Autonomous Device for Obstacle Detection

By

170423: Ahtsham Alam

171456: Syed Ahmed Abdullah

Supervised By

Hafiz Dr. Ahmad Jalal

FYP – II (Report)

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FYP – II (Report) Mark Form

Scheme – 1: Software Project

To Be Filled By Students		
	Student 01	**Student 02**
Registration No	170423	171456
Student Names	Ahtsham Alam	Syed Ahmed Abdullah
Project Title	Autonomous device for obstacle detection	
Supervisor	Hafiz Dr. Ahmed Jalal	

To Be Filled By Examiners			
	Max	**Student 01**	**Student 02**
Project Poster			
Design	**10**		
Content	**5**		
Project Management (Attendance)	**10**		
Presentation			
Layout and Design	**5**		
Delivery and Appearance	**5**		
Content and Impact	**5**		
FYP – II Report			
Analysis of Problem	**10**		
Use Cases	**10**		
Requirement Analysis	**10**		
Design of Solution	**10**		
Implementation of Solution	**10**		
Business Model	**10**		
Total	**100**		

Feedback:

Supervisor	Session Chair	Moderator

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1. Introduction

This is the Smart city project that will be based on Artificial Intelligence, Image Processing and some touch of Hardware (Robotics). We make autonomous device that moving and taking decision on its own intelligence. The things done so far is that the device can detect the obstacle and take decision and move to the side where distance is greater than the provided max distance.

1.1. Goals and Objectives

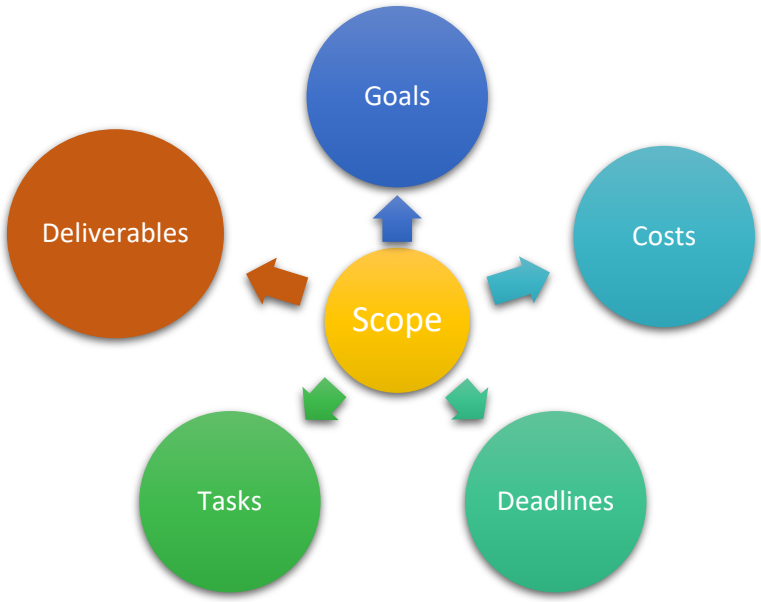
Our fundamental goal is to facilitate the people so for this purpose our project objectives is to make a device autonomous and this autonomous device has an ability to taking decisions on its own and also an ability to detect the obstacles on its way. By making the device autonomous is itself a big achievement but if we can detect obstacles and recognize the obstacle as well then imagine how many goals, we can achieve through this like real world settings in different fields such as military, medical field, space exploration and everyday housekeeping etc.

Our main objectives are following:

Beneficial thing for the people: Less human responsibilities, Machine Vision, so that there are less chances of human errors.
Autonomous Device: Device moving and turning by taking decision on its own intelligence.
Obstacle Detection: Detection of the obstacles is possible while device moving or static.
Obstacle Recognition: Able to recognize specific type of obstacles.
Voice based Movement: Device able to move on the basis of voice.

1.2. Scope

Basically, the scope of the Autonomous device for obstacle detection is to make a device autonomous and this autonomous device has an ability to taking decisions on its own and also an ability to detect the obstacles on its way. Furthermore, the device is able to control through voice and also able to recognize the obstacles. For voice it using the Voice module, Bluetooth and for objects recognition it's using Camera and Data set to learn. Things that we done so far to achieve that scope are given below. we are defining our goals, task, deadlines, cost on the basis of the things we have achieved.



