THE ROBOCON DIARY 2011-2012

Indian Institute of Technology Delhi

July 15, 2012

The Robocon Diary 2012

The Robotics Club IIT Delhi proudly presents before you, Robo Diary, our club's annual report on Robocon. The Robotics Club, IIT Delhi is located on the first floor of the Students Activity Centre and is one of the most active technical clubs in IIT Delhi. Following is a detailed account of our year round preparation for, and participation in ROBOCON, the annual inter college Robotics contest held in Pune from March 1st to March 3rd 2012.

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ACKNOWLEDGEMENTS

We, the team members of ROBOCON 2012 sincerely acknowledge the financial, logistical and moral support provided by Professor R.K. Shevgaonkar, Director of IIT Delhi, and Professor Surendra Prasad, former Director IIT Delhi, whose support has been instrumental in all our activities throughout the year and without whom, we would not have been able to participate in Robocon 2012. We also sincerely acknowledge the support of Prof. Shashi Mathur, Dean of Students, Prof. S.K. Saha (Associate Dean of students) and Prof. Aditya Mittal, BRCA President, in allocating funds for all our activities. We take this opportunity to specially thank Prof. S.K. Saha, our mentor and Faculty-in-Charge and Prof. Kolin Paul for their insight and motivation. Last, but not the least, we also place our thanks to Assistant Registrars of the Accounts and Stores, and Purchase Sections for their support in reimbursement of bills in a very short duration.

Certificate

The following fifteen students of IIT Delhi have participated in *DD-MAE-Robocon-2012 held in Shree Shiv Chhatrapati Sports Complex, Pune (1st -3rd March,2012):*

- Mr. Dhruv Gelda: Team Leader
- Mr. Nirupam Gupta: Coordinator
- Mr. Avnish Kumar: Coordinator
- Mr. Pankaj Fauzdar: Electrical Department
- Mr. Kunal Sethiya: Electrical Department
- Mr. Piyush Dane: Electrical Department
- Mr. Abhimanue Jalan: Electrical Department
- Ms. Harveen Kaur: Electrical Department
- Mr. Ankit Goyel: Mechanical Department
- Mr. Viplove Arora:Mechanical Department
- Mr. Vishal Mehta: Mechanical Department
- Mr. Konik Kothari: Mechanical Department
- Mr. Gaurav Kumar: Mechanical Department
- Mr. Manikanth Devarakonda: Mechanical Department
- Mr. Vijay Lavahale: Mechanical Department

Prof. Subir Kumar Saha — Dr. Kolin Paul

Guide — Guide

Above students have worked for DD-MAE-Robocon-2012, held in Shree Shiv Chhatrapati Sports Complex, Pune (1st -3rd March,2012) after working on the design, fabrication and testing of the robots for the Robocon competition since September, 2011 when the game plan was declared in www.aburobocon2012.com.

The Team

Following is a list of the team for ROBOCON 2012, with witty one-liners that best describe them.

- **Dhruv Gelda: Team Leader**-

  He is the guy who had the tedious responsibility of listening to 15 screaming nerds, (Dhruv, being one of them) and coming to a conclusion which met everyone's approval.

- **Nirupam Gupta: Coordinator**

  The one guy who ensured that all our components arrived as early as possible, often at his personal cost!

- **Avnish Kumar: Coordinator**

  Avnish worked extensively on strategies and resolving tactical issues:

- **Pankaj Fauzdar: Electrical Department**

  The one guy who made Robocon happen for us. The most consistent of our lot, Pankaj managed the club's finances and the technical part amazingly well.

- **Kunal Sethiya: Electrical Department**

  When it came to perseverance and dedication, this guy was impossible to beat.

- **Piyush Dane: Electrical Department**

  The guy slogged in the MCA department throughout the day, managed our club's finances during his breaks, and then, perfected our algorithms till dawn.

- **Abhimanue Jalan: Electrical Department**

  Though this guy was particular about keeping spares of just about everything under the sun, his laptop, which contained most of our codes, but was sans a spare, was the most prized possession of ours

- **Harveen Kaur: Electrical Department**

The only "guy" who preferred to work during the day, Harveen played a key role in interfacing all our new devices, and worked extensively on the collector robot

- **Ankit Goyel: Mechanical Department**

Always in the line of fire for his urge to order expensive things and never use them, Ankit took the initiative to introduce new instruments in our robots

- **Viplove Arora:Mechanical Department**

Having been a part of last year's Robocon team as well, Viplove was the "experienced" guy, cool as a cucumber, lending a practical approach to all problems.

- **Vishal Mehta: Mechanical Department**

True to his name, the guy was always ready to do the "heavy" jobs, be it drilling, sawing or filing. Brimming with ideas, he was sure to conjure up a solution to any problem.

- **Konik Kothari: Mechanical Department**

Be it a moment of delight or disaster, this guy never ceased to have a smile on his lips! A maestro at calculations, he helped make our designs technically sound

- **Gaurav Kumar: Mechanical Department**

Famous for his style of speaking and the long hours he spent on phone, Gaurav made sure that all mechanical problems that arose during testing were immediately corrected.

- **Manikanth Devarakonda: Mechanical Department**

Slow but steady, Manikant was not only an indispensable worker but his antics were a constant source of amusement for the team too!

- **Vijay Lavahale: Mechanical Department**

Seeming to follow the mantra "actions speak louder than words", this quiet guy made his presence felt by his diligence

Team Leader speaks

Well, it's always difficult to put into the words an experience such as Robocon. We, a team of 15 members, worked hard every night for eight months with a single objective in mind to win the competition and one can imagine the kind of emotional turbulence one undergoes every time the memories are brought back. It seems like just yesterday that the competition got over and all of us returned to our homes. The infinite learning experience both on the technical and the managerial aspect, the art of negotiation with the different people we meet in the way to get our work done and the practice of working in a team and realizing the goal together as a team rather than an individual were some of the priceless things that we extracted through this competition.

