**10/11/2017**



**Convoy Project**

Proposal Report

**Company Name:** OJO

**Submitted to:** Emre Ozkan

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**Report Submission Date:** 11/10/2017

**Project Initialization Date:** 11/10/2017

**Project Duration:** 200 Days

**Expected Completion:** MAY 2018

**Project Cost:** 150 USD

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**Problem statement:**

A self-contained robot will be designed which follows similar robots in a single line. It will also be capable of leaving the line upon the external leave command and re-join the convoy as a last one. Robots will not communicate each-others directly, they will broadcast the information which indicates that they are leaving, or they are the last one in the line. Any signal will be provided by two different actuators and be sensed by according sensors. The vehicles will keep appropriate following distance and move in the reasonable speed. When followed robot will turn on the leaving signals and start to leave the line, the following one will stop following it and look for and follow the vehicle in front of the leaving robot. All robots will have distance sensor to prevent crash. Vehicles will be able to follow leading robot when it is not following a straight line and changes its direction, also turning to the sides will not cause a problem if this process happens in the same time as a leaving process. Vehicles will be able to change their speeds as well. A vehicle should follow only the robot right in front of it and that’s why it will be able to differentiate that vehicle and the one in front of it.

**Requirements:**

The robots should be able to follow the leading robot with a certain accuracy. The exact requirements will be determined in the standards committee.

On being given a signal the robot should leave the convoy and rejoin it at the last positon.

The robot should be able to determine if it is the last robot in the convoy.

The robot should indicate to the other robot if it is the last robot or not using two independent methods.

The robot should indicate to other robots when it is leaving the convoy using two independent method.

**Objectives**

The robot should be,

* Power efficient.
* Cost Effective.
* Environment compatible (e.g. it should work in all lightening conditions).
* Light and easily maneuverable.
* Robust (minimal number of moving components).
* Have good response time (should rejoin the convoy in 10 seconds).
* Easy to use for the customer

Environment compatible Control

Light-weighted

Easily manoeuvrable

Performance

Rejoin in 10 sec  
(For a good response time )

Minimum number of components to robust

Leaving and rejoining the convoy

Power Efficient

Marketable

Cost Effective

User Friendly

*Figure 1: Objective Tree*

**Societal impact:**

Autonomous cars are getting popular nowadays due to their obvious advantages. This project will act like an initial step toward this industry. Preventing crashes, moving in reasonable speed and being able to get out of the traffic and re-joining are the similar tasks that autonomous cars should be capable of. On the other hand experiences gained from this project can be used also in truck convoy projects similar to the one “Tesla” company is working on. Only the leading truck should have a driver and the ones follows it. This approach will decrease the drag force because vehicles will move in a line and have smaller following distance. Less drag force means less fuel consumption, less driver means less payment. Overall autonomous trucks will decrease transportation fees and contribute to the economy.

**Human Resources:**

For the selection of the company members, individuals were chosen so that can they complement each other’s skills. The company wanted to implement the project in a hi-tech manner therefore three members from the computers option were selected. These members have a deep underlying knowledge of computer systems and this will allow the company to utilize microcontrollers to its full potential. The computer members can design basic hardware circuitry to offload the CPU as much as possible. The project requires accurate and precise control of actuators, motors and/or servos for physical movement of the designed devices. OJO has a control option member who will help the company greatly with any problems that might be encounter during implementation and design. Power management is a crucial consideration in any project. OJO’s projects will be no exception to this. Given that devices the company plans to build will be mobile and will not have any direct connection with mains power. Keeping sure that the power system can provide plentiful power is essential.

Brief explanation about the team members and organizational chart of the project are listed below:

Abdullah Aslam:

Option: Power Systems

Experience with UAV control and familiarity with programming languages.

Anar Abdullayev:

Option: Computers

Experience with microcontrollers(Arduino, PIC and ARM based ones), motion sensors and communication interface.

Bulut Ulukapi:

Option: Computers

Experience with data structures, microcontrollers and various programming languages

Syed Saad Saif:

Option: Control

Experience in microcontroller based discrete time feedback controllers and has deep understanding of C programming language as well as object oriented programming

Umut Can Serçe:

Option: Computers

Experience with various programming languages and HDLs.

Convoy Project

B.Microcontroller

A.Microprocessor

E.Visibility Markers and Flags

D.Chassis

C.Power Systems

1.Image processing/ visibility marker recognition

1.Motors and Drivers

2.Interfacing with the microcontroller

2.Feedback Control Algorithm

*Figure 2: Organizational Chart for subsystems of the project*

Projects subsystems are assigned to the project members according to their final year options and experience. The assignment is as follows:

Abdullah Aslam: Subsystems C and D

Anar Abdullayev: Subsystems B1 and B2

Bulut Ulukapi: Subsystems A1 and B1

Syed Saad Saif: Subsystems A2 and B2

Umut Can Serçe: Subsystems A1 and E

**Standards**

Besides from the standards are given in the description of the project, there are also other requirement to be met because this project requires collaboration with other groups. In order to prevent some problems such as blocking other robots or colliding with each other, setting the standards is highly important and directly affects the solution.

After the meetings held between the group members, it is decided that there were three main categories related with standards. These standards are about sensor types, physical properties of the robot and its path and the types, shapes or color properties of the markers.

**Sensor Types**

There will be certain standards about the markers and the signals that are going to be used in the projects in order to be in collaboration with other groups. For this reason, sensors should be arranged in a way that they should detect the predefined flags.

**Physical Standards**

A minimum and a maximum value should be set for the speed of the robots. This will make them avoid collision or losing the track. If a robot exceeds a certain speed, its follower may not be able to reach it and lose its track. In addition to the speed on the queue, the speed of leaving or joining the convoy should also have standards because of similar reasons. Furthermore, an interval for the distance between the robots needs to be determined because of reasons that were mentioned previously.