1.2.1 Goals:

- **Make device Autonomous.** No human interaction the device can move autonomously.
- **Detecting the Object.** Device itself detecting the obstacle.
- **Taking Decision** Device itself taking the decision and control itself.

1.2.2 Tasks:

- Study related Projects
- Buy Equipment's
- Learning Arduino IDE
- Learning other sensors and motor module connectivity.
- Discuss with supervisor
- Designing stage
- Developing stage
- Make device autonomous
- Device detecting obstacles
- Device taking decision.

1.2.3 Deadlines:

Task	Deadlines
Study Related Projects	15th august to 30th august
Buy Equipment's	1st September to 10th September
Learning Arduino IDE	11th September to 28th September
Learning other sensors and motor module Connectivity	1st October to 10th October
Discussion with supervisor	After every 15 days.
Designing stage	11th October to 30th October
Developing Stage	1st November to 14th November
Make device Autonomous	17th November to 20th November
Device Detecting Obstacles	14th November to 30th November
Device Taking Decision	1st December to 10th December

1.2.4 Cost:

Cost structure may include the following:

- Components cost
- Travelling Cost
- Manufacturing Cost
- Maintenance Cost

1.2.5 Deliverables:

Deliverable may include:

- Device with All Objectives and features
- Backend source code of Arduino
- Mobile Application (optional)

1.3. Major Constraints

There are some major constraints for proper execution of our project.

No abnormal Path:

There no chance for the device to complete working on the path like sandy, slippery.

Descent Weather:

Not working in the rain as well as in a stormy weather. Basically, device requires normal weather like sunny or cloudy because their equipment's may affect.

Budget:

Budget is one of the major constraints that lemmatize our Project objectives because the more you have the budget the more you buy the more powerful equipment's that can help to achieve more objectives.

Battery and components compatibility:

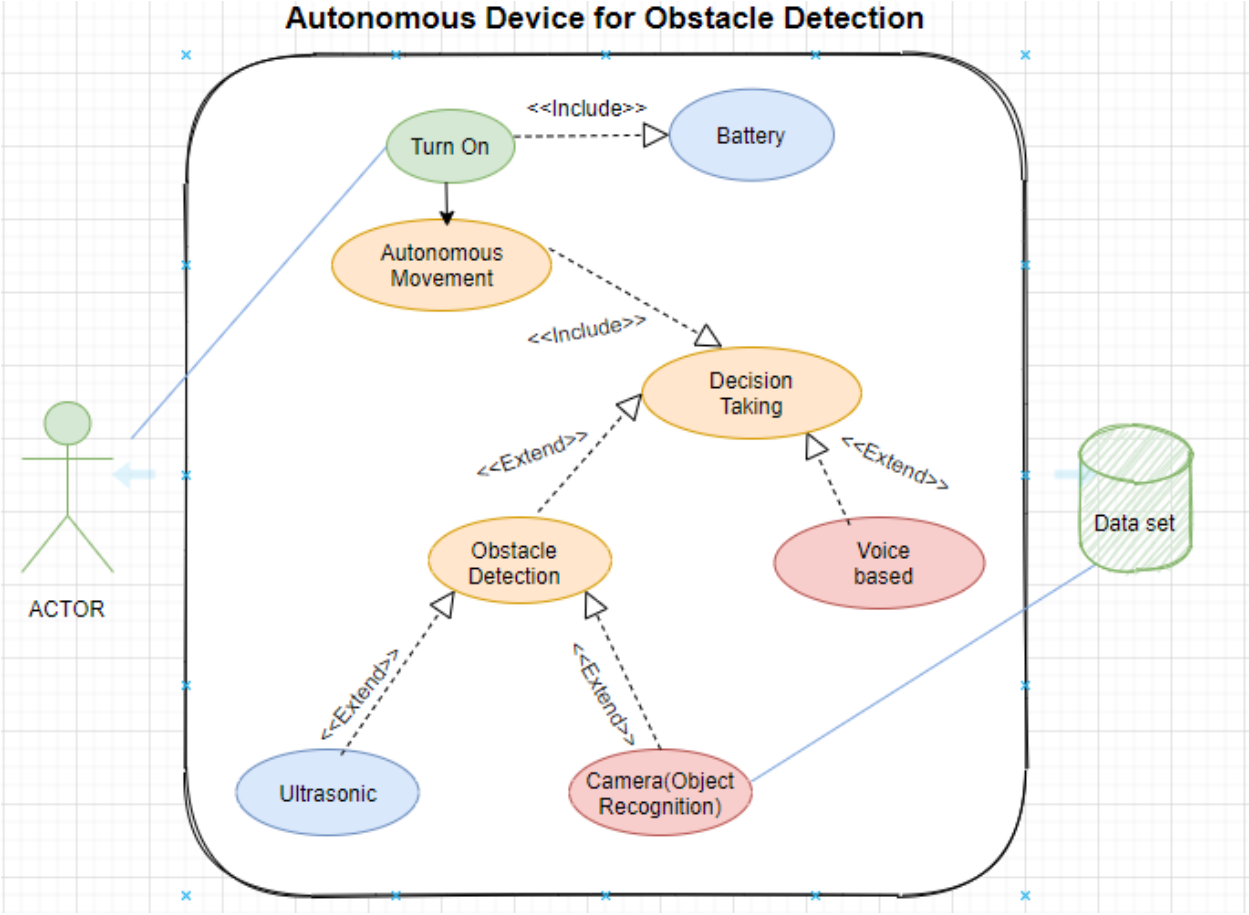
In the field like robotics components compatibility is one of the major constraints because if you connect wrong input and output to the component's then they going to be dead and you have to buy the new ones ☺.