As a Team Leader, there is always some extra burden as the responsibility of guiding the team in the right direction so that all the acts of the team contribute positively towards the common goal, lies on your shoulders. Our path, too was full of pinches, there were at times situations when the whole planned out process suddenly dashed against the wall as the strategies failed and we were forced to start from square 1. But It was during these times that the team members took charge of their responsibilities themselves and the enthusiasm of the team was unparalleled. These moments were inspirational and were also the reason that the ship of our team propelled and survived even the worst conditions. Though the result of the competition did not land in our favour and this has been happening over the past few years, does not mean that our preparation in any field lacked. We were a little late in implementation of the new technologies and due to the tight curriculum we face here in academics it has not been so easy for us to do the kind of work everyone expects. Despite of all this, the morale of the team is not down. We went there, learned a lot of the new things from other teams, both technical and organisational, and will try to remove all the ills that we faced this year by proper management of time. Cheers!

1. The Problem Statement

1.1. Theme of the Contest

Figure 1.1

The idea behind the Robocon problem statement is always inspired by a theme, “Peace and Prosperity”[Fig 1.1] , being the theme this year.

Cheung Chau, one of those little islands of Hong Kong, was once devastated by a plague in the late Qing dynasty; accordingly local residents set up a sacrificial altar in front of Pak Tai Temple to pray for peace, which ended the plague. Since then, the residents on Cheung Chau organize a Bun Festival every year.

At midnight, athletes scramble up one of the towers to grab the top-most ‘luckiest’ buns as told in traditions so as to achieve “PengOn Dai Gat”, that means peace and prosperity.

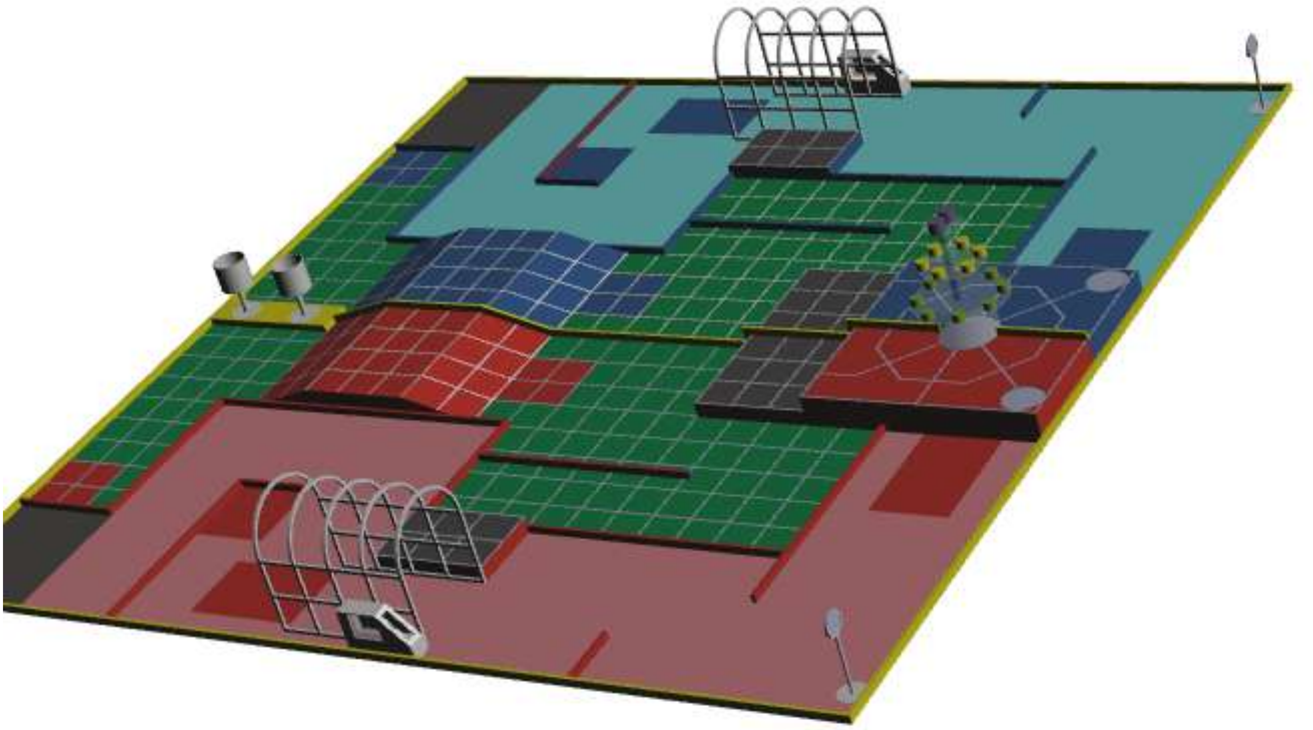

Figure 1.2 3D View of the Field

1.2 Game Procedure & Competition Tasks

1. Manual Robot’s operator navigates Manual Robot from Manual Robot Starting Point to the Token Stand.
2. Manual Robot picks up the Token at the Token Stand and carries it to the tunnel
3. Arriving at the Tunnel, Manual Robot inserts the Token into the Token Box (10 Points).
4. When the Token is totally put inside the Token Box, motion of Automatic Robot can be self-started or started by “one push

button" by a team member after the signal from referees. Automatic Robot may start picking up the Basket in the Common Zone and puts it in any place of Manual Robot Zone (20 Points). Or, Automatic Robot may start later as the strategy of the team. The task of putting the Basket in Manual Robot Zone will be considered as "Completed" when the Basket is put in Manual Robot Zone and is standing on its own on its bottom base; it means there is no contact between the Basket and neither Automatic Robot nor Manual Robot.