There should also be certain standards about the path that the robots are going to follow. As indicated in the description, the path might be non-linear. Therefore, a minimum radius for the curvature, which is going to be followed by the robots, needs to be set in order to prevent sharp turns. This will also help on detection of the convoy and rejoining it.

For some solutions which the group members came up with, the body of the robot itself blocks the signal which is coming from the front robot and does not let robots behind it to receive the signal. In other words, this provides the leaving signal of a robot to reach its follower only. This blocking mechanism can be applied if all the groups agree upon certain standards about width and height.

**Marker Standards**

There are three different flag types in the task. The first one is the visibility marker. This will keep the follower robot on the right path. The second one is the leaving signal. This signal needs to be received by the robot that is following the one that is leaving the convoy. This will tell the follower to increase its speed and fill the gap that is left behind. The third one is the signal that will be transmitted by the last robot. This signal make the leaving robot understand where to rejoin. Since there are lots of signals and markers, there should be certain standards in order to prevent signals interfering with each other.

Some sensors which are planned to be used, requires visual inputs. For this reason, there needs to be standards for the size, the shape, the colors and the location of the marker. If these standards are not set, the indirect communication between the robots may not be proper as it is planned.

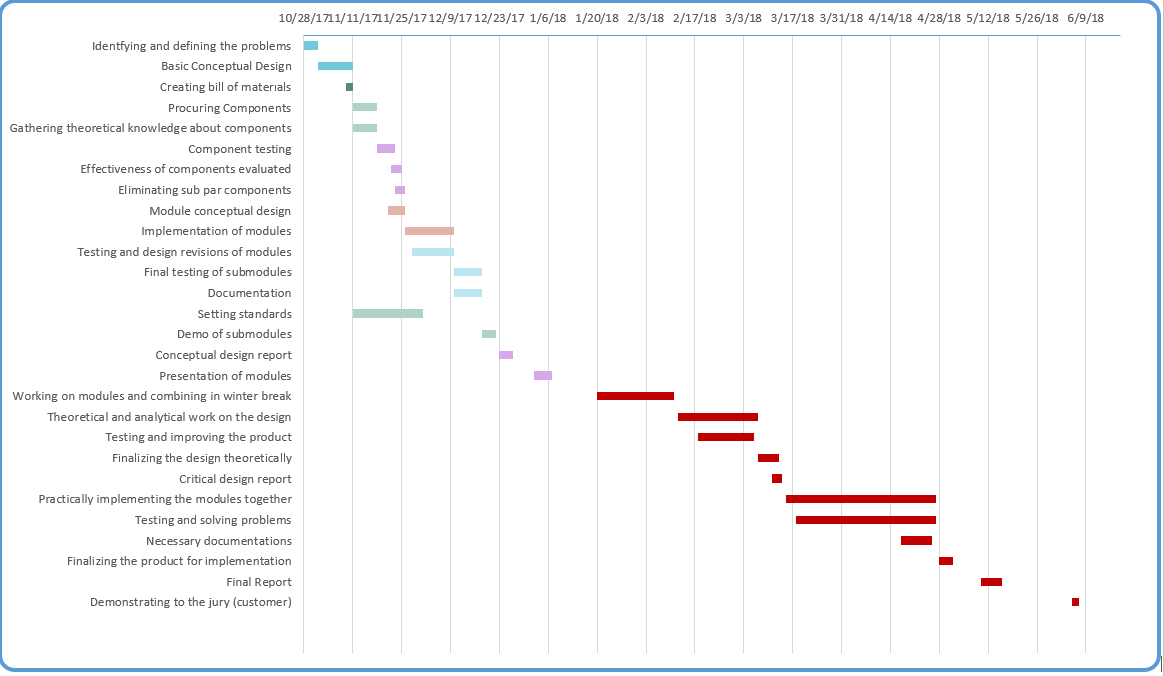


Figure 3. Gantt chart

**Deliverables and expected outcomes.**

The product includes a vehicle which will be a part of a convoy and a leading dummy robot. Additional documents such as instructions on how to use the robot, circuit schematics, and software part of the project will also be provided. The product is a great source to practice on autonomous vehicles model. Since the project is open source, one can easily make changes on the robot to use it in different conditions.

**Tentative cost-budget analysis:**

Our company aims to provide a cost effective end product. A product that can complete the objectives exactly and efficiently and is also within the required budget range which is $200. Our company plans to use microcontrollers, sensors, geared motors and other necessary equipment for the project. The tentative total cost mentioned, is the minimum cost for the project and is also subject to change, if a different component is used.

**Total cost: 533 TL ($141)**

The main equipment that will be used along with their prices are as follows:

12-40V 10A Motor Driver Board (25 TL)

12V 16mm 1500Rpm Gearbox Motor (31 TL \*2 =62 TL)

Raspberry Pi Adjustable Focusing Camera Module (70 TL)

Arduino UNO R3 Clone - With USB Cable - (USB Chip CH340) (16 TL)

Raspberry Pi 3 (138 TL)

Ultrasonic Distance Sensor (5 TL)

Speaker (6 TL)

Sound sensor (11 TL)

Battery (60 TL)

Chassis (60 TL)

Other stuff like resistors, transistors, LEDs, capacitors, wires etc. (80 TL)

**Conclusion**.

In this project a self-contained robot is going to be created. The mission of the robot is to follow another robot in front of it in a curly trajectory, be able to leave the line when received a predefined external command and rejoin the convoy. To solve the problem separate modules such mechanical basis, sensors, flags, controller will be designed and tested. All members of the group will be actively involved in both design and prototyping process. As a final product, OJO Company will offer a convoy vehicle which is able to solve the given problem in a smart, user-friendly and effective way.