision cameras.

Qatar International University

Processing Phase:

The second phase after the preprocessing phase where we:

- Use Support Vector Machine algorithm to classify sensors readings.
- Use CNN to classify images from stereovision cameras.
- Store anomalies locations in a cloud server.
- Use stereo vision disparity map algorithm.

Output Phase:

The final phase of the system where car:

- Alerts the driver of the anomaly detection through a buzzer.
- Slows down or changes lane before passing through previously detected anomaly.
- Avoids crashing with any car or obstacle by slowing down, changing lane or stops using stereo vision disparity map.

- **State Diagram**: In this diagram we are showing the states of our car from the start of the system.
  - First the user will start the self-driving mode and choose destination to launch the system so the car moves if the path to location is available.
  - The car will start moving and keeps on checking if the road was clear of obstacles, cars & road anomalies or not.
    - If road is empty and clear ⟶ the car keeps moving on the same road lane and keeps on checking for changes or close anomalies.
    - Else if road is not empty of cars, obstacles and potholes ⟶ the car either slows down or changes lane if the other lane is empty.
  - The car also will keep on checking if there is a road bump detected on the road so it slows down when it's getting closer to it.

Faculty Advisor Signature:

Give the most relevant plans that you have developed for your project (for example, time schedule, resource plan, training plan, risk management, contingency plan, etc.)

Time Schedule:

- 15/9/2019 - 30/9/2019: Information Gathering about the project and all the similar systems in this field.
- 1/10/2019 - 12/10/2019 Collecting our own Data Set
- 13/10/2019 - 10/11/2019 Designing and implementing Prototype
- 11/11/2019 – 30/11/2019 Filtering sensors readings
- 1/12/2019 – 20/12/2019 Enhancing captured images
- 20/12/2019 – 6/1/2019 Not available due to Final Exams
- 7/1/2020 – 20/2/2020 Training and testing our dataset on the machine learning algorithms
- 7/1/2020 – 20/2/2020 Designing the car track
- 21/2/2020 – 21/4/2020 Implementing the rest of the features
- 22/4/2020 – 15/5/2020 Implementing the mobile application
- 15/5/2020 – 30/5/2020 Re-test for the whole system

Resource Plan:

In order to implement and complete the system, we will be needing lots of resources. These resources include:

Sensors:

- Gyroscope
- Accelerometer
- GPS
- Ultrasonic

Cameras:

- Stereo vision camera

Hardware components:

- Raspberry pi
- Arduino UNO
- Wires, batteries and DC motors
- 2WD car