5. Manual Robot goes through the Tunnel and proceeds to Collector Robot Starting Point.
6. Manual Robot picks up Collector Robot at Collector Robot Starting Point.
7. Manual Robot carries Collector Robot and navigates through the zigzag path in which obstacles are present.
8. When Collector Robot is completely separated from Manual Robot and transferred to Automatic Robot, motion of Automatic Robot can be self-started or be started by a team member by "one push button".
9. Automatic Robot carries Collector Robot across the Bridge towards Collector Robot Loading Area 2 or Loading Area 3.
10. After transferring Collector Robot to Automatic Robot, Manual Robot is allowed to pick up the Basket when it is placed in Manual Robot Zone and puts the Basket in the Basket Area on the Island(10 Points). When the Basket was placed at the Basket Area, no robot is allowed to touch the Basket.
11. Automatic Robot must unload Collector Robot inside Loading Area 2 or Loading Area 3. Collector Robot is not allowed to touch the game field before being unloaded inside Loading Area 2 or Loading Area 3 (30 Points).
12. Collector Robot can either leave Automatic Robot and climbs the stairs onto the Island from Collector Robot Loading Area 2, or it can be lifted up to the Island by Manual Robot from Collector Robot Loading Area 3.
13. The actions of Collector Robot must start-up by push-button to be pushed by Automatic Robot / Manual Robot, or, a non-radio signal emitted by Automatic Robot or Collector Robot can automatically start itself.

14. Buns in the Middle and the Lowest Layer can be picked up and put into the Basket by Collector Robot itself while it is not in touch with Manual Robot and stands on the Island by itself. Buns will be considered as “Collected” only when they were picked up and clearly put into the Basket. Buns dropped on the game field can’t be used again. (10 Points per Lowest Level Bun, 25 Points per Middle Level Bun)
15. A team’s Collector Robot can only pick up Buns placed on its side of the Tower.
16. Manual Robot can directly pick up Buns from the Lowest Layer of the Tower during the last one minute of the game, therefore 2 minutes from the start. It is not allowed to pick up Buns from the upper two layers.
17. After at least one Bun from each of the Middle and Lowest Layers were picked up and put into the Basket, the Bun at the Top Layer can be touched and picked up by Collector Robot while Collector Robot is being lifted up from the surface of the Island by Manual Robot.
18. Once Collector Robot puts the Top Bun into the Basket after successfully put at least one Bun from each of the two lower layers into the Basket, the match will immediately end. This is called “PengOn Dai Gat”. If neither team achieves the “PengOn Dai Gat” within 3 minutes, the winner will be decided by the total scores of the team in this match.

1.3 Robot Specifications

1. Each team is required to build 3 robots: one Manual Robot, one Automatic Robot and one Collector Robot.
2. Power sources of the robots
    i. The voltage of the power sources used by each robot must not exceed DC24V.
    ii. The pressure of the compressed air power must be less than 6 bars.
3. Weights of the robots
    a. The total weight of all robots must not exceed 50kg.
    b. Manual Robot must not exceed 25kg.
4. Automatic Robot

a. Automatic Robot must perform its tasks automatically after it is started.
b. In Automatic Robot Starting Point (A), Automatic Robot must have its dimension no larger than 1M in length, 1M in width, and 1M in height. Automatic Robot can expand, stretch or extend within a cylinder of 1.5M in diameter considered from top view. No stretch up in height is allowed.
c. Automatic Robot must be a single body and only one Automatic Robot is allowed.

5. Collector Robot
    a. Collector Robot must perform its tasks automatically after it is started.
    b. In Collector Robot Starting Point (C), Collector Robot must have its dimension no larger than 1M in length, 1M in width and 1.3M in height. The robot can expand, stretch or extend within a cylinder of 2M in diameter considered from top view. It's fully extended total height must not exceed 1.3 M.
    c. Collector Robot must be a single body.
6. Manual Robot
    a. Manual Robot is operated by a team member. The operator has to ride on the robot.
    b. The operator is not allowed to actuate or control the movement of Manual Robot by mechanical means except for steering. All the energy source of the robot should not come from Manual Robot Operator.
    c. In Manual Robot Starting Point, Manual Robot must have its dimension no larger than 1.5M in length, 1M in width and 1.5M in height. Manual Robot can expand, stretch or extend without any limits. (Caution: the size of Manual Robot should be able to go through the Tunnel.)

1.4 Field Description[Fig 1.2]

1. The game field consists of Manual Robot Zone, Automatic Robot Zone, Starting Points, Restarting Points, Loading Areas, Common Zone and an Island. The symbols of points and areas such as A, C, M, L1, L2, L3, S1 and S2 are not necessary to be painted on the floor of the real game field.
2. Starting Points

a. Manual Robot must start in Manual Robot Starting Point (M).
b. Collector Robot is placed in Collector Robot Starting Point (C) and will be picked up by Manual Robot.
c. Automatic Robot must start in Automatic Robot Starting Point (A).

3. Common Zone
   a. Common Zone has a rectangular shape with a height of 100mm, a width of 500mm and a length of 1985mm painted in yellow color. Two notches are located at the surface of the Common Zone. Two Baskets are placed in these two notches separately before the game starts. Each team can collect one Basket from the Common Zone only.
4. The Basket
   a. The two Baskets are placed at two notches separately in the Common Zone. The weight of a Basket is 2.85kg.
5. Bun Tower
   a. The Bun Tower is placed on a square stage, the Island. It consists of three layers. The details of each part are explained as follows:
   b. Number of Buns in different layers:
      i. Top Layer: 2 Top Buns (One for Blue Team, One for Red Team)
      ii. Middle Layer: 6 Buns (Three for Blue Team, Three for Red Team)
      iii. Lowest Layer: 8 Buns (Four for Blue Team, Four for Red Team)
   c. The weight of the Buns
      i. The Top Bun for the Top Layer: 105gm
      ii. The Buns for the Middle and the Lowest Layers: 47gm
   d. The size of the Buns
      i. The Top Bun: 200mm in diameter, 150mm in height
      ii. The Buns for the Middle and the Lowest Layers: 150mm in diameter, 100mm in height
   e. The diameter of the three layers
      i. Top Layer: 500mm
      ii. Middle Layer: 850mm
   f. Lowest Layer: 1200mm
   g. The height of the Bun Tower

i. The Tower is 1850mm high in total (measured from the top surface of the Island).
ii. The height of the three layers surface from the Island are:
iii. Top Layer: 1500mm
iv. Middle Layer: 1000mm
v. Lowest Layer: 500mm

h. The angular placement of the Buns in one layer is different with the Buns in other layers.

