REPORT

Event: Srishti 2020

Indian Institute Of Technology Roorkee

Project name: Swarm Robotics

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OVERVIEW

Every year Models And Robotics Section (MARS) IIT ROORKEE organises annual technical fest "SRISHTI", especially for freshers, where they can sharpen their technical and entrepreneurial skills. Group of few diligent members are assigned to certain projects within a few months, under the mentorship of intuitive MARS members. We got the window of opportunity to be the part of this technical fest where we came out of the idea of building swarm robots , which coordinate among themselves to form various shapes which includes square, triangle, some alphabets and numbers etc.

MOTIVATION

As a swarm of ants work in union to achieve an intimidating task, similarly a swarm of robots can work in union to achieve seemingly impossible tasks. As the enthusiastic newbies we were fascinated by this idea and decided to work on the same.

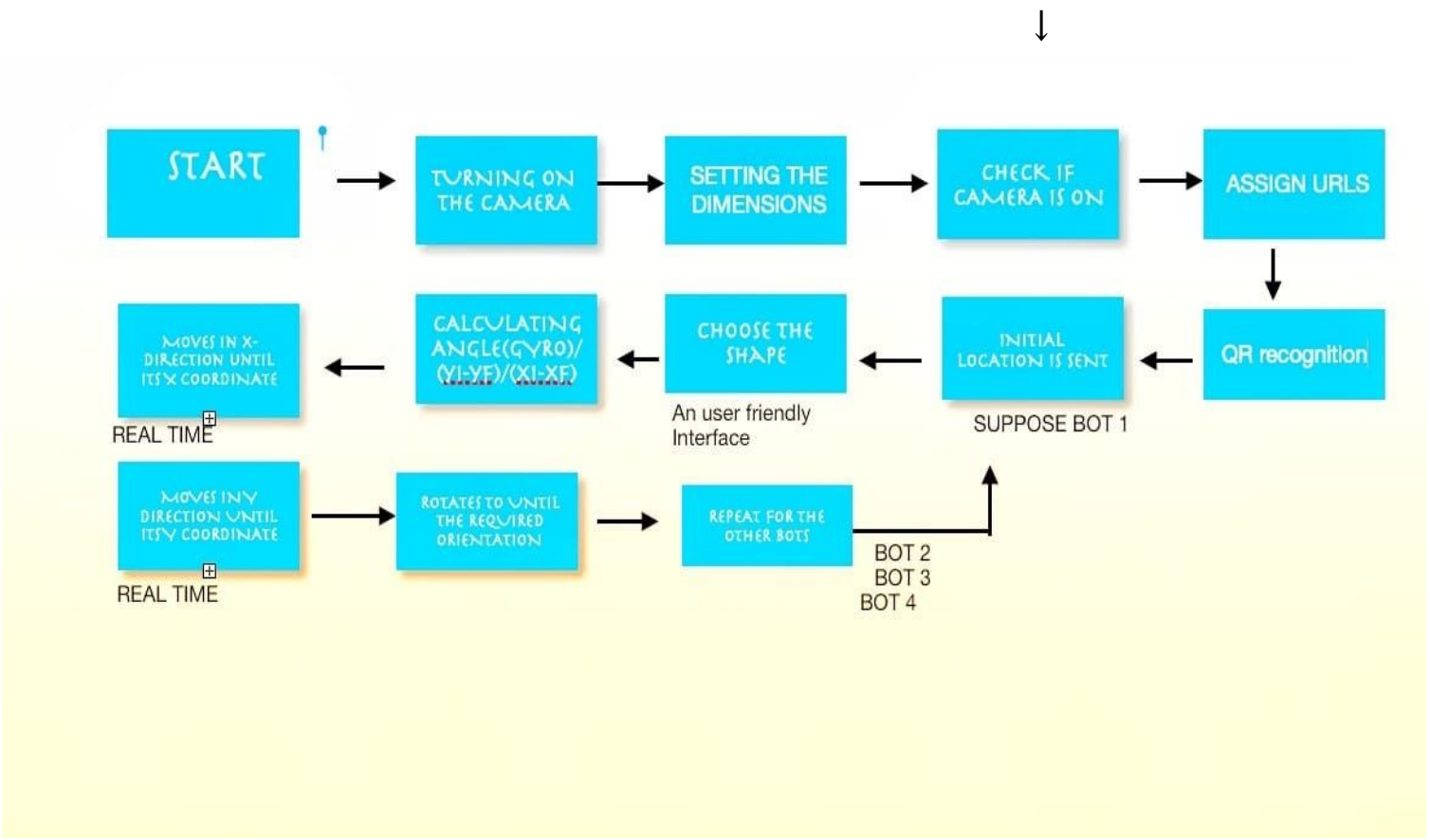
APPLICATIONS

- Tasks that demand miniaturization, like distributed sensing tasks in micro machinery or the human body.

