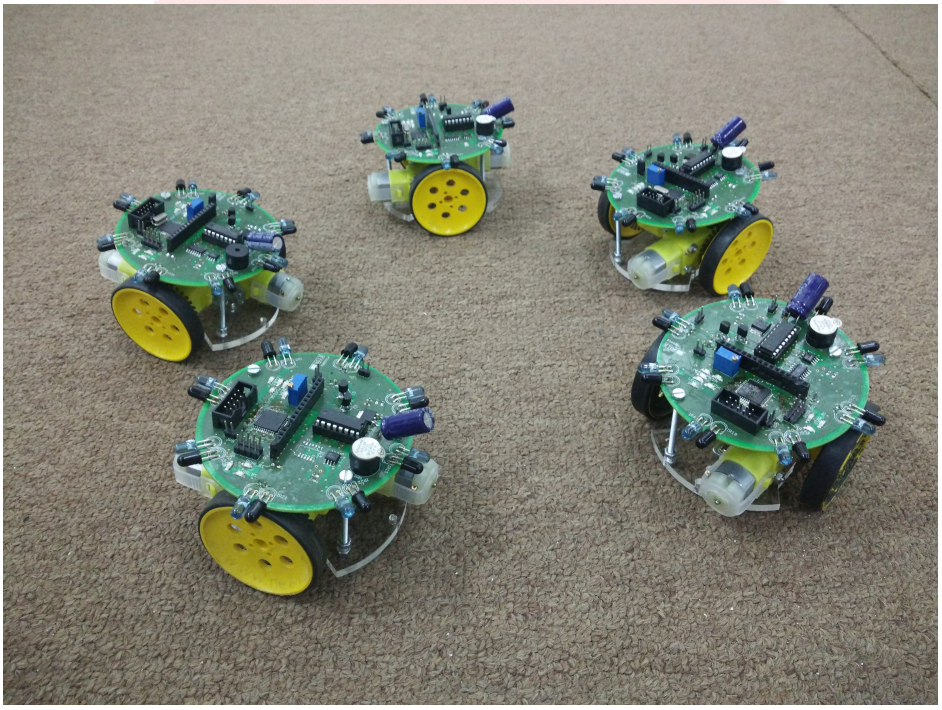
eYSIP2017

# Distributed robotics - multi swarm robots



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# Distributed robotics - multi swarm robots Hardware manual

## 1.1 Abstract

Swarm robotics is a field in robotics which implements coordination of multi robot systems which consist of large number of robots having simpler robots. There is a collective behavior that emerges from interactions between robots and interactions of robots with the environment. This behavior is emerged from field of biological studies of fishes, birds, ants, insects, etc. Application of swarm robotics varies from military, aviation to collective behavior of self driving cars. The objective of the project was to build miniaturized swarm bots and develop an algorithm for generic shape formation.

### Following points are completed:

- Study the concepts of swarm robotics and get familiar with different robots available
- Study the kinematics of differential drive configuration
- Selecting appropriate sensors to be added
- Designing the PCB
- Assembling all the components
- Making of Mini bots
- Testing of Mini bots
- Implementing circle formation of asynchronous fat robots with limited visibility in V-REP simulator

- Developing and implementing generic shape formation algorithm for a system of distributed robots in V-REP simulator
- Implementing follow the leader swarm behavior on Mini bots
- Implementing rendezvous swarm behavior on Firebird V robots

# Hardware parts

- List of all hardware components are available here
- Microcontroller Atmega16 Datasheet, Chip component, Lamington road, Mumbai
- Hex buffer CD40106 Datasheet, Chip component, Lamington road, Mumbai
- Motor driver L293D Datasheet, GALA Electronics, Lamington road, Mumbai
- Comparator LM158 Datasheet, Chip component, Lamington road, Mumbai
- Actuators BO motors: 60 rpm 12 volts
- LCD 16x2: GALA Electronics, Lamington road, Mumbai
- Position encoders MOC7811: GALA Electronics, Lamington road, Mumbai
- ISP programmer STK500v2: , Nex robotics
- IR proximity sensors: GALA Electronics, Lamington road, Mumbai

# Softwares used

- **Autodesk Eagle 7.6.0**
  - Download Eagle
  - Video tutorials on YouTube
- **V-rep 3.4.0**
  - Understanding V-REP for beginners
  - Downloading V-REP
  - For more details on V-REP
- **Autodesk Fusion 360**
  - To download fusion 360 and get details on it
- **Avrdude**
  - To download Avrdude and get details on it
- **Avrgcc**
  - Worked on windows platform
  - To download Winavr to get avrgcc
  - To understand avrgcc
- **Texstudio**
  - Download Texstudio
- **Git**
  - Link to our github repository
  - Download Git