6. Island
   a. Island is a lifted up platform with a height of 400mm, a width of 3,030mm and a length of 3,050mm. It is divided equally for Red and Blue Teams. Each part consists of a half side of Bun Tower and a notch at the corner, which presents as the Basket Area, with a depth of 12mm and a diameter of 500 mm. A Basket will be placed at the Basket Area of the Island by Manual Robot.
7. Tunnel & Token Box
   a. A Tunnel is located at the Manual Robot Zone. The inner size of the Tunnel is 2040mm in length, 1200mm in width, and 1600mm at the highest point. The ceiling of the Tunnel is arched.
   b. A Token Box is placed at the side of the Tunnel. The slot of the Token Box is 100mm in width and 400mm in length.
8. Token
   a. The Token is placed at the Token Stand. The size of the Token is 300mm in diameter, 20mm in thickness. The weight of a Token is 170gm.
9. Token Stand
   a. The Token Stand is fixed on the ground of Manual Robot Zone. It consists of three sections: a frame, a pole and the bottom. The arc-shaped frame is made of mild steel with an indent inside.
10. Bridge
    a. The Bridge is located in Automatic Robot Zone. It has a three-dimensional trapezoidal shape with a length of 3500mm and a width of 1970mm. The top of the Bridge is 300mm high.

2 A Glimpse of the Journey: An account of Robocon and its preparations

2.1 Before Robocon

Our team was selected through a competition- “Robochunks”, where separate problem statements were given for selecting Electrical and Mechanical team members. The problem statements were designed to test the fundamentals of electronics and mechanics as per-requisite for a basic knowledge about robotics. We were then trained for a month in technologies used over the past years at our club. As a result, we were well acquainted with basic technologies that are used in fabricating robots for Robocon.

2.2 Release of Problem Statement

The problem statement was released in mid-September. The primary task on our agenda was discussing the design of our robots. The team was divided into groups of 4 (two each from electrical and mechanical). Each team was expected to brainstorm all possible ideas and come up with designs which were approved by both the departments in each team. The seniors were intent on giving equal time and emphasis to all three robots, something which they felt had been missed last year.

2.3 Design and Discussions

“Design is the most crucial stage” the seniors used to reiterate all the time. Meetings were held every alternate day all through the month of October right up to mid-November.

It was obvious from the problem statement that the Collector was the most crucial of the three and that is where our discussions begun. There was a general consensus on climbing the stairs instead of the alternate route despite the fact that the second route greatly simplified the design of the Collector. So we set our target- designs should be prototyped by end of November to gauge the viability of stair climbing. Designing of the mechanism for stair climbing, with mind boggling calculations abound, took up most of our time and did kind of overshadow the discussions for Manual and Auto. However, towards the beginning of November, designs of Auto and Collector were finalised to the extent of finalising dimensions and the CAD models. Besides, a separate team from among us was assigned the responsibility of ensuring the field was created at the earliest.

In the early stages of design, when the problem statement was still being discussed, Auto was considered to be the “easy” bot, the one which only had to do “line following, what else”. The heavy duty tasks were with the Manual bot, whereas the Collector was in a way “all about stair climbing”. The other tasks of Collector were relatively trivial, gripping of buns which didn’t weigh any more than about 100 grams. The main thrust from the beginning was thus, on getting the collector to climb the step.

The discussions in the meetings were rigorous, more so because of the elaborate calculations which were becoming an inherent part of every meeting. “Was this really necessary?” is a question we pondered on after Robocon. But at the designing stage, we took the calculations at face value and considered only those mechanisms which seemed to be feasible based on our calculations. Based on the discussions, we ordered components- motors, actuators, etc. - which fit our requirements. At one point of time, pneumatics was considered but the since no work had been done on it, we decided against it. Over here, we would like to mention one thing specifically- <u>when deciding on the specifications of motors, actuators, etc. it is necessary to arrive at decisions only after prototyping designs with available equipment, not be calculations alone</u>. <u>As engineers, it is necessary that we are able to observe from what we see in real and not depend on theoretical calculations -which involve lots of assumptions.</u>

2.4 Deciding the drive

Even before discussions for the collector was underway, it was decided that building the manual drive from scratch would take up the better part of our time and we might still end up with an inefficient, relatively slow and probably unsafe drive. Hence, the drive for the Manual Robot was ordered separately

2.5 Mechanical Design

Many possibilities were discussed, -swerve, three wheel and holonomic drive. So much was the enthusiasm of a few of us in the mechanical department, that they prototyped the base for holonomic drive in no more than 2 days!! Holonomic gave us the advantage of faster speed and easy manoeuvrability. However, even before we could decide much on it, there came a simple suggestion from our senior members of the 4th year. A 4 wheel drive with suspension built in the chassis design. Since it was so easy to prototype, it was definitely worth a shot. There are no words to describe that feeling when our first “prototype” worked – and worked like no one had expected it to! Our primary point of contention was the fact that a four wheel design would make the base heavy and hence it would limit the weight of the remaining parts of the robot. However, the prototype was smooth as silk in climbing the ramp, the suspension technique was efficient in maintaining a four point contact on the ground at all instances. Besides, this prototype was able to climb the ramp with added dead weight of 25 kg, and that too with dilapidated motors and batteries. Four wheel drive it is!! We consider this to be the first real work done by our team.