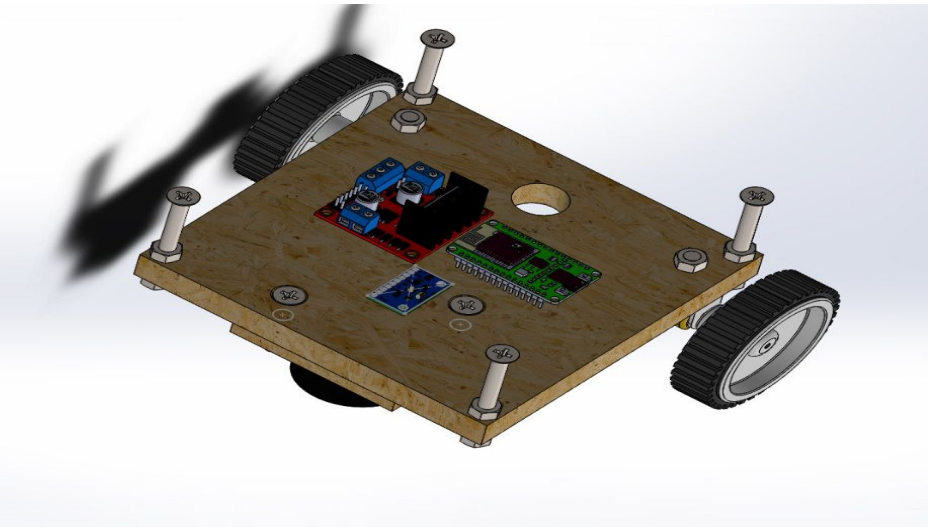
- Swarms can be used in traffic handling.
- Swarms can form different shapes and designs so they can reach forbidden areas.
- One of the promising uses of the swarms is in disaster rescue missions.
- SWARMS CAN BE USED AMID PANDEMIC BREAK DOWN(COVID 2019): As these swarms can provide all the

necessary stuff to the patients,which can prevent doctors and medical staff from coming in direct contact with them.

WORKING



Mechanical Aspect of the design:



Angled view of the bot

Details of Components Used:

1. Plywood

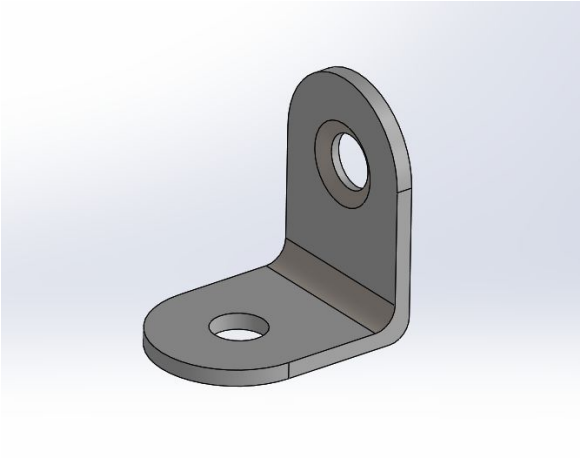
   Larger Plywood a
   cts as a base for assembling all parts of swarm robots and provides support to all items. It has a size of 150x150x15 mm , and has a hole of 20mm on it for connecting motors with Arduino.

   Larger Plywood is also used to make roof of robot which has QR Codes for scanning purpose

   Smaller plywood is used to level the castor wheel with normal wheels and provide stability to bot.

Its size depends on the size of castor wheel , in our case, from the standard cad model of caster wheel, the thickness of smaller plywood is 13.8mm.

2. L-brackets



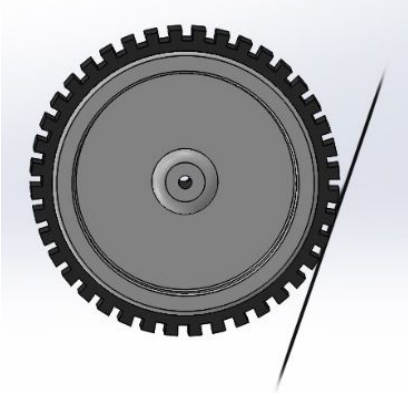
L-brackets are used for mounting motors and holding it in the correct fixed position. It is mounted on a plywood base with the help of 3mm nuts and bolts.

3. Castor Wheel

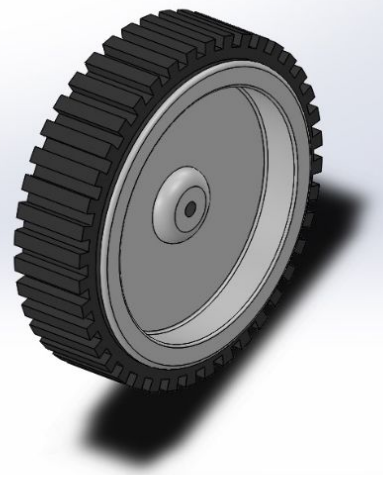
Caster wheel is used in the front part of the robot to provide all direction movement to the robot.

It is mounted below base plywood with help of another ply of appropriate thickness to level castor wheel with normal wheels. Nut and bolt are used for mounting

4. 70mm Wheels

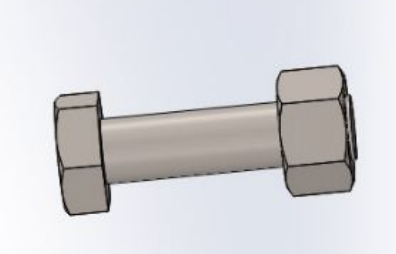


Wheels are used to provide mobility to the robot. It is directly attached to motor and a screw is tightened to motor shaft to prevent the wheels from coming out while robot is moving



Wheel size used in our robot is of 70mm diameter and 20mm thickness which is the size of standard robot wheel available in the market.

5. Nuts , bolts and countersink

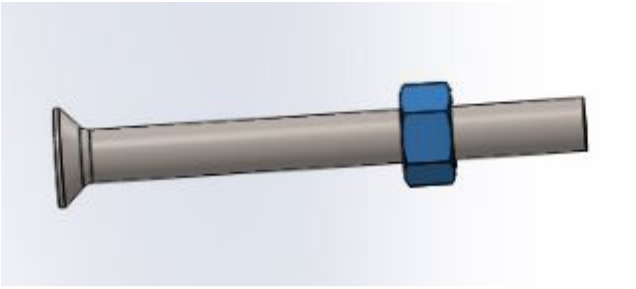


Nut and bolts are used to fix L-brackets,
Castor wheels in the position .

It is also used to keep the roof of the robot at a certain height above base so that it doesn't interface with any electronic parts. For fixing Caster wheel and L-brackets nut and countersink of size 3mm is used.

For keeping the roof at a certain height, a nut and countersink of size 6 mm diameter is used, with one nut below base and one on base as shown in figure.

Here the countersink is used as the head of the countersink gets embedded in plywood and thus there is no protruding head in the roof of the robot.



Electronics Aspect of the Design:

Details of Components Used:

1. Microcontroller :

   A **microcontroller** is a compact integrated circuit designed to govern a specific operation in an embedded system. In this project, we need a microcontroller that can receive information in wireless mode. So, we used a NodeMCU in this project.

   NodeMCU is an open source firmware for which open source prototyping board designs are available. The name "NodeMCU" combines "node" and "MCU" (micro-controller unit).

   The model we used is ESP8266 NodeMCU.The ESP8266 WiFi Module is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor.

   In our project, we not only used it for data transfer from the host to an individual bot but also as a substitute for an ordinary Arduino microcontroller unit.

2. Gyroscope Sensor :

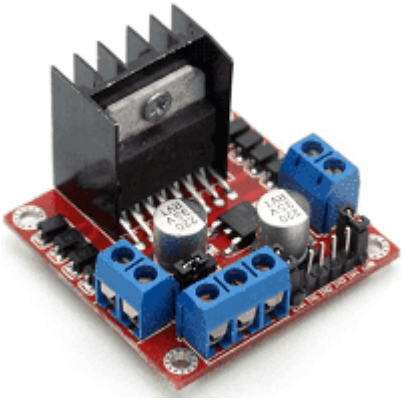
Gyroscope sensor is a device that can measure and maintain the orientation and angular velocity of an object. These are more advanced than accelerometers. These can measure the tilt and lateral orientation of the object whereas an accelerometer can only measure linear motion.