2 Background

Previously there are many autonomous devices build for obstacle detection purpose (Ms. D.D Jadhav 2016), (Kolapo Sulaimon Alli 2018) and (Pandit 2020) But the problem is that their behavior is not rational and the accuracy is not much efficient because it maximizes the computational time. That's why device stuck in the loop sometimes and not take the required decision on time that can affect the working. So, what we are doing is to make the computational time as less as we can by following the rational behavior so that the accuracy and decision on time performance increases. Furthermore, our device is able to control through voice and able to recognize the obstacles.

3 Use Cases(s)

3.1. Use Case Diagram



3.2. Use Case Description

[Create a use case description for all use cases using following template.]

Use Case ID:	UC-01
Use Case Name:	Autonomous movement
Actors:	Device
Description:	Device can move autonomously
Trigger:	Device can move when receiving voltage from the motor.

Preconditions:	There must be proper wiring, battery connectivity, Arduino and motor module must present.
Post conditions:	Sensor must be connected for obstacle detection
Normal Flow:	Arduino give signal to motor module that can move tire automatically.
Alternative Flows:	Nothing
Exceptions:	Battery low, decision problem
Includes:	Decision use case
Assumptions:	Nothing
Notes and Issues:	Wire connectivity issues

Use Case ID:	UC-02
Use Case Name:	Turn On
Actors:	Human/ User
Description:	To on the device
Trigger:	When user change direction of button
Preconditions:	Proper connectivity of button with the device battery Vcc.
Post conditions:	-
Normal Flow:	Turn On the button and then current flows in the device then device movement occurs
Alternative Flows:	Nothing
Exceptions:	Device not move
Includes:	Battery
Assumptions:	Nothing
Notes and Issues:	Button is not working

Use Case ID:	UC-03
Use Case Name:	Decision Taking
Actors:	Device
Description:	Machine can understand the environment

Trigger:	When device starts.
Preconditions:	There must be proper connections of sensors and other components.
Post conditions:	Obstacle availability and Object recognition connectivity.
Normal Flow:	Take reading from the environment then give information to the motor module to move the tire.
Alternative Flows:	Voice based Decision
Exceptions:	Logical issues occur
Includes:	Arduino, and other sensing components.
Assumptions:	
Notes and Issues:	Arduino and motor module sometimes dead.