For the Collector, stair climbing was the main focus. We looked at numerous videos, trying to decipher the mechanisms used and finalise one which suited our needs. 4 mechanisms were shortlisted and allotted to each team for further designing and calculations. Finally, we decided to prototype 2 of these designs within November and then choose which one to use. We also bore in mind that neither may work satisfactorily and we might have to go for the alternative route (without step climbing).

2.6 Electrical Design

In parallel with the mechanical design, the basic algorithm for running Auto and Collector were discussed to get an idea of the type of sensors that would be used. There was a massive change in the components we used from the previous years. We switched from PIC to ATMEGA 2560, from relays to Mosfets, from IFM’s to visible light sensors (OPT101), from Lead Acid batteries to Li- Po batteries. When it came to electrical design, our imagination was the limit. We considered every possible sensor, from IMU's to Mouse sensor to even trying our hand at image processing (for detection of basket). The electrical side truly saw a radical shift this time, and much of the credit goes to the decision to use ATMEGA 2560 as the main processor for all robots, which greatly simplified interfacing any kind of sensor/device, thereby opening up numerous possibilities.

Thus, when designing was in process we also interfaced and tested all hardware/circuits/algorithms we would require in October itself. This was again done by dividing us into small teams, each having a particular task to complete- PID control on Arduino, testing and finalising the Mosfet Driver circuit, and testing the visible light sensors whose samples had been ordered (OPT101)- within a given a time frame.

2.7 The Automatic Robot

The Automatic robot was the simplest, yet the most crucial of the three robots in the problem statement. The final design of the robot[FIG. 2.1] was made keeping two very important factors in mind:

1. It had to efficiently traverse the incline with around 20 degrees of slope.
2. If the robot could follow a line in both directions, it would save us lots of 180 degree turns, and with it, lots of time.

2.7.1 Technologies Used

1. New sensors OPT101 were used for line following so that robots can detect the white strips with different colors in background without significantly changing the threshold values.
2. New sensor plates were designed so that leds with different colors could be switched on using a switch. In the past, there had been a problem of following lines in a field with two different backgrounds using leds of the same colour. To avoid this blue and red led were used in the plates- red for blue field and blue for red field.

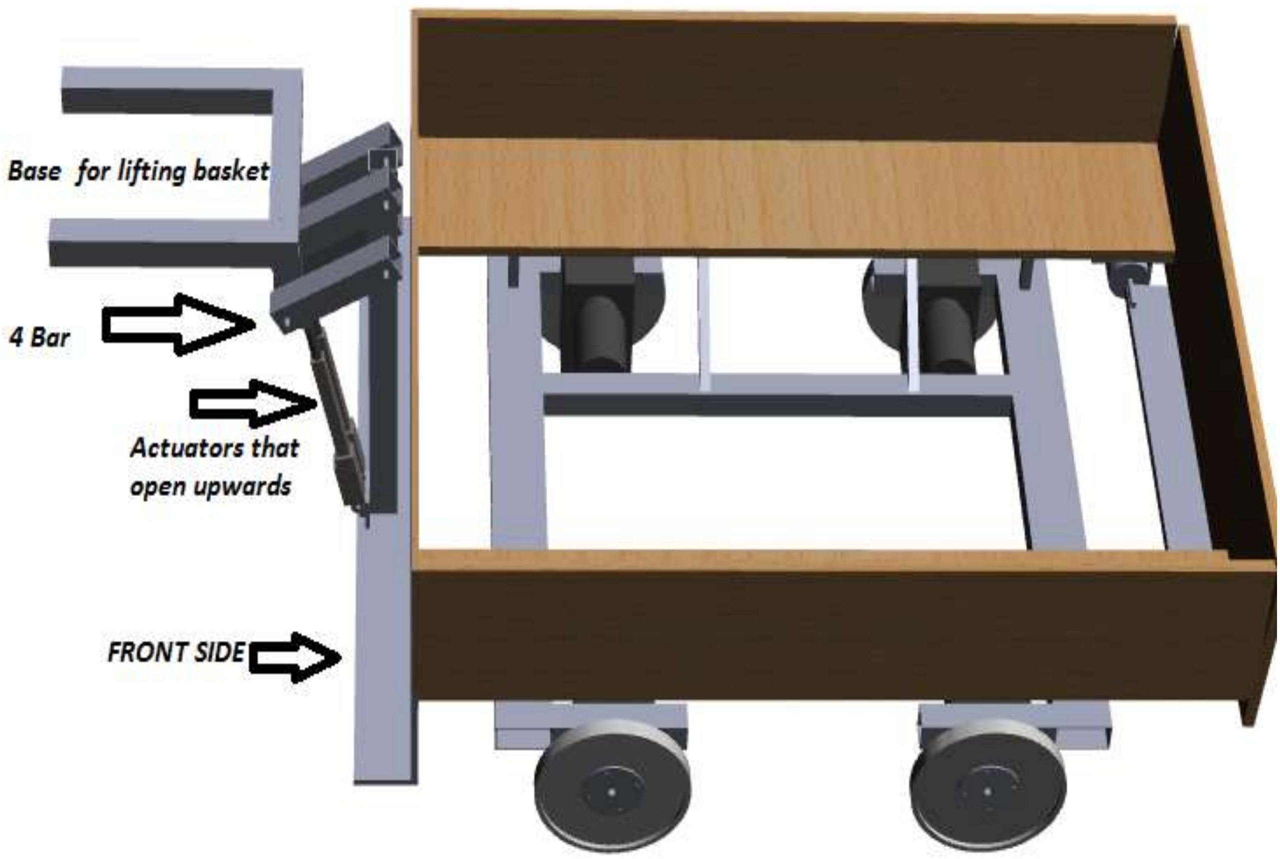

FIGURE 2.1 FINAL CAD OF THE AUTO BOT

3. Improved Vex Encoders were used which were very light and didn't add much to the weight of the robot. Previous years had seen the use of heavy encoders, each weighing more than 1kg, something which significantly increased the weight of the robot.
4. Four-Bar mechanism was used for lifting the basket.
5. Linear actuators were used to lift the basket.
6. An indigenous motor driver using transistors was used for driving all motors other than those for the base.

