TDPS Initial Report

Team 34: Friday

April 6, 2022

1 Introduction

In the course Team Design Project and Skills (TDPS), we are required to construct an intelligent rover to complete the tasks given by the handbook. In this report, we propose the initial design of our rover. In Section 2, we performed task analysis and breakdown to facilitate the system's top-level design and specify the components required. Then in Section 3, we presented the top-level system design, illustrated the connections between the submodules, and explained our selection of components.

2 Task Analysis

The rover we designed should be able to complete all the tasks without any human interference. As shown in Figure 1, two functions are required in Patio 1, including tracking along the gravel and beacon detection. The functions require an OpenMV for computer vision and an ultrasonic radar for distance measuring. The required modules are indicated in Figure 1.

In patio 2, the tasks are more complicated. An OpenMV Camera is first required to detect the shape of the picture at the bottom vertex of the diamond. A gimbal is required to level the camera from a pitched-down attitude. The rover will then use the OpenMV Camera to detect the edge of the diamond to decide the time to turn. An ultrasonic radar is needed to navigate the rover to the tennis ball releasing site by measuring the distance between the rover and obstacles. A steering engine (servo motor) will then be applied to open a gate to release the tennis ball. Finally, a communication module is used to send messages to the computer. The required modules are indicated in Figure 2.

3 Top-level System Design

In our system, seven components are integrated, including an STM32L432KC as the controller, an OpenMV to facilitate computer vision, motors to drive the rover, a compass to indicate direction, 3 ultrasonic radars for distance detection, a Bluetooth HC-12 to communicate with the computer and two servo motor to release balls and rotate cameras. The structure of the system is shown in Figure 3.

We picked an STM32L432KC as the central controller of the system. The main reason we choose it is that every group member already owns an STM32L432KC. As a result, it will be convenient for us to develop our parts individually. This microcontroller also features 26 I/O ports. Although it cannot satisfy the requirement of all the components, an expansion board can be added to solve the problem. To facilitate the computer vision of the system, OpenMV Cam M7-OV7725 is chosen. This is because OpenMV is a mature and easy product to use and has strong performance. The motor driver applies the chip A4950 because it can provide enough driving current for our motors. A compass GY-271 is applied so that the rover can detect its direction and make a precise turning. To transmit the real-time information to the computer, as a complement to the Bluetooth chip HC-12, an external real-time clock (RTC) DS1302 is chosen to generate the time information for the required message without consuming too many central controller's resources. Other components, including the ultrasonic radars HC0-RC04 and servo motors SG90 are chosen because they are the most widely applied models.

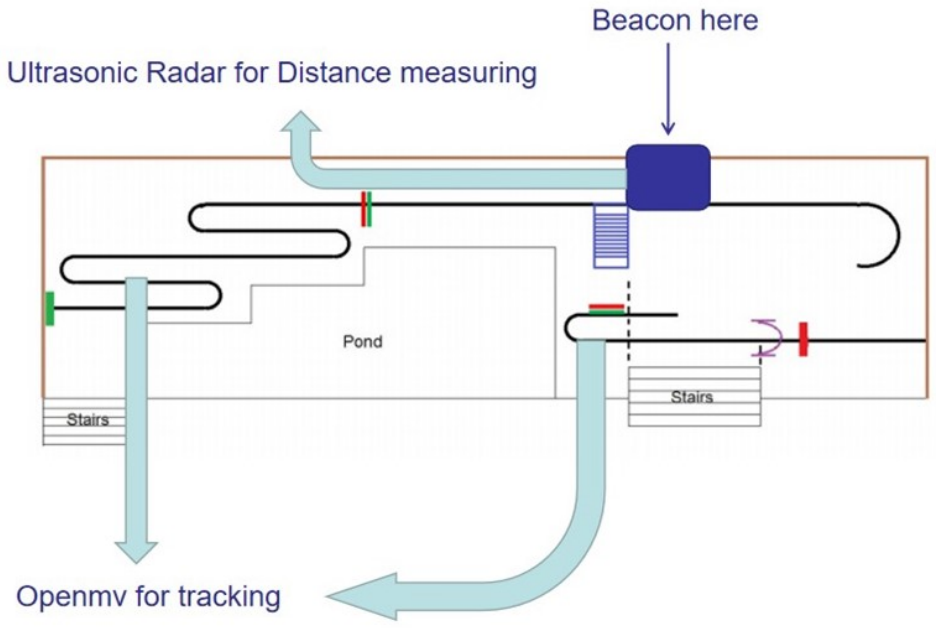

Figure 1: Modules required in patio 1.

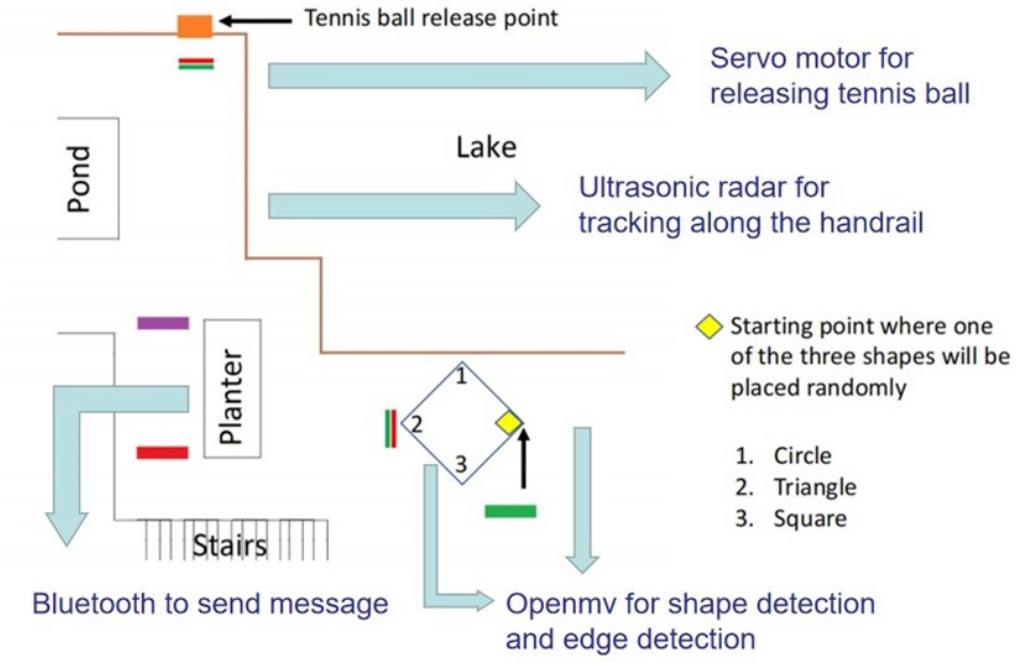

Figure 2: Modules required in patio 2.

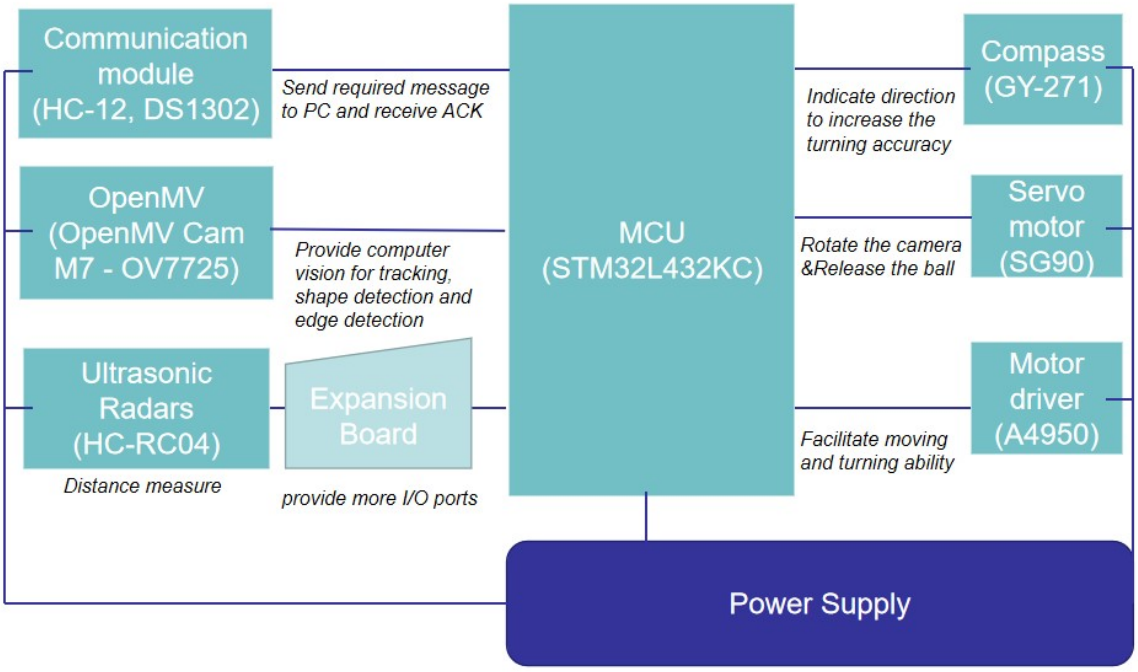

Figure 3: Block diagram for top-level system and function definition.