Use Case ID:	UC-04
Use Case Name:	Obstacle Detection
Actors:	Sensors
Description:	Detect Obstacle so that it Avoid obstacle from hitting with the device.
Trigger:	Whenever obstacle reach specific distance to the device
Preconditions:	There must be proper configuration of sensor with the device.
Post conditions:	Obstacle availability and Recognition configuration.
Normal Flow:	When sensor reach the specific distance to obstacle then it can detect
Alternative Flows:	
Exceptions:	Not timely detection.
Includes:	Ultrasonic (in our case)
Assumptions:	
Notes and Issues:	Sensor dead.

Use Case ID:	UC-05
Use Case Name:	Voice Based
Actors:	Device

Description:	Move Autonomously on the basis of voice
Trigger:	When listen the specific key words of voice
Preconditions:	Proper Voice Equipment Configuration
Post conditions:	Proper Predefined Voice instructions and its configurations.
Normal Flow:	When listen the specific key words of voice the device moves on that direction.
Alternative Flows:	
Exceptions:	Device not respond after hearing the voice
Includes:	Bluetooth, Voice Module.
Assumptions:	
Notes and Issues:	Response late, Half keyword detect.

Use Case ID:	UC-06
Use Case Name:	Camera (Object Recognition)
Actors:	Device
Description:	Compare the Obstacle image with pre feeded image in dataset and display object name.
Trigger:	When find the obstacle then its trigger.
Preconditions:	Proper Camera Configuration, Image data set.
Post conditions:	Proper Shapes of the objects must be visible and make sure the objects must be those that are defined in the data set.
Normal Flow:	When detect obstacle Compare the Obstacle image with pre feeded image in dataset and display object name.
Alternative Flows:	
Exceptions:	Image of the obstacle that are not in dataset
Includes:	
Assumptions:	
Notes and Issues:	Sometimes not capture the proper obstacles so that's why camera not recognize that obstacle.

Use Case ID:	UC-07
Use Case Name:	Ultrasonic
Actors:	Device
Description:	Detect the distance of obstacle by receiving the sending sound waves.
Trigger:	Send signal for object
Preconditions:	Proper wiring and other ultrasonic required Components configuration.
Post conditions:	Make sure Reflect-able objects Not waves absorbable object.
Normal Flow:	Sending sound waves that reflects from the obstacle and then calculate the distance.
Alternative Flows:	
Exceptions:	Not timely receive the sending waves.
Includes:	
Assumptions:	
Notes and Issues:	Due to different Obstacles shapes some time sending waves not received.

4 Specific Requirements

Specific Requirements includes Functional and Non-Functional Requirements of the project.

4.1. Functionality

The Functional Requirements of our Project are: -

Identifier	FR-01
Title	Autonomous Movement
Requirement	Arduino, motor module
Source	Supply of current by turning on the button.
Rationale	Obstacle Detection
Restrictions and Risk	Dead risk

Dependencies	Battery
Priority	

Identifier	FR-02
Title	Obstacle Detection
Requirement	Sensors, Camera
Source	Environment
Rationale	Receiving the sending waves after reflected by the obstacle.
Restrictions and Risk	waves absorb obstacles
Dependencies	Obstacle must available
Priority	

Identifier	FR-03
Title	Distance between Device and Obstacle
Requirement	Ultrasonic sensor
Source	Mathematical Formulas
Rationale	Time taken by the sound waves to reach the receiving end and divided by 2.
Restrictions and Risk	Waves not received
Dependencies	Arduino, battery
Priority	

Identifier	FR-04
Title	Decision Taking
Requirement	Arduino, Voice module,
Source	Signals Receiving from the Arduino.
Rationale	Distance measurement
Restrictions and Risk	Wrong or late decisions

Dependencies	ultrasonic sensor, Bluetooth
Priority	

4.2. Non-Functional Requirements

The core feature of the device is to make it autonomous and obstacle detection, but it will certainly have more features given below that are worth mentioning.