2.7.2 Electrical Problems faced and the solutions

1. A major difficulty with the Auto robot was the change in its dynamics whenever it carried either the collector robot or the basket. The problem persisted even when we tried to turn the bot in a curved path using encoders. It was later found out that the feedback values of the encoders changed when extra weight was put on the Auto, and hence, turning was done using the sensors on the robot. Hence, the robot would take 90 degree turns and

stop only when the sensors at the centre of the plate detected the white line, thus indicating that the robot is properly oriented.

2. Before placing the basket in manual zone, the robot used take a turn in during which it would hit the wall of field. To avoid this, the robot was made to follow a line that was farther from the wall. This was done by detecting the line using IFM sensors- As soon as these sensors detected the line, the robot would start moving straight till it didn't cover a specific fixed distance such that it could shift to the next line.
3. The weight of the basket (3.2 kg) was sufficient to topple the auto. To avoid this, the speed of robot was increased linearly with distance measured using encoder from a given initial speed to a given final speed- thus preventing any jerked motion that could have caused the robot to topple. Similarly, the climbing down of the auto robot, with collector on it, was done with a linear decrease in speed along the slope, to circumvent toppling.
4. Though a trivial issue, the connectors used for connecting the main circuit board with the sensors used to often come off, and it was necessary that these be permanently fixed even for preliminary testing.
5. Fine tuning the line following was a task in itself, with the following major problems:
    a. Missing lines: Even with sensors that had a high rate of response, the lines were being missed. This problem was also seen last year. The solution came in a very unexpected manner, when we were cleaning our code and removing unnecessary statements which were eating up the execution time (particularly, "Serial.print()") . Removing these delay inducing lines from the code solved the problem.
    b. Ambient light, "tilted" LEDs: The eight sensors being used started giving very different values. Though some difference is expected because of device characteristics, the error was too large. The reasons were found out to be

       i). unequal ambient light falling on the sensors (more light was entering on the leftmost and rightmost sensors) and

       ii). the LEDs on the sensor plate had not been soldered completely upright, they were a bit "tilted" and not exactly vertical. This was causing unequal lighting on the floor and hence, different sensors gave differing values.These problems were initially rectified by using black paper to shield the plate from ambient light and by re-soldering the LEDs. Later on, the code was changed to set individual thresholds for each sensor (rather than using a single threshold for all sensors) and this solved much of the problems.

c. Repeated Calibration: The code when reset, required calibration of sensors to be done every time. To avoid this, the facility to store the last calibration (thresholds) in the EEPROM was added to the code.
d. Dynamic threshold: To make the code even more robust and resistant to changes in lighting, we tried to use a dynamic threshold rather than a "static" constant for thresholding. The idea was to compare the "difference" in values given by the sensor and not the absolute value. For eg., if the output of sensor 1 changed by about an amount of +200, it would mean there was a transition from low to high, and similarly a -200 change would mean a transition from high to low. But this did not work satisfactorily because of intermediate states possible between high and low. So, this idea was dropped.
e. Mosfet Drivers: Though during initial testing, the Mosfet Drivers worked satisfactorily, once the circuit was printed and soldered on PCBs, it started to occasionally give problems. The reasons varied from using bad quality Mosfets, to improper soldering, to sheer bad luck as many a time the reason could not be identified. One major error was detected later on, which was that pull-down resistors had been omitted in the PCBs. But this still does not explain the numerous malfunctions of the circuit. Hours of debugging at times bringing us to near frustration were spent on making these driver circuits to work.
f. Over-counting lines in halogen light: In later stages, testing was done under Halogen lights, to imitate the real field conditions. This time the algorithm counted a single line multiple times. The solution was obtained by integrating data from light sensors and encoders. Encoders were used to read the distance moved and any line detected before a

specific distance (the expected distance between 2 lines) had been moved was not counted. Also, shielding of the sensor plates was improved by using black rubber tubing.

g. Problems due to low battery: When the power supply to the Arduino starts going below around 7 volts, its operation becomes unreliable and may lead to unexpected behaviour of the bot. Many a time this used to be the reason behind the malfunction of the robots.

2.7.3 Mechanical problems faced and their solutions:-

1. The encoder wasn't mounted perfectly. It is necessary to note that encoders should be so mounted such that they can have vertical movement- to compensate for uneven surfaces. However, it is also necessary to deprive them of lateral movements. The encoders were finally mounted with the help of a spring which kept pushing the encoder to the ground and only lifted when the surface was uneven. Lateral displacement was removed by using glue over all nuts and bolts whose movement created the shift.
2. It was necessary to check the mounting of all components time and time again.
3. The four-bar that was being used for picking up the basket had been riveted. Hence, with wear and tear, the rivet holes grew in size, thus preventing the Four Bar from opening to its maximum possible limit.
4. Incorrect mounting of IFM sensors often caused the robot to behave in a strange way.

2.7.4 Problems faced in Pune

1. The major problem in Pune was the blowing of the mosfet driver circuit boards. After a lot of debugging, some parts of the circuit did work, but never reliably. One reason for this could be the sub-standard quality of the mosfets and the thin width of traces on the pcb. Hence it is advised that trace widths for all future PCBs be at-least doubled.
2. The different colour of the walls in the arena caused the banner sensors, set for detecting the walls, to malfunction.

Subsequently, these sensors were removed and time and distance constraints were set in code so that bot would stop at required distances from the wall.

3. With wear and tear of actuators, perhaps because of the improper mosfet driver board, it often so happened that the four bar would not remain at its maximum possible height. Hence, while placing the basket in the manual zone, the basket would collide with the wall in between. Ultimately, the mosfet driver boards were done away with, (in the Auto) and were replaced by Sabertooth drivers.
4. The slider switch- used to change the colour of the leds at the base of sensor plates- was not of the required current rating, current enough to simultaneously keep the eight leds switched on, and hence, they often blew up. Another reason behind this must have been the hotter conditions in Pune.
5. The change in temperature conditions caused many of our components to overheat and often blow off.
6. Besides, the thin traces blew off at the slightest increase in current, and were one of the major reasons why the Auto couldn’t function properly in the competition

2.8 The Collector Robot

The collector robot[Figure 2.2] was the most complex in design primarily because of the number of degrees of freedom that the robot had to be given. Besides, it was necessary to keep the robot as light as possible so that the manual could pick it up and place it easily.

2.8.1 Innovative Technologies

- The introduction of BLDC motors paved way for lighter, more efficient robots, though they couldn’t be used finally.
- The implementation of the turntable created three degrees of freedom, making the collector very dynamic.
- Implementation of rack and pinion for both vertical and horizontal motions of the collector.
- Implementing various sensors together and ensuring proper control of the turntable and its three degrees of motion.

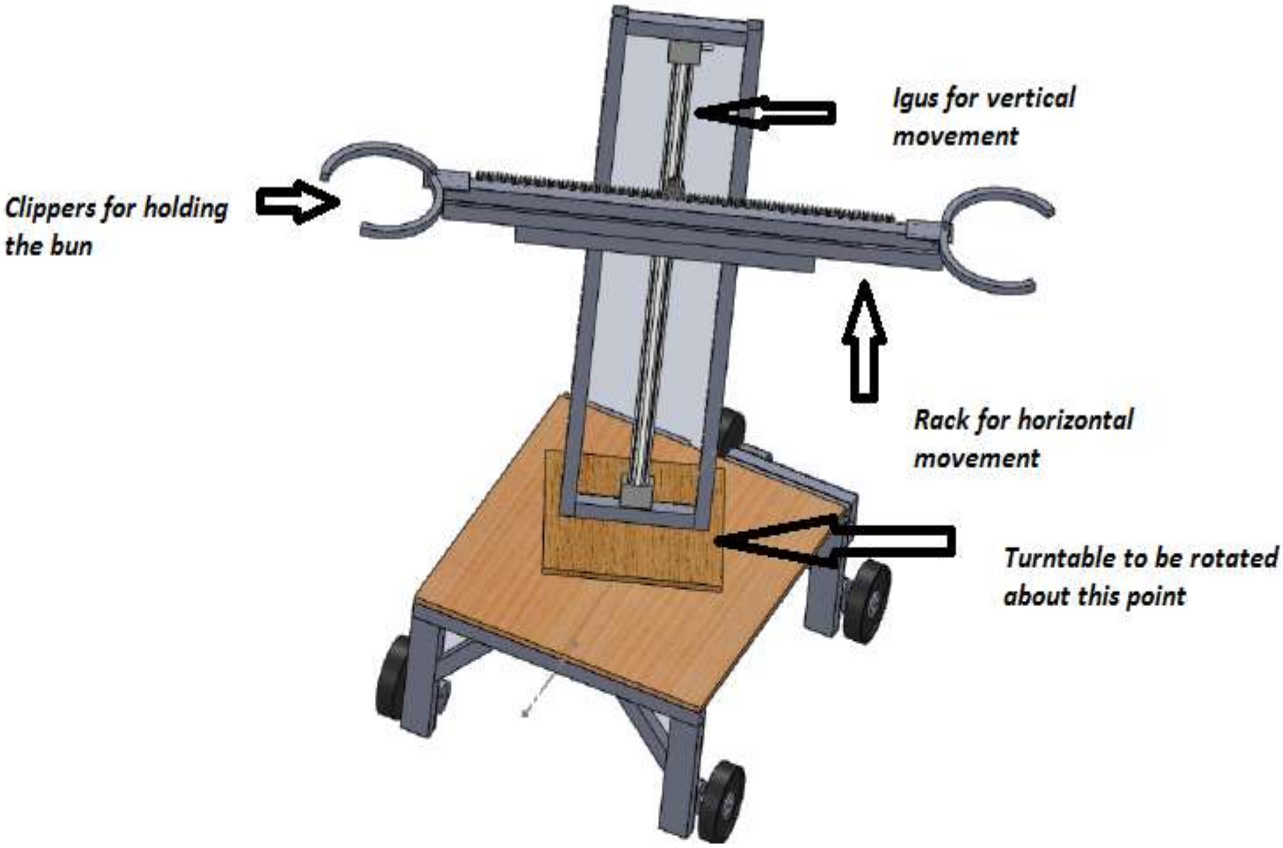

FIGURE 2.2 CAD of the Collector Robot

2.8.2 Problems faced and solutions

1. Stair climbing: The initial design -that used an extra 5th motor in the front to guide the robot above the stair- failed in spite of all the theoretical calculations done. It was then decided to use banebots both in the front and behind the robot to lift it above the stair. Though successful, this design was extremely unstable and uncontrolled. Hence, with time running out of hand, it was finally decided to use the second loading area. Disappointing though, it was a pragmatic decision nonetheless. It allowed us to redirect our efforts towards other parts of the problem statement, and in hindsight, we believe we made the right choice. However, there was a major drawback during this whole process of stair climbing:
    a. Delay in prototyping: Prototyping was delayed because we didn't have the right motors to test our design. However, care must have been taken so that prototypes for both the designs were absolutely ready before the arrival of motors. Besides, since all our efforts were concentrated in making the first design work, by the time we realized that this design was not working, it was too late to test the second design, (especially when its prototyping had not even begun)

2. The base of the turntable was not driven by a single servo motor, but by four wheels at the base of the turntable. This created issues of four point contact at the base.
3. Rack and pinion: A recurrent problem was the motion of the rack and pinion sometimes becoming too stiff. Also, at times there was slipping at the motor shaft. These were rectified by i). filing the rack and ii). bolting the shaft tightly to the pinion.
4. Ensuring four-point contact, weight imbalance: This was one of the most recurrent problems of the turntable, and was perhaps inherent in the design. There would occasionally be slipping at the wheels of the turntable, which was to some extent solved by changing the mounting of the motors (using L shaped angles instead of using U-clamp).
    a. The problem was finally solved when the gripper arm was cut short, eliminating the shifting weight problem and ensuring that at least three of the four wheels were always in contact with the surface.
5. Noise and Servo motor vibrations: The relays used by us used to start switching on their own at a very high frequency whenever the main power was turned on. This was due to noise in the power supply and was rectified by isolating the relays supply from the Arduino's power supply. Similarly, the servo motors used to vibrate a lot when at standstill. This was also rectified by isolating their power supply from Arduino's power supply.
6. Overshooting of turntable due to inertia: The base of the turntable would overshoot while rotating because of inertia, i.e. it would keep rotating for some distance even after the supply to the motors was stopped. This problem was tackled in software, by giving a velocity in the negative direction with the help of feedback from encoders. This improved the braking of the motors and the table rotated backwards correcting the overshoot.
7. Bun detection: Initially, picking up the "buns" and dropping them in the basket had been hard coded (i.e. open loop) since the tolerable error margins seemed to be quite large. But later on we realized that when the Manual bot would place the Collector on the island, its position would be uncertain. Though the bot's position was corrected further by line following, but still this was a source of error and could lead to missing of buns by the bot. Thus, we

decided to use Sharp proximity sensors to detect the buns. This increased reliability manifold.

8. Automatically unloading the Collector from Auto: This task seemed so trivial that it was overlooked by us for long. Only in February, when final testing of all robots was being done, did we decide that the same IR module being used for communication between Manual and Collector will be used for its unloading from the Auto bot to the Loading Area also. The Manual operator would press the button in the IR remote which would give the signal to the Collector to start. This though worked well on our field as well as the practice field in Pune, it failed to work on the main field during the first game. The only probable reason for this seems to be the interference of the lighting of the main field with the IR receiver.
9. Missing strips: The IFM sensors on preliminary testing failed to accurately count the black and white strips. The solution was to include a slight "delay" in the code as the IFM sensor should not be read too frequently for proper functioning.
    a. Even after this, the sensors would sometimes stop showing accurate readings because of i). wrong calibration, ii). loose connection of optical fibre cable and iii). varying distance of sensor from surface (rectified by using a mechanical stop).
10. Wiring: The wiring of the Collector seemed to be a mammoth task due to the numerous motors and sensors used in it. The many degrees of freedom meant that wires had to be extensible for proper movement of the parts. Also, the rotational degree of freedom posed the problem of entanglement of wires. We decided to place the main circuit on the rotating part and not on the static part of the chassis to minimize entanglement. We also tried to use telephone wire (coiled wire) because it is extensible, but it turned out to be unsuitable for our purpose as it had a very small gauge and cannot be used for high current applications. After extensive use of ties, sleeves and elastic threads, the wiring was brought to a satisfactory level. But in retrospect, it can be said that it still had scope for improvement.

2.9 Manual robot

The biggest challenges in manufacturing the manual robot[Figure 2.3] were:

1. The design of an efficient chasis which was string as well as light enough to carry a man on it
2. The fabrication of an efficient picking and placing mechanism which could pick up the token, the basket, and most importantly, the collector, without letting it topple.

FIGURE 2.3 CAD MODEL OF THE MANUAL CHASIS

2.9.1 TECHNOLOGIES AND IDEAS USED

1. Linear actuators were used for coin grippers and also for the lifting mechanism.
2. A 4R 4Bar mechanism was used for lifting the collector robot. Though difficult to fabricate, it was extremely well implemented and made the lifting mechanism very sturdy.

3. A power braking mechanism was installed in the robot to do the braking with the help of motors.
4. The manual robot was powered by a brushless DC motor.
5. It had driving motor only at one side and was driven by steering mechanism.
6. Its chassis was very strong and was made up of steel and aluminium so that it could bear the weight of the manual rider.

2.9.2 PROBLEMS FACED AND SOLUTIONS

1. In the initial designs it was decided to operate the four bar by actuators but after testing it came to light that the stroke length of the actuators was not sufficient. Besides, the actuators were heavy because of which our robot exceeded the maximum permissible weight limit of the robot. Hence we used high torque motors instead of the actuators, causing significant weight reduction.
2. The driving motor of the drive could run only in one direction. Hence, to allow for backward movement of the robot, an extra mechanism was created so that the robot could move in both directions. The wheel in the reverse movement was lowered when in use, and would otherwise lift upwards on the command of the rider.
3. The complete operator consisted of 7 motors! After much brainstorming, the arrangement of the buttons of 7 motors on the robot was so made such that it becomes easy for the manual operator- something that we did create pretty well finally.
4. Manufacturing the links of the FOUR BAR system needed precise measurements of the links, something which was achieved using vernier callipers.
5. We also had the problem of channels getting bent due to high load of collector when it was lifted. For avoiding the bending of the channels we used wood reinforced aluminium channels i.e. wood was inserted in hollow square aluminium channel to give it extra strength.
6. Mounting of FOUR BAR on the main chassis of the manual bot was also a big challenge. The mounting was made sturdy by

using steel pipes and wood reinforced aluminium channels and supporting from trusses.

7. We faced the problem in designing the coin gripper as the drop box of the coin was located such that it becomes difficult to enter the tunnel immediately after dropping the coin. The coin gripper was so designed that it could go offset and could again come inside the dimensions to enable smooth entering inside the tunnