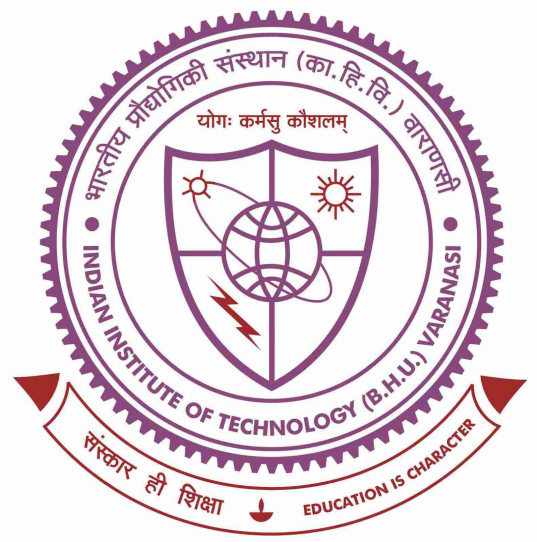

Exploratory Project

Object Tracking Robot Using Image Processing

Under the supervision of Dr. Ramashray Dwivedi

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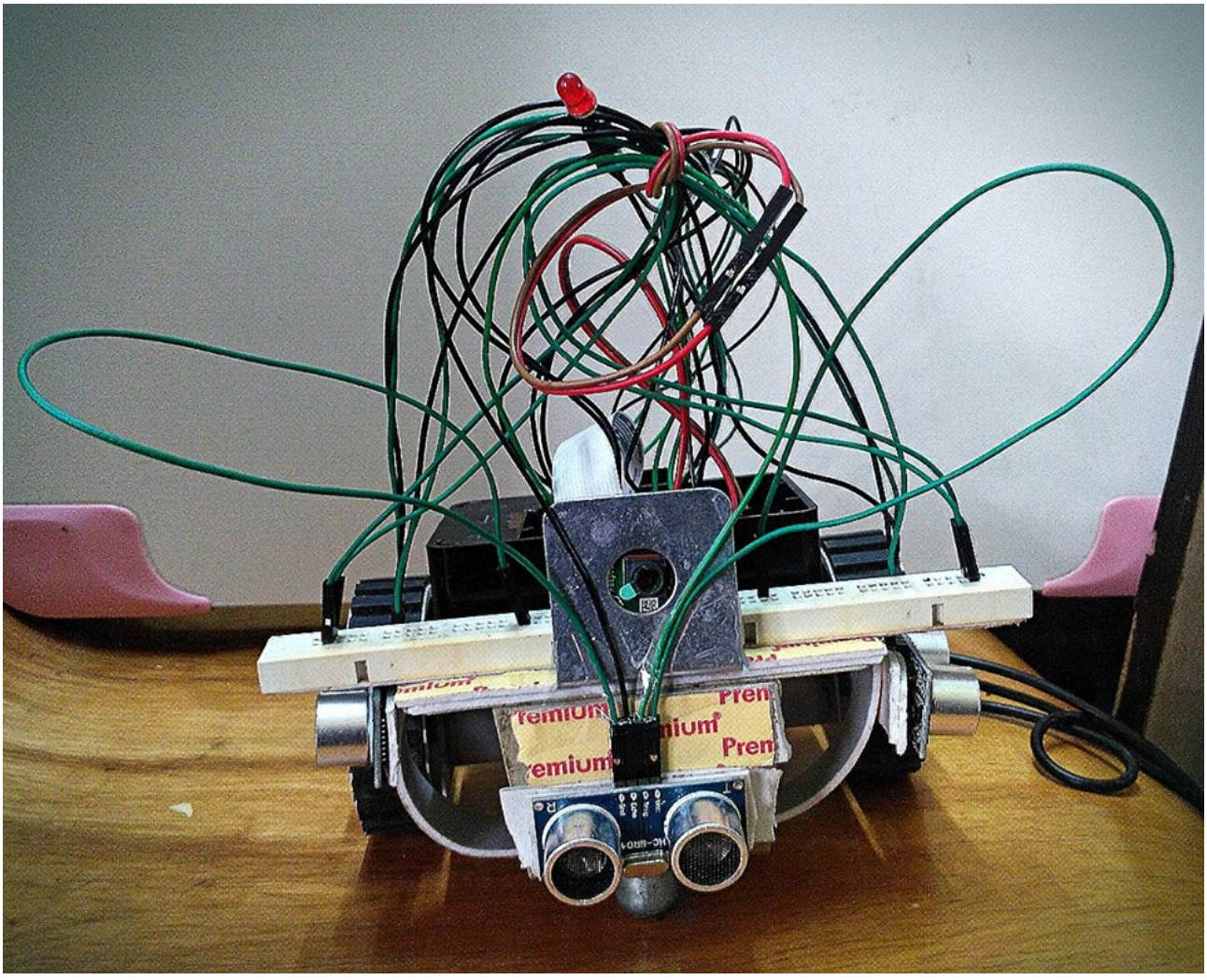
Objective :

In our exploratory project, we have developed a small robotic bot capable of tracking an object of the desired color of our choice through image processing (as specified in the code).



