MIDDLE EAST TECHNICAL UNIVERSITY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

EE 493-DESIGN STUDIO 1

WEEKLY REPORT III

revolusys

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1. SUMMARY OF THIS WEEK'S PROGRESS

After our meeting with our design coordinator last week, we realized that we need to spend more on the projects in this week. Throughout the week we met two times to discuss the modules and possible solutions of each project and decide which objectives we are going to take into account while choosing our project. Onur and Ahmet worked on the project "Where am I?", Ozan worked on "Cat Feeding", Doğukan worked on "Gimme Fast" and Mert worked on "Autonomous Valet Parking Service" during the week and in our meetings each member explained what they have learned so that each member can have an idea on each project. The modules and the possible solutions we found to the modules are further explained in the following part.

2. ANALYSIS OF PROJECTS

2.1. <u>**CAT FEEDING**</u>

This project is basically ''image processing'' project. Detecting the cat and differentiating it from dog requires image processing. There are lots of algorithms about cat detection in the internet sources. These sources can be a guide for creating our own algorithm. Our algorithm can be implemented on Raspberry Pi but at that point we have doubts because compilation can take long time for that kind of algorithm on Raspberry Pi. That's why it effects its testability. Also, we have to create a database for images.

On the other hand, for user access, a mobile application is needed. At first glance, writing an application seemed difficult but there are some visual application development interfaces like ''*Android Studio''.* So, it is not that hard.

There are not challenging mechanical parts in this project.

We need to propose a test method for this project also.

Simple units of the system summarized roughly in a diagram.

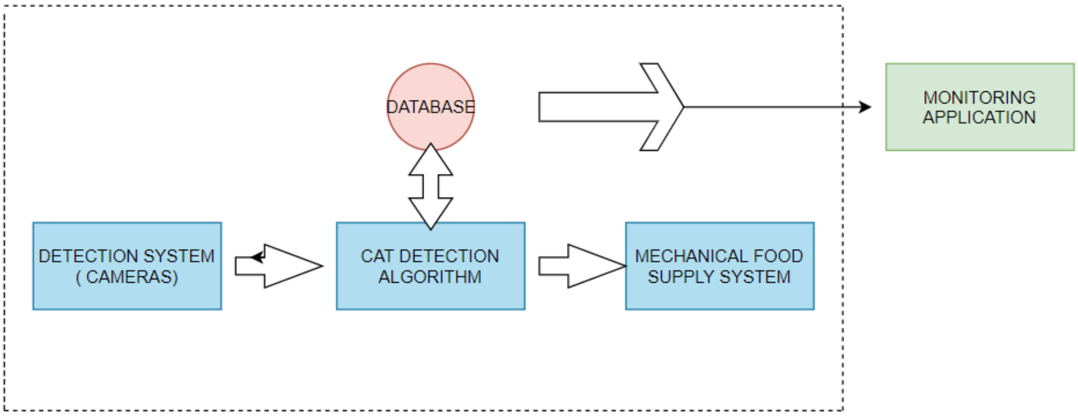

figure 1: Simple Block Diagram of Cat Feeding Project

At the end we have some questions to ask:

1) Is there any limitation about number of cameras for detection?
2) Is there any restriction about battery (For example: Battery capacity can not exceed … mAh)

-Are we free to create our own test method? (Testing with 3D objects/ Testing with photographs etc.)

-Residual Food Problem: Do we need to test the scenario in case of ‘’cat does not eat all of the food supplied.’’ It is important because in that case, we need additional mechanisms for taking back the residual food.

2.2.GIMME FAST

In this project, the basic purpose is to build up a transportation system which transfers a picture from one side to the other. If we choose to do this project, a deep research on Li-Fi will be required. Also, some ideas from communication theory must be exploited. What we have discussed about this project in this week includes the general overview of the project and some concepts related to it. For example, although we are not going to implement it, the very basic idea about the communication part of the project includes Frequency Shift Keying in which we map a frequency value to each binary symbol. We have also discussed how the picture data can be parceled for transmission to the other side. Hence, we have concluded that this project is roughly composed of the following parts:

1) Camera module

   In this module, we couldn't understand from the project description that whether a computer is allowed to capture and then send the image to the second module. Otherwise, probably a microcontroller or Raspberry Pi will be needed to manage the data at this step.

2) First transmission module

   This module includes all the structures that will be constructed to transmit the data from the first terminal to the vehicle. Here, to further understand the doability of this module, we believe that the specifications of the LEDs, photodiodes and LDRs must be announced as early as possible. This part will include the usage of Li-Fi knowledge. Also, knowledge on networking may be required to effectively transmit the signal.

3) Vehicle module

   Here, a vehicle should be designed to carry the information across as fast as possible. However, a question was raised here to further understand what is meant by physically guided. The question was that whether we can use a railway vehicle or does it have to be a wheeled car which moves on a straight path.

4) Second transmission module

   Second transmission module transfers data from the vehicle to the output module. Its structure will be similar to the first transmission module.

5) Output module

   The output module is the part where we will see the picture. Here it is not clear that whether a computer is allowed or should we find another solution.

To sum up, the problems to be adressed are as follows:

1) Are computers allowed to use?
2) Is there a way to obtain the specifications of the LEDs before the final project decision part.
3) What does the phrase physically guided mean exactly? Can we use a railway vehicle or does it have to be a car going on a straight way?
4) Can we use tubes at the outputs of the LEDs and how will the 5 cm rule be applied? If we are allowed to use tubes, are they included in the 5 cm rule?

2.3.**WHERE AM I?**

For this project, there will be several obstacles, both physical and magnetic. In order to complete the mapping part, several sensors and a camera are needed to be utilized. As a vehicle, RC controlled car can be used. To sense the physical obstacles and to record their distance to vehicle, LIDAR, which stands for Light Detection and Ranging, can be used. So as to sense the magnetic obstacles, Hall Effect sensors, which outputs in the presence of magnetic field, can be used. Sensitivity of both of these sensors can be arranged manually. Necessary computations can be done by Raspberry Pi, which is a general purpose computer. This computer will be embedded on the vehicle. Using a Wi-Fi module along with the Raspberry Pi, wireless communication between Raspberry and computer will be provided. A camera can be connected to Raspberry Pi, again by means of Wi-Fi module. In camera side, there can be a microcontroller to drive the camera. In both mapping and localization parts of this project, we will use outputs which came from several different sensors. These sensor data should be managed somehow. To solve this problem, we came up with the idea to use sensor fusion method.

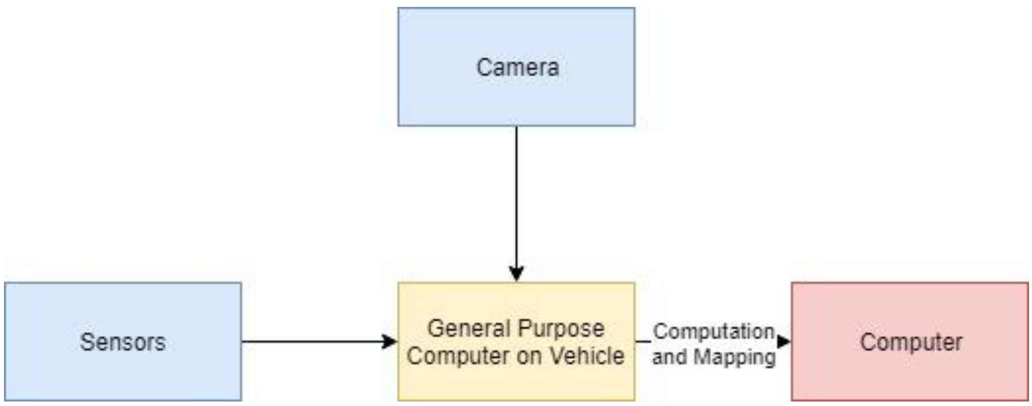

figure 2:Simple Block Diagram of Mapping Part

In mapping part of the project, there are 4 submodules. Sensors on the vehicle will collect the data and send it to the general purpose computer on the vehicle to be processed. Camera submodule will also send the data to be processed, image processing will be needed for this task. Via Wi-Fi module, the computer will collect the computations and mapping.

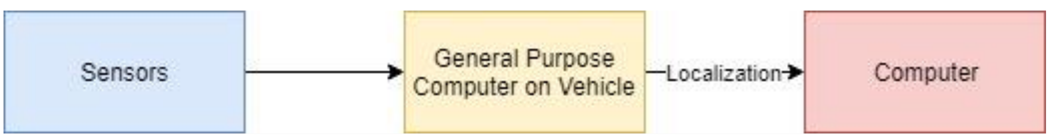

figure 3: Simple Block Diagram of Localization Part

In localization part, sensors submodule will again collect the data and send it to the computer on the vehicle. The data collected in the mapping part will be compared with the recent data and this localization information will be sent to the user computer.

For “Where am I?” project, following questions will be addressed:

1) Where will be the integration of camera and sensors handled?

2) Should the heights of the objects be sensed? Should the mapping be 2D or 3D?

3) Is sensing the presence of magnetic object enough or is the magnetic intensity information important?

4) Will the vehicle pass on the objects?

5) In the second part, localization, will the vehicle be kept still or moving?

6) What is the acceptable time constraints for mapping and localization tasks?

2.4.**AUTONOMOUS VALET PARKING SERVICE**

For this project, we are requested to build an autonomous valet robot which can park cars into a 3 by 3 grid parking area. We roughly divided the design problems mainly as path planning, path following and the mechanical structure of the robot.

For the path planning part we have found out that there a lot of path planning algorithms available for autonomous robots such as Djikstra algorithm, A* algorithm, potential field algorithm etc. As the starting and parking locations of the robot will be known after the parking request is made, we could use such an algorithm to plan the optimum path between those points. However, we also thought that as the initial position is always the same and there are only 9 possible parking slots, we can actually predefine the paths for each case. We thought that his approach may eliminate the risk of planning a wrong path.

For the path following problem again we found up several solution methods. The first method is “absolute measurement” which means obtaining the absolute location of the robot at any time and use it for the control of the robot. This method requires the use of a GPS, but GPS devices have limited functionality indoors and lack accuracy in short distance movements which is exactly our case. Thus, we don’t think this is the appropriate method for us. The second method is “Simultaneous Localization and Mapping (SLAM)”. In this approach the robot environment is scanned throughout its movement by possibly using a laser or camera, and an obstacle map of the vehicle surroundings is generated. This technique provides information of the robot’s location in regard to the nearby objects it detects. This approach offers position estimation with multiple reference points. Some of the disadvantages are the complexity of the system, the increase in the required computational power, and the high price of the scanning device. Due to all these disadvantages we think that neither this solution is the right one for us. The final method we came across is named “daed reckoning” which relies on calculating the position of the robot from its previous position, based on information about the current velocity and direction. The velocity and direction data will be gathered by using an IMU (Inertial Measurement Unit) which is a sensor consisting of an accelerometer, a gyroscope, and sometimes a magnetometer. By using these data an approximation of the robot position can be made. We think this method is the most suitable one however precise measurements are required for this approach, because an error would grow proportionally to the travelled distance. To solve this problem we thought that a way of marking the parking grids can be used so the last part which needs to be accurate can be done by following those markers instead of using dead reckoning method.

For the mechanical design the main question was how the valet will carry the cars? Although we came up with several solution we believe that the best and the easiest to implement is to uplift the car by using platform that goes under it. So, there will be a platform on the valet which can go under the cars and as the car is totally above this platform the platform will be lifted. As the platform is lifted the valet can go with the car to the required position and leave it there by lowering the platform. The main problem of the mechanical design part might be designing the valet so that it is lighter than the cars.

Further Questions:

1) Can we use moving grids?
2) Are the cars wheels locked during carrying?
3) Can we use lines to guide the valet?

3. PROJECT SELECTION OBJECTIVES

We discussed which objectives should we consider while choosing the best project for us. The posiible objectives that we have come up are listed below.

1) The amount of mechanic knowledge required.
   - 5 points: No mechanical parts are required
   - 4 points: Basic mechanical parts required
   - 3 points: Moderate amount of mechanical parts required
   - 2 points: An original mechanical design needs to be done

- 1 point: An original mechanical design and skilfull labor is needed
- 0 points: Most of the project depends on mechanics

2) Suitability of the project to the skills of group members.
   - 5 points: All members have related skills
   - 4 points: Most of the members have related skills
   - 3 points: We have the main required skills
   - 2 points: Our skills ae only related to some parts
   - 1 point: Only of our skills are related
   - 0 points: No member has related skills

3) Excitement that the project creates on us.
4) Variety of the possible solutions.
5) Testability of the project and submodules.
6) Clarity of the project requirements.
7) Possibility of finding implemented solutions.

4. CONCLUSION

In this week, we have divided each project into its submodules and discussed the possible solutions. After this research, we now know that which parts of the projects would be easier to implement and which require more time to be spent. By knowing that, we did some barinstorming and come up with several project selection objectives. We will further think on those objectives and may eliminate some of them or add new ones. After the objectives are determined, we are going to rate them and choose are final project.