The concept of Coriolis force is used in Gyroscope sensors. In this sensor to measure the angular rate, the rotation rate of the sensor is converted into an electrical signal.

In this project, we used the MPU-92/65 model of gyroscope sensor. The gyroscope sensor gives us the angle rotated by the bot i.e. Angle between the direction of bot at time t and the initial direction of the bot.

3. Motor - Driver :

A motor driver is an integrated circuit that makes the motor move as per the given instructions or the inputs (high and low). It listens to the low voltage from the controller/processor and controls an actual motor which needs high input voltage.



The model of the motor-driver we used is L298. This motor-driver can control 2 DC motors at the same time. So we need a single motor driver for each bot.

While connecting a motor driver to a battery, it must be carefully noted that the positive terminal of the motor

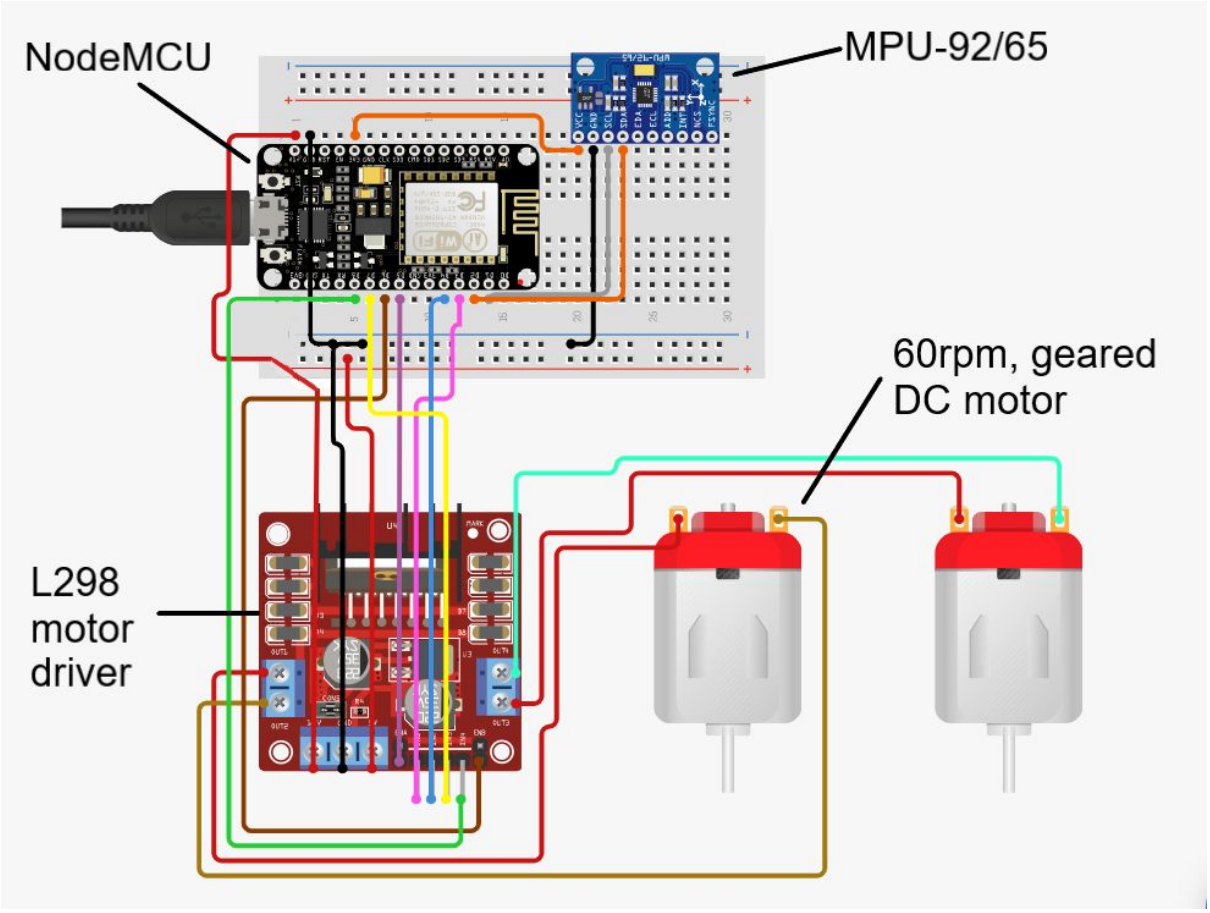
driver must be connected to the positive terminal of the battery, and vice versa. Otherwise, it might cause damage to the motor-driver.