Components required for the project :

- Raspberry Pi 3 model B
- Raspberry Pi Camera Module V2 – 8 Megapixel,1080p
- HC-SR04 Ultrasonic Distance Measuring Sensor Module
- H-Bridge L298n Motor Driver Module
- 100 rpm, 12 Volts DC Motor
- Breadboard
- Connecting Jumper Wires
- 2 Amp, 5 Volts Adapter
- 2 Amps, 12 Volts Adapter
- Super Jumbo Bot Chassis
- Plastic Bot Wheels
- 9V DC battery
- Castor Wheel

Softwares :

- OpenCV
- Python
- Raspbian Operating System

Introduction :

We have specifically built a ball tracking bot. For this, We have used our bot to track a red color ball through image processing ,what our robot does is it rotates in a 360-degree manner until it finds a red color ball and then it moves in the direction of the object and stops in front of it at a certain distance to avoid collision from the object through the use of ultrasonic sensors.

Explanation of process of building the robot :

We have built our robot in three parts.Starting with the assembly of mechanical components that make the body of our bot, followed by the circuitry part where we have made proper connections required for the functioning of the robot then we have done the coding and image processing part of the project.

Mechanical Assembly :

We had started making our robot with the superjumbo chassis as the body of our bot and connected plastic wheels to the bot through its L-clamps to provide motion to the bot. Then we have connected a castor wheel in the front L-clamp to provide free rotation in the bot. Also, We have connected DC motors to both the plastic wheels to provide rotational energy to the wheel when desired for translation of the bot.

We have used bolts and nuts to hold the different parts tightly together with the mechanical chassis.

Circuitry Assembly :

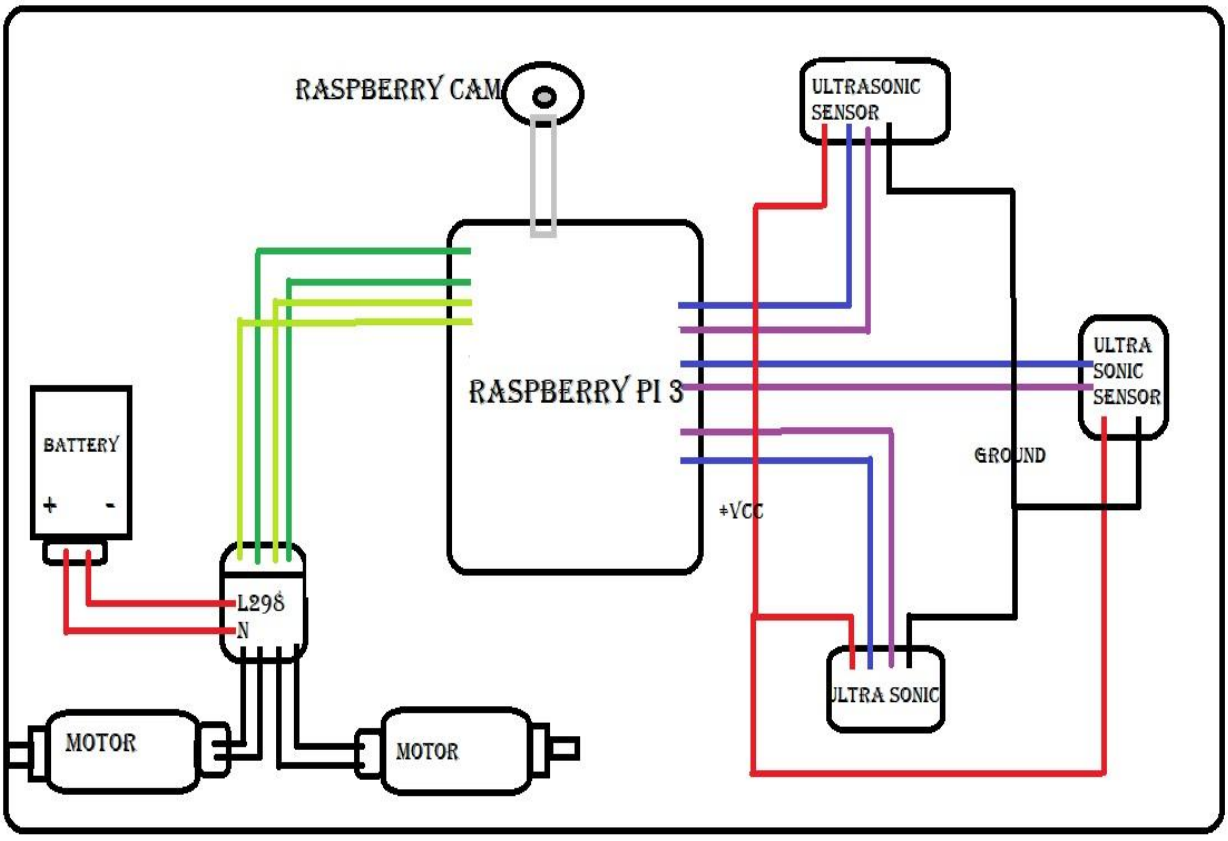
The two DC motors mentioned in the above part each have two terminals one positive and another negative one which is connected to Pin 1, 2 for first motor and Pin 13, 14 for the other motor to L298n. We have given a supply of +12 Volts at Pin 4 and grounded Pin 5 of L298n. We control these motors through Pins 8, 9 and Pins 10, 11 respectively of L298n. For the left motor, these are connected to GPIO Pins 18, 22 and whereas for the right one they are connected to Pins 21, 19 respectively of Raspberry Pi.

