Arunachalam Venkatachalam (333000500)
Padmashree Srinivasan (731007503)
Carlos Navarro Naranjo (726003363)

Dr. Won-Jong Kim

MEEN 667

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Term Project Proposal: Vision-based Object-following Voice-controlled Rover

OBJECTIVE & SIGNIFICANCE:

To build a vision-based object-following voice-controlled rover. Arduino receives input either from a camera (PixyCam2) through detection of an object or a Bluetooth module through voice commands and produces a motion control output. The motion of the rover is controlled by pairs of DC motors via the motor driver. The rover would be put into motion when an object is introduced before its sight. Only a known object (color of the object is taught to the PixyCam2 and pre-coded accordingly) when put in front of the camera would drive the rover into motion. The rover would continue to be in motion until the object either goes out of the camera frame or when the object is removed manually. Feedback would be employed to control the motion of the rover. Depending on the camera signals, the rover would move if an object were present else stay at the same position. The rover can also be controlled via voice. Based on the voice commands given to the rover through a mobile application, the rover moves in the desired direction. Our objective is to control the motion of the rover by either voice or visual, one at a time.

This concept could be employed real time for platooning autonomous vehicles and to enable voice-based autonomy to a vehicle. The vehicle controller obtains input from sensors, such as cameras and produces a vehicle control output, such as a steering wheel angle to navigate the vehicle safely in a roadway traffic environment. The concept used to develop such a vision-based object following system could be extended to perform tasks such as image classification, facial recognition, and object detection. Given this feature, it might one day prove to be a milestone in vehicle automation.

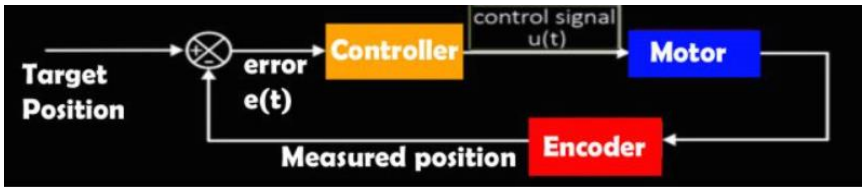
DESIGN CONCEPT:
Components Required:

1. DC Motors
2. Arduino UNO Mega
3. Motor Driver
4. Pixy2
5. Battery
6. Chassis + wheels
7. Bluetooth Module

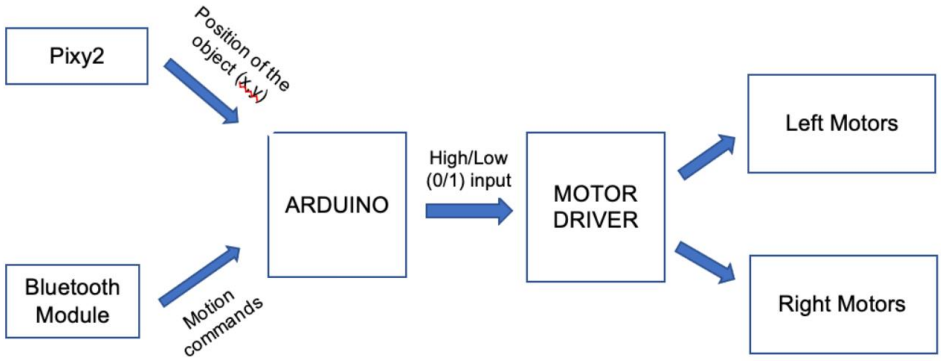
Pixy2 is a fast vision sensor used for image recognition, which can learn to detect objects when taught. In this project, Pixy2 camera is employed for object detection. The object to be taught must have a distinct hue since Pixy2 uses a hue-based color filtering algorithm to detect objects. Pixy2 is capable of tracking multiple objects simultaneously while providing the data of the object of interest.

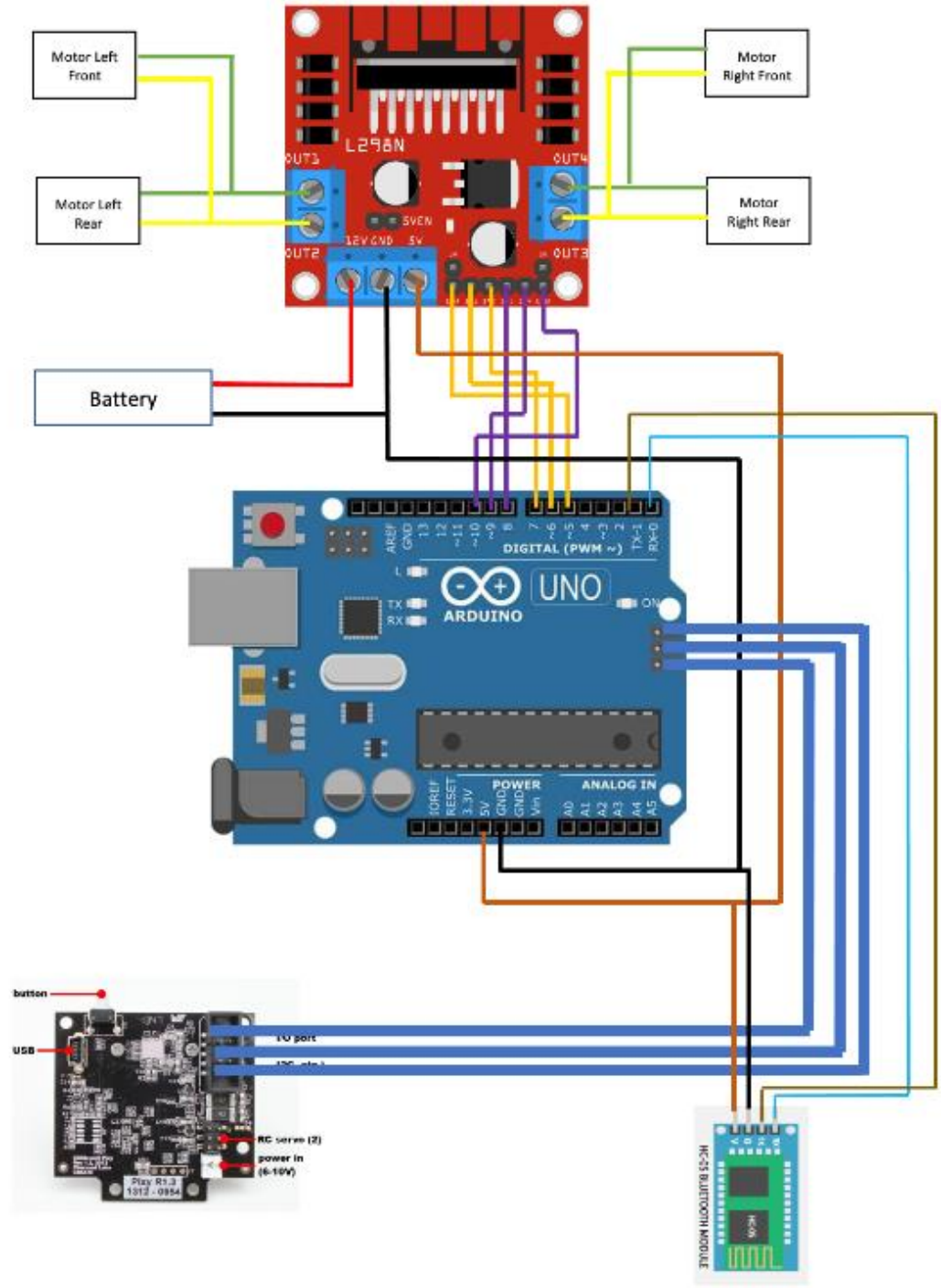
For Pixy2 to provide the data for our object of interest, the characteristics of the object must be previously taught to it, and this can be done in many ways. We'll be teaching Pixy2 about our object of interest through PixyMon since the object we want to teach is small and we want more control over the pixels.

Pixy2 sends block information to Arduino through the cable. Based on the Pixy information given to Arduino, the microcontroller triggers the motor driver module. Input conditions of high and low (1 and 0) are given to the input pins of the motor driver's H bridge construction. The DC motors are connected to the output pins of the motor driver. Based on the input, motion is provided to the DC motors through the motor driver. The feedback control will be employed in terms of monitoring the position of the object being tracked. We will be having the target position (i.e., the position of the object being tracked) and the position of the rover will also be measured and the difference between these positions will be the distance travelled by the rover.



A Bluetooth module is used to communicate the voice commands to the rover via an android application. Through the app, the RF transmitter of the module can receive human voice commands, which are subsequently translated into encoded digital data up to a sufficient range of 100 meters. To drive DC motors via motor driver for appropriate movements, the receiver of the module decodes the input data before feeding it to the microcontroller. The Arduino recognizes voice instructions and carry them out as instructed.




Motor Left Front
Motor Left Rear
Motor Right Front
Motor Right Rear
L298N
OUT1
OUT2
OUT3
OUT4
5VEN
12V GND 5V
Battery
DIGITAL (PWM ~)
UNO
ARDUINO
POWER
ANALOG IN
button
USB
I/O port
RC servo (2)
power in (6-10V)
HC-05 BLUETOOTH MODULE

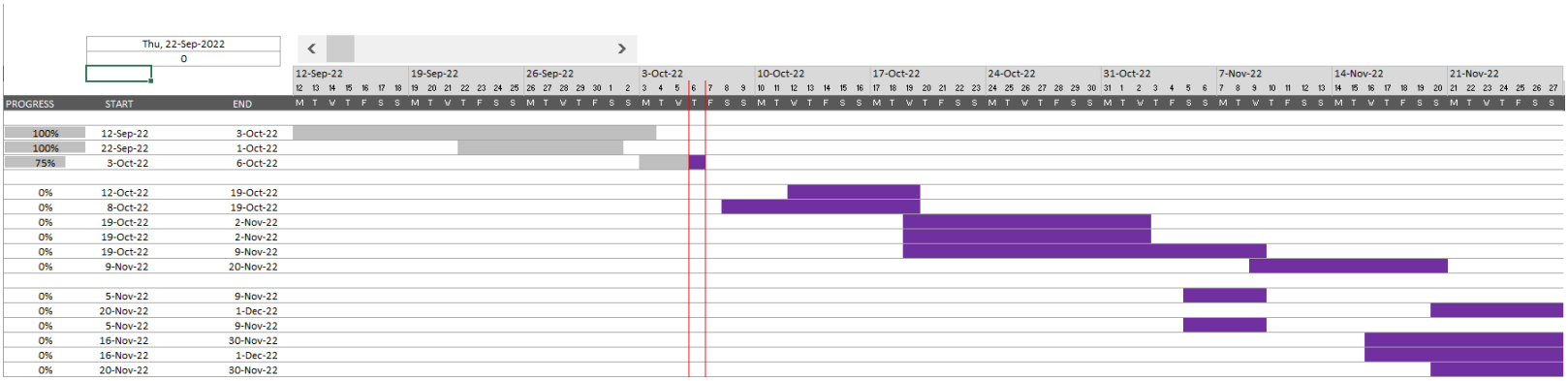
WORK PLAN & DETAILED MILESTONES:

An interactive MS Excel plan that allows to modify dates and milestones automatically has been created. Using the cursor on the Excel, our group can acccess the desired week. The members can update the progress percentages when each task is advanced, and grey portions will get updated. Any of the dates as well as tasks can be revised or edited and its effect will be reflected in the entirety of the plan.

MECHATRONIC PROJECT

PROJECT START: Thu, 22-Sep-2022
Display Week: 0

TASK	PROGRESS	START	END
Introduction Phase			
Task 1.1 Brain storming + Instructor's Feedback	100%	12-Sep-22	3-Oct-22
Task 1.2 Meeting + Section Assignation	100%	22-Sep-22	1-Oct-22
Task 1.3 Proposal	75%	3-Oct-22	6-Oct-22
Building Phase			
Task 2.1 Material Purchase Round 1	0%	12-Oct-22	19-Oct-22
Task 2.2 Coding/Software Work Part + Lab Notes 1	0%	8-Oct-22	19-Oct-22
Task 2.3 Circuit Assembly + Lab Notes 2	0%	19-Oct-22	2-Nov-22
Task 2.4 Material Purchase Round 2	0%	19-Oct-22	2-Nov-22
Task 2.5 Code Testing with Assembly Testing + Lab Notes 3 & 4	0%	19-Oct-22	9-Nov-22
Task 2.6 Improvements if Experiments work + Feedback Instructor	0%	9-Nov-22	20-Nov-22
Reporting Phase			
Task 3.1 Term Project Evaluation	0%	5-Nov-22	9-Nov-22
Task 3.2 Lab Notes Copilation	0%	20-Nov-22	1-Dec-22
Task 3.3 Satisfactory Progress	0%	5-Nov-22	9-Nov-22
Task 3.4 Presentation	0%	16-Nov-22	30-Nov-22
Task 3.5 Term Project Report	0%	16-Nov-22	1-Dec-22
Task 3.6 Novel Idea Bonus	0%	20-Nov-22	30-Nov-22



BUDGET AND BUDGET JUSTIFICATION:

As discussed before, the required components for the project and their estimated cost are as follows:

Component	Quantity	Cost (USD $)	Links
Motor Driver	1	6.49	Motor Driver
PixyCam2	1	89.43	PixyCam2
Battery	1	15.99	Battery
Chassis + Wheels + Motors	1	19.91	Chassis + Wheels + Motors
Bluetooth Module	1	15.49	Bluetooth Module
Total		**147.31**	

The significance of most of the components has been clarified in the circuit design portion of the proposal. The most expensive component on our list is the Pixy2 which will be used for the purpose of object detection, object tracking and/or collision avoidance. It is necessary for it to facilitate all these functionalities. If we use different type of camera which might be at a lower price point, but the tradeoff would be that it may not provide all the required functionalities, or the compatibility required for us to be able to control it using Arduino as the Brain.

Another thing included in our component list is the Arduino Board, this may not be an actual expense incurred as we are allowed to use the boards provided to us in our lab kits.

All other components are standard and within the nominal price range. The only components that we could find alternatives were the wheels, motors, and the chassis for the rover. We looked at multiple options and the bundle with a chassis, four DC motors and four wheels seemed to be the most economical option available along with good guarantees for the durability of the product.

ANTICIPATED RESULTS:

The rover is expected to be aware of its surroundings and actively look for the taught object or voice commands to move without colliding. Since Pixy2 is used, the rover must be able to follow one hue in case of absence of a voice command. The rover would move if an object were present and is detected by the Pixy2 else it would stay at the same position.

We expect the rover to be pretty accurate since using the Bluetooth module for voice command is proven to be very effective in short ranges. We will be communicating the voice command to the rover using an android application which ensures precision and accuracy. We expect this rover to have a good performance once the project is complete.