Identifier	FR-01
Title	Obstacle Recognition
Requirement	Camera, Dataset

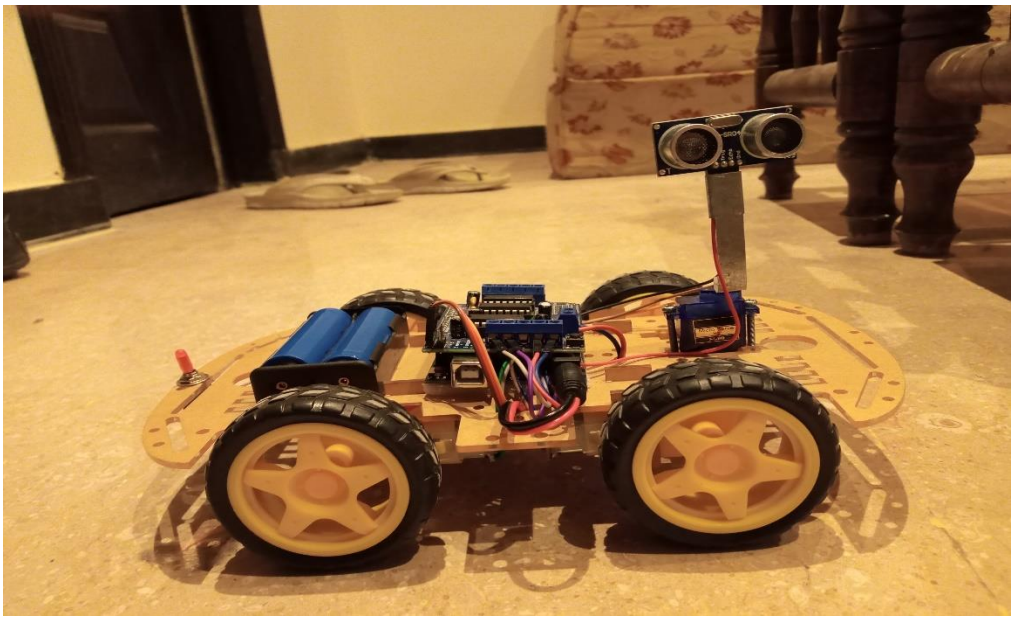
Identifier	FR-02
Title	Voice based Movement
Requirement	Voice recognition Module, Bluetooth Module

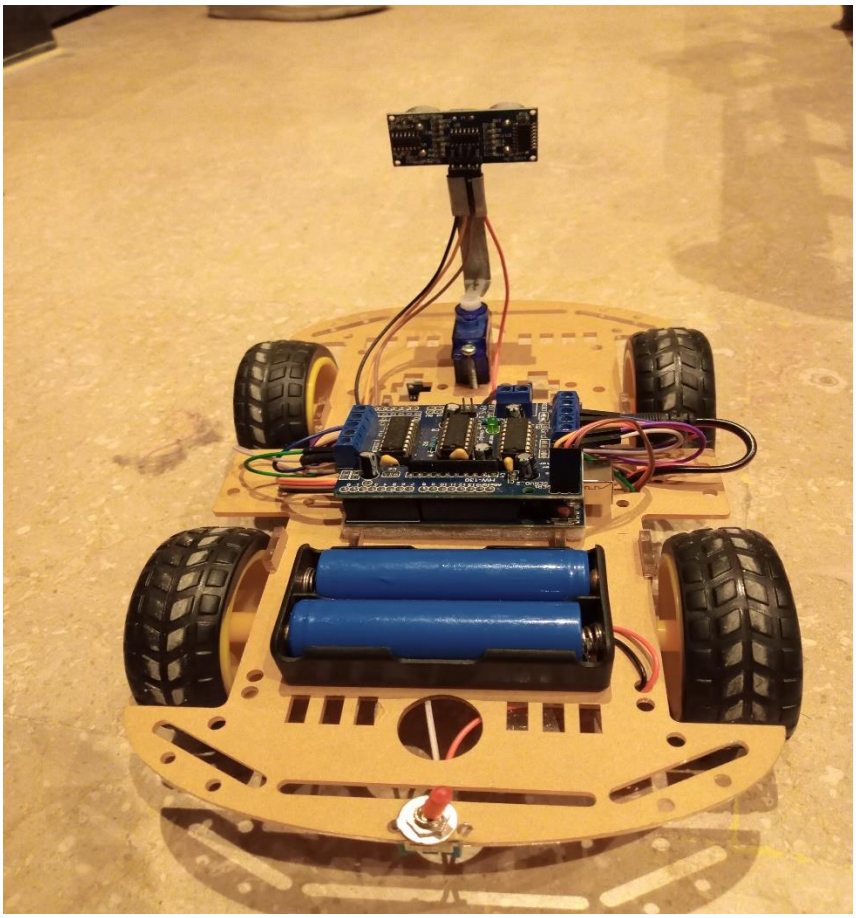
Identifier	FR-03
Title	Verifying Pin
Requirement	Keypad