# Assembly of hardware

Refer to our Hardware Manual to understand Mini Bot better

## 4.1 Circuit Diagram

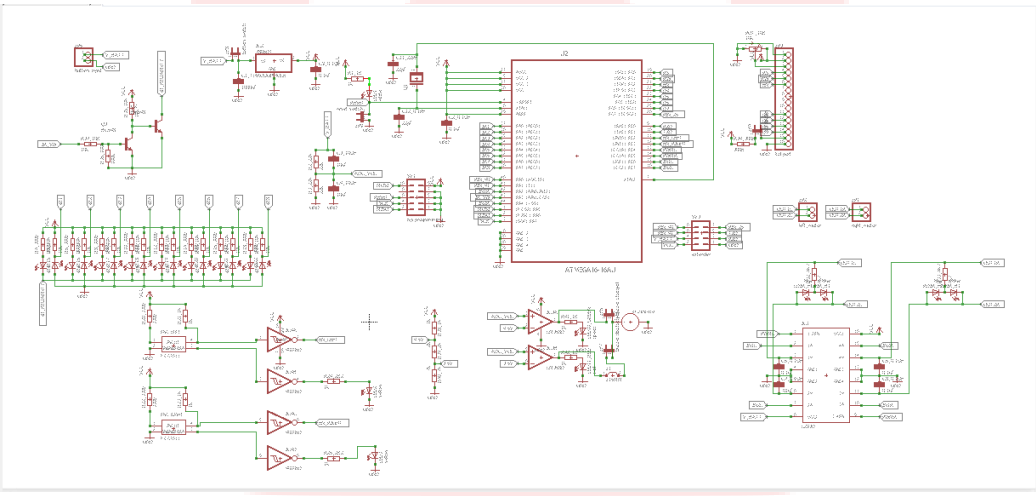

Figure 4.1: Overall schematic of Mini Bot PCB

**Main circuits:**

- L293D motor driver circuits: refer to Motion control section of Hardware Manual
- Position encoders circuits: refer to Position encoders section of Hardware Manual
- IR sensors circuits: refer to Infrared proximity and Directional light intensity sensors section of Hardware Manual
- Battery voltage sensor circuits: refer to Battery voltage sensor section of Hardware Manual

## 4.2 Steps to build Mini Bots

### Step 1: PCB designing and routing

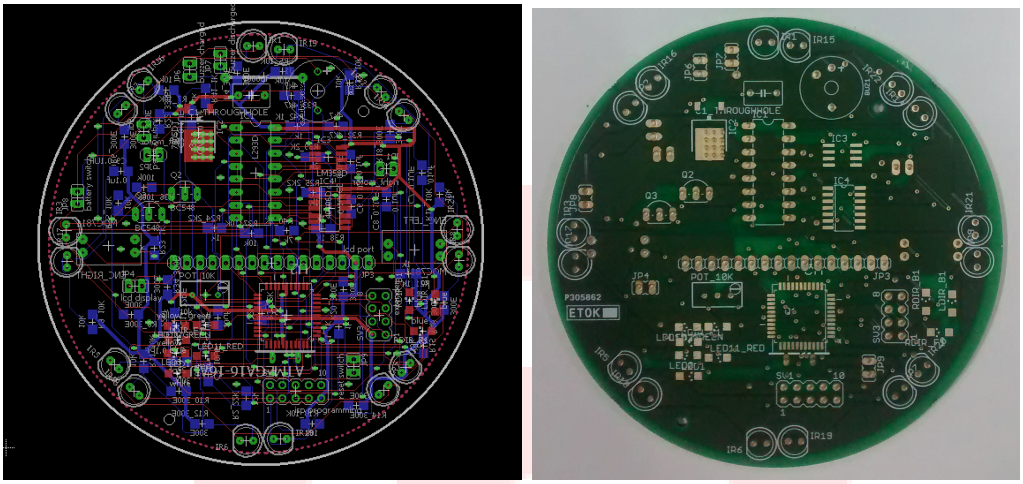

Figure 4.2: Routed and Printed PCB respectively

We used Eagle software for designing the PCB. Gave printing of PCB to PCB power, Circuit Systems India Ltd., Gujarat.

### Step 2: Designing of chassis

We design chassis in Fusion 360 and got it laser cut on 5mm acrylic sheet in Tata Centre, IIT-B. The straight BO motors were fixed with L-clamps and then attached to chassis as shown in figure 4.3.

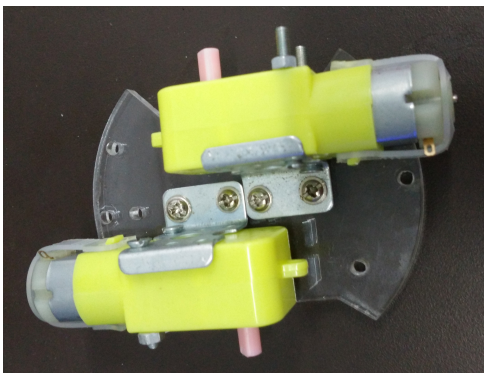

Figure 4.3: Chassis design

## Step 3: Soldering components on PCB

Soldering the SMD components onto the PCB, based on the schematics.


Figure 4.4: Soldered PCB

## Step 4: Assembling the robot

The motors are attached to the chassis and the PCB is screwed to the chassis. The battery connections are appropriately made.

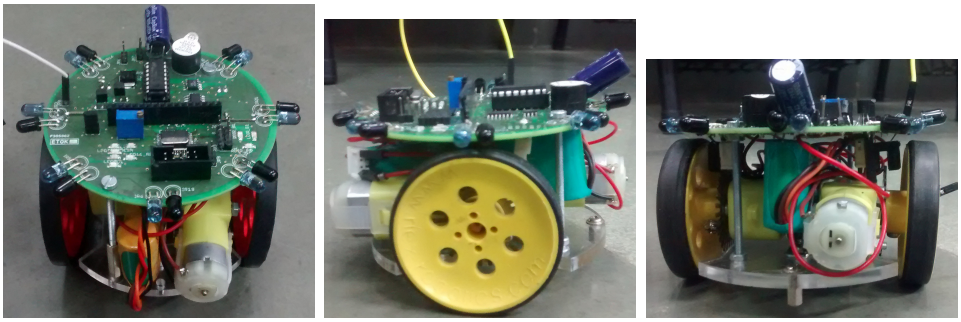

Figure 4.5: Assembled robots

# Software and Code

## 5.1 Github repository

Github link for the repository of code

Github repository contains all the documentation and code of the project worked on. The document folder contains the manuals for hardware components/structure of Mini bots, generic shape formation algorithm for system of distributed robots and a small article to understand the working of V-REP simulator. It also contains video results of the project.

The code folder contains following codes:

- C code for P controller for angular control
- Embedded C code for rendezvous problem (Firebird V platform)
- Eagle EDA project folder
- Test code for Mini Bots
- V-REP project for circle formation of fat robots
- V-REP project for generic shape formation

# Use and Demo

Videos of the demos can be seen here

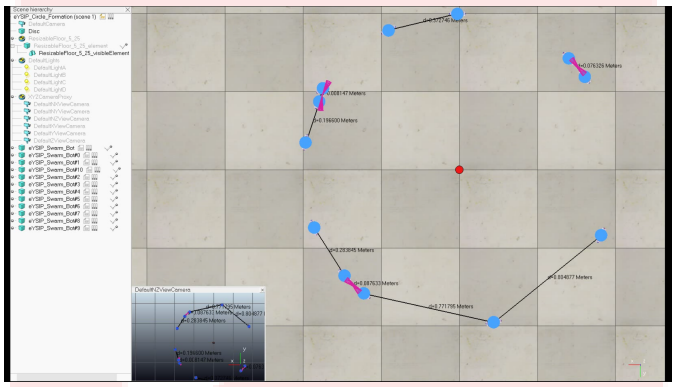

Figure 6.1: Multiple robots forming a circle based on algorithm defined in "Circle formation for asynchronous fat robots with limited visibility" in V-REP simulator.