Also, we have connected three HC-SR04 in left, right and front directions of bot chassis. We have held these sensors in their place by the use of double-sided tape. Pin 1 of each sensor is given +5V, Pin 4 is grounded, Pin 2 of each left, right and front sensor are connected to GPIO Pins 29, 33, 36 respectively and Pin 3 of each left, right and front sensor are connected to GPIO Pins 31, 35, 37 of Raspberry Pi respectively.
Also, we have attached Raspberry Pi to the bot chassis and given it a supply of +5V, 2 Amps and connected a Raspberry Pi camera module to it. We have used a breadboard to make positive supply and ground common for each module and made connections using male and female connecting jumper wires.

Working of Circuitry :

We first give supply to Raspberry Pi so as to start the Raspbian OS and Raspberry camera module and run the code necessary for object detection, image analysis, and bot traversal. Supply of +12V is given to L298n to run the motors with proper power requirements. The HC-SR04 helps in measuring the distance from an object to avoid a collision by measuring the time taken for ultrasound rays to reach back to the sensor and distance calculation is done in the code. The code initially makes the bot move in 360-degree fashion until it finds a red colored ball then by distance measurements from HC-SR04 it moves to the object in a straight line to a certain fixed distance and stops there. All the data being transmitted for these processes is done through the pin configurations explained in the previous section.

Schematic of circuitry :

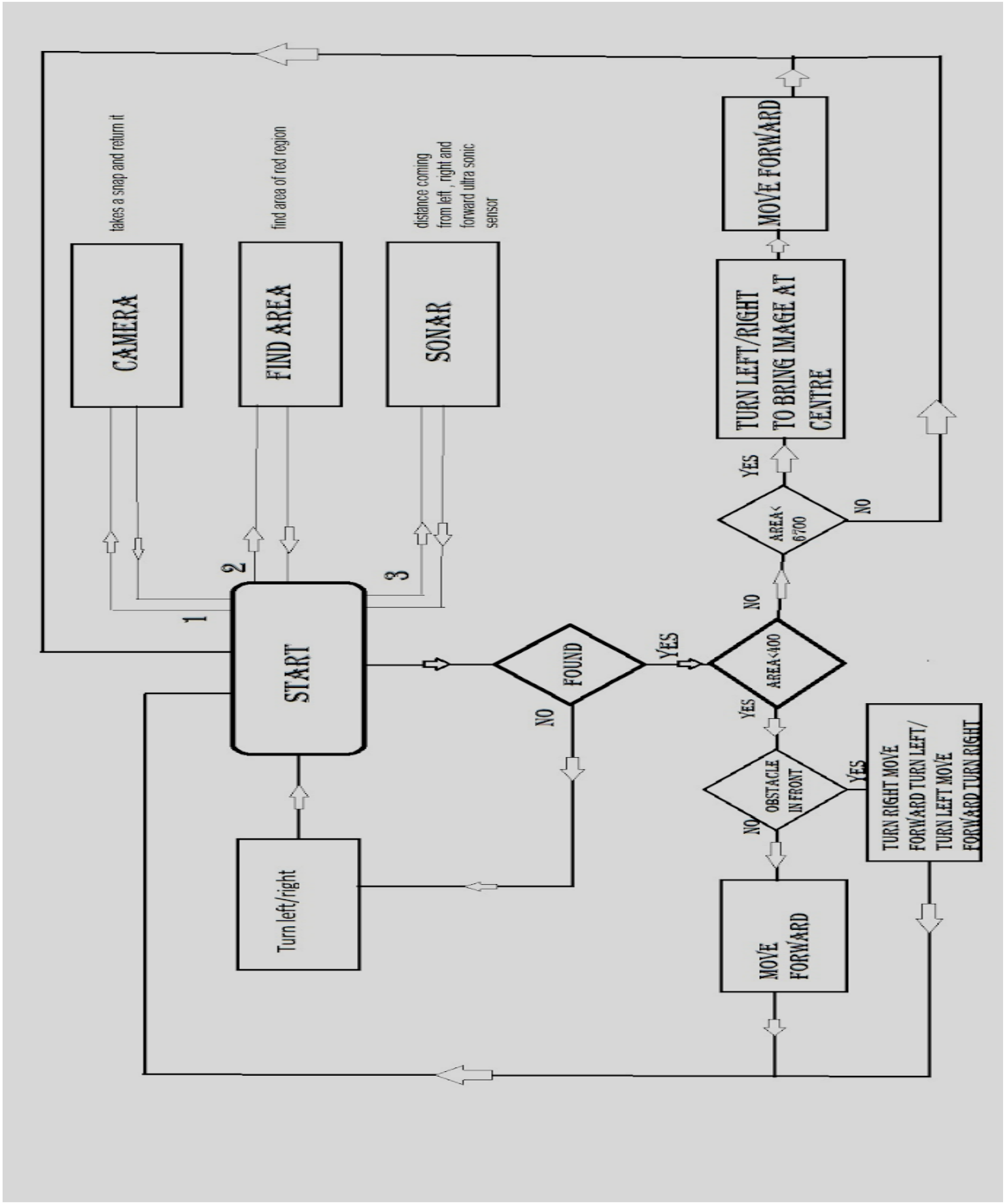


Pseudocode for finding an object :

```
// Function for image conversion
Mask_with red ( frame ) :
    Mask = frame : BGR->HSV ;
    Return mask ;
// Function for finding circular object out of image
Find_circle(blob) :
    Largest_contour = 0, cindex = 0 ;
    Contours = find contours() ;
    //Finding largest area
    For x in contours:
        If( area > Largest_contour ):
            Largest_contour = area ;
        If( length ( Contours ) > 0 )
            L = cv2.boundcircle( ) ;
    Return L ,Largest_contour ;
Frame= takeframe() ;
//Robot working starts here
While ( frame is TRUE ) :
```

```
        Mask_red = mask_withred( frame ) ;
        l = find_circle( mask_red ) ;
        x-cord, y-cord, width, height = l ;
        if ( width * height < 10 )
                NOT FOUND
        else
                FOUND
        Frame = takeframe( ) ;
// Function to find distance from an object
function sonar_working() :
        Elapsed_time = stop_time  -  start_time ;
        Distance = elapsed_time * speed of sound ;
        Distance = Distance / 2 ;
```

Flowchart of working of the robot:



Problems faced during the robot development :

- We had to choose which Raspberry Pi model to use then we went with Raspberry Pi 3 due to its more versatile features.
- Needed to choose which operating system to use on raspberry pi, we choose the Raspbian OS due to its large online community and support.
- Time was spent on considering which library or platform to use for image processing, then we choose OpenCV due to its vast and efficient algorithm implementation in its library.
- We faced a lot of problem in giving proper supply to each module and their respective components.As, most of the time, the supply given to these modules became less than the values required to run them.
- We had problems in properly connecting the wires on bot as the robot when moves make vibrations that make connections come loose.
- We had problems with properly adjusting all the components on the bot chassis due to the problem of space and need to make it compact.
- A lot of time was spent on writing and debugging the python code to ensure its proper working.
- Also, we needed to properly align the castor wheel and plastic wheels to make the bot stable.

Possible applications of our project :

- Can be used in emergency situations or hostile environments for finding humans autonomously and pointing out their locations quickly for proper retrieval of these people in short time.
- Could be used as an garbage and unwanted objects in a house collector and detector appliance.
- It can be used for finding unusual or out of the place objects in busy environments and alert the proper authorities for handling of these situations to avoid possible hazardous situations.
- It could be used as an intruder detector system in a constrained environment like a house or a small field.

Conclusion :

Throughout the building and making of this project.We had dealt with a lot of different aspects of robot making, image processing and mechanical and electronics engineering. We learned different image analysis and filtering techniques and their vectorized algorithmic implementation. Learned proper bot chassis usage and importance of alignment and proper positioning of modules in a bot to make a balanced and compact robot. We learned the usage of Raspberry Pi and its camera modules and their vast potential in electronics and how it acts an efficient small computing machine. Learned about writing proper code with comments and different debugging techniques in the python environment. Also learned about proper supply to be given to HC-SR04, H298n and Raspberry Pi 3 modules. Also learned proper usage of the breadboard to make our connections concise and proper.

Overall a lot of practical knowledge was gained by us during the project development while working as a team.

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