Identifier	FR-04
Title	Night Vision (Optional)
Requirement	Night vision sensors.

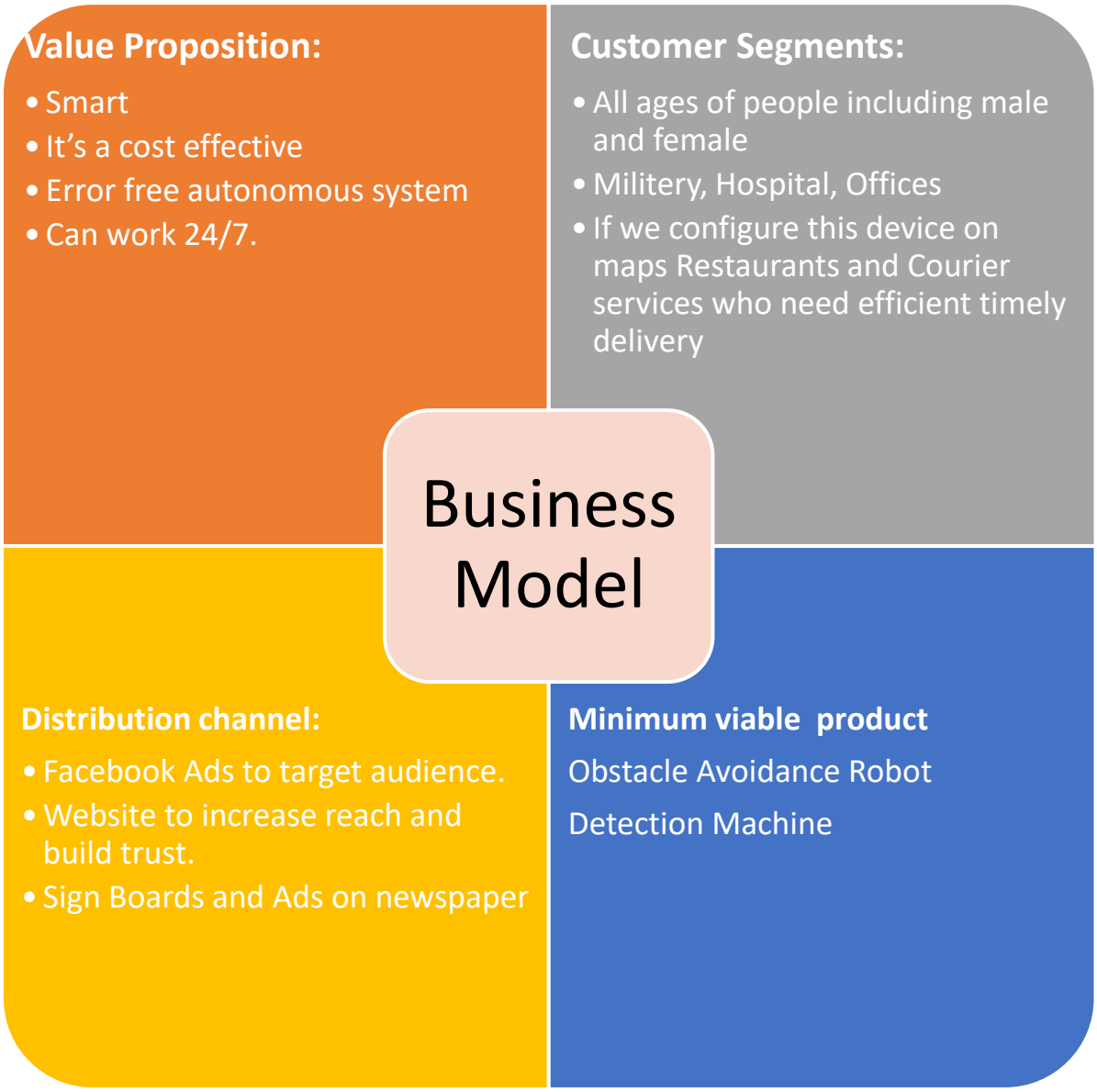
5 User Interfaces

Autonomous Device for Obstacle detection is