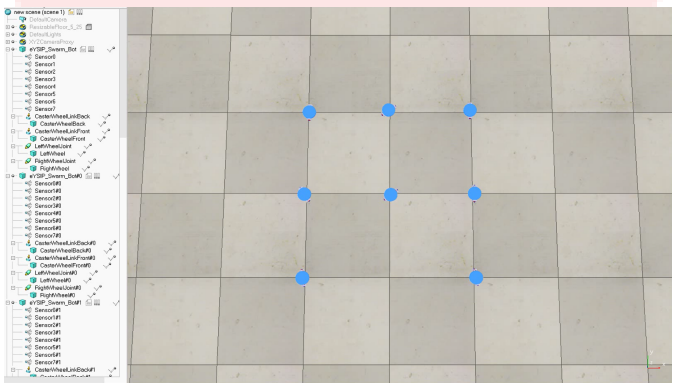

Figure 6.2: Multiple robots forming shape A based on the algorithm defined in "Generic shape formation algorithm for a system of distributed robots" in V-REP simulator

Figure 6.3: Follow the leader swarm behavior portrayed by our Mini bots

# Future Work

- Design an outer covering
- Implementing circle formation algorithms on Mini bots
- Implementing gathering algorithms on Mini bots
- Solve shape formation with Mini Bots
- Solve collision of homogeneous dynamic swarm robots
- Find a better algorithm for tie breaking when many robots approach a single point

# Bug report and Challenges

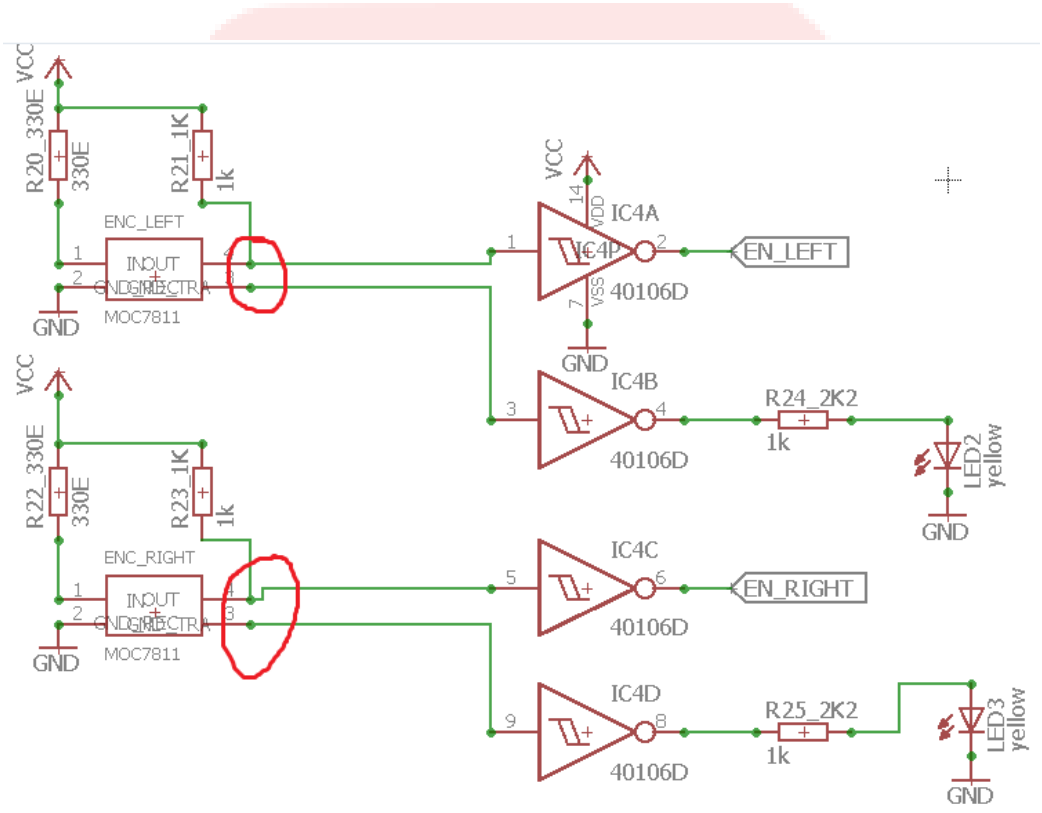


Figure 8.1: Position encoder connection

Bugs: Pin 3 of both encoders was supposed to be shorted to ground and connection to buffer connected to led was supposed to be shorted to pin 4
Fix: The bug is fixed by shorting pin 3 to ground externally

Challenges faced:

- Placing components and routing air wires of PCB.

- Reducing overall size of PCB
- Understanding different algorithms for circle formation and gathering algorithms for swarm robots to determine a common point for resolving global coordinate system
- Soldering SMD components accurately

# Bibliography


[1] Ayan Dutta, Sruti Gan Chaudhuri, Suparno Datta and Krishnendu Mukhopadhyaya, *Circle formation by asynchronous fat robots with limited visiblity*

[2] Sruti Gan Chaudhuri and Krishnendu Mukhopadhyaya, *Gathering Asynchronous Transparent Fat Robots*

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