4. DC-motors :

The electric motor operated by direct current(DC) is called DC motor. This is a device that converts DC electrical energy into a mechanical energy. This type of motor comes in different rantings of Torques and RPM(maximum Rotation per minute)

In this project, we used a 60 rpm DC metal geared motor. For each of the bot, we need 2 DC motors.

Electrical Connections :



The electrical connections should as shown in the figure. But it should be noted that the figure is for connectivity purposes only. In actuality, gyroscope when connected to the microcontroller via jumpers, shows non negligible error in angle detection. So, while using the gyro with the microcontroller, we need to solder a perfboard to connect the gyro with the microcontroller. Thus in actuality, we use a soldered perfboard at the place of breadboard.

Real-time QR code reading with OpenCV

Open cv facilitates the process of reading QR codes, including loading images from disk, grabbing a new frame from a video stream, and processing it.

Important libraries we imported are pyzbar, `argparse` and `cv2`.

The ZBar library will decode the barcode or QR code. OpenCV can come back in to perform any further processing and display the result.

For Python, we use pyzbar, which has a simple decode function to locate and decode all symbols in the image. The decode function simply wraps pyzbar's decode function and loops over the located barcodes and QR codes and prints the data.

The decoded symbols from the previous step are passed on to the display function . If the points form a quad (e.g. in a QR code), we simply draw the quad. If the location is not a quad, we draw the outer boundary of all the points (also called the convex hull) of all

the points. This is done using an OpenCV function called cv2.convexHull.

Finally, the main function simply reads an image, decodes it and displays the results.

STEPS:-

1. Placing components
    A. Place NodeMCU
    B. Place DCMDriverL298
    C. Place DCMotor_A
    D. Place DCMotor_B
    E. Place MPU9265
2. Connect NodeMCU
    - NodeMCU1 GND to Bus GND
3. Connect DCMDriverL298
    - DCMDriverL298 OUT1 to DCMotor_A Coil2
    - DCMDriverL298 OUT2 to DCMotor_A Coil1
    - DCMDriverL298 OUT3 to DCMotor_B Coil2
    - DCMDriverL298 OUT4 to DCMotor_B Coil1
    - DCMDriverL298 12V to Bus POS
    - DCMDriverL298 5V to NodeMCU Vin (Power Input of NodeMCU)
    - DCMDriverL298 ENA to NodeMCU1 D5

- DCMDriverL298 ENB to NodeMCU1 D6
- DCMDriverL298 GND to Bus GND
- DCMDriverL298 INT1 to NodeMCU1 D3
- DCMDriverL298 INT2 to NodeMCU1 D4
- DCMDriverL298 INT3 to NodeMCU1 D7
- DCMDriverL298 INT4 to NodeMCU1 D8

4. Connect MPU9255
    - MPU9255 GND to Bus GND
    - MPU9255 SCL to NodeMCU1 D1(On perfboard using male and female headers)
    - MPU9255 SDA to NodeMCU1 D2(On perfboard using male and female headers)
    - MPU9255 VCC to NodeMCU1 3V3
5. Connect Battery and Switch
    - Connect BUS POS to the positive terminal of the battery.
    - Connect BUS GND to the switch and then the negative terminal of the battery

Cost Structure

Part	Quantity	Cost per unit	Total cost
ESP9266 (NodeMCU)	4	330	1320
L298 (Motor Driver)	4	250	1000
60rpm DC Motor	8	200	1600
MPU 92/65 (Gyroscope)	4	300	1200
Overhead Camera (WebCam)	1	3000	3000
12V Li-polymer Battery	4	2000	8000
Jumpers	60	5	300
Nut & Bolt (Medium)	16	5	80
Nut & Bolt (Long)	16	10	160
L - Brackets	8	15	120
Normal Wheels	8	30	240
Castor Wheels	4	25	100

PlyWood	1	280	280
Miscellaneous	-	-	600
Total			Rs.18000/-