a Hardware based Project So this is basically an interface that show to the user.





6 Business Model

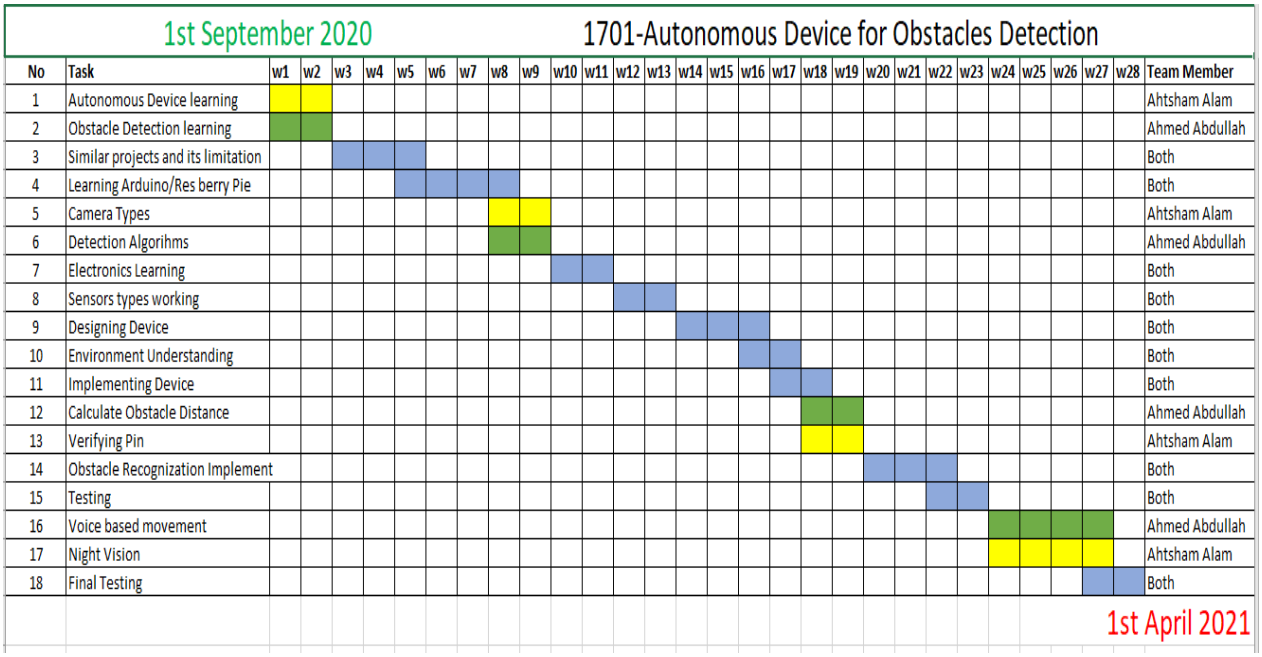


7 Project Gantt chart

Group Member:

Ahtsham Alam

Ahmed Abdullah



7.1

Gantt Chart of the task we achieved so far is given below

Autonomous Device for Obstacle Detection																Member
Up to December		Months														
	Tasks	w1	w2	w3	w4	w5	w6	w7	w8	w9	w10	w11	w12	w13	w14	w15	
1	Study Related Projects																Both
2	Buy Equipment's																Ahtsham
3	Learning Arduino IDE																Ahmed
4	Learning other sensors and motor module Connectivity																Both
5	Designing stage																Ahtsham
6	Developing Stage																Ahmed
7	Make device Autonomous																Both
8	Device Detecting Obstacles																Both
9	Device Taking Decision																Both

8 Bibliography

Gijs Dubbelman, Wannes van der Mark, Johan C. van den Heuvel, Frans C.A. Groen. 2007. "Obstacle Detection during Day and Night Conditions using Stereo Vision,." *Intelligent Robots and Systems,* Page 5 and 6.

This paper proposes different statistical methods to find the distance using stereo vision techniques. The strength of this paper is that it's a practical approach that using in many robotics and real time car manufacturing companies because stereo vision can find distance and path allocation in Day as well as night. We Chose this paper for our research because in future its very helpful to related to our Project when we do obstacle detection on basis of camera and also helps in our night vision feature.

Hind Laghmara, Mohamed-Taha Boudali, Thomas Laurain, Jonathan Ledy, Rodolfo Orjuela, Jean-Philippe Lauffenburger and Michel Basset. 2019. "Obstacle Avoidance, Path Planning and Control for Autonomous Vehicles." *Université de Haute-Alsace, France.* Page 3,4,5,.

This paper proposes three different levels to reach autonomous vehicles. The strength of this paper is that grid-based approach is used for obstacle detection. smooth and control obstacle avoidance trajectory is generated which helps to reach an accurate result. We Chose this paper for our research because it's very helpful to related to our obstacle detection functionality but this approach is very costly.

Kolapo Sulaimon Alli, Moses Oluwafemi Onibonoje, Akinola S. Oluwole, Michael Adegoke Ogunlade, Anthony C. Mmonyi, Oladimeji Ayamolowo and Samuel Olushola Dada. 2018. "DEVELOPMENT OF AN ARDUINO-BASED OBSTACLE AVOIDANCE ROBOTIC SYSTEM FOR AN UNMANNED VEHICLE." *ARPN Journal of Engineering and Applied Sciences* Volume 3.

In this paper the system consists of two (Infrared and Ultrasonic) sensors, an Arduino microcontroller and a gear DC motor. The ultrasonic and infrared sensors are implemented to detect obstacles on the robot's path by sending signals to an interfaced microcontroller. The micro-controller redirects the robot to move in an alternate direction. The main strength of this paper is that Its a less costly approach through which we can achieve maximum result.

Mario Hirz, Bernhard Walzel. 2018. "Sensor and object recognition technologies for self-driving car." *Computer-Aided Design & Applications, Graz University of Technology,* Page 3 and 4.

This paper proposes different levels of automated driving functions according to the SAE standard and derives requirements on sensor technologies. Subsequently, state of the art technologies for object detection and identification as well as systems under

development are introduced, discussed and evaluated in view of their suitability for automotive application. It using LADAR approach which is very costly.

Ms. D.D Jadhav, Komal Jadhav, Kajal Shinde, Anjali Sonawane. 2016. "Autonomous Vehicle with Obstacle Avoidance and Tracking." *International Journal for Research in Applied Science & Engineering Technology (IJRASET)* 4.

In this paper a driverless vehicle that has an onboard GPS module which is capable of driving the vehicle from one point to another without human operator. Arduino the micro-controller redirects the robot to move in an alternate direction. The main strength of this paper is that it is low cost, and has high ranging capabilities approach through which we can achieve maximum result.

Pandit, Abhiemanyu. 2020. "Obstacle Avoiding Robot using Arduino and Ultrasonic sensor." *Circuit Digest*, May 20.

This is basically a link that shows to how to manufacture the autonomous device for obstacle detection. Complete working of the components, Problems of connectivity, limitations and every thing that we need to develop the device are in this.

Remenan., Surya. 2019. "Beginners Guide to Object Detection Algorithms." *Analytics Vidhya*, April 28.

This is basically a link that helps to learn three main type of obstacle recognition algorithms techniques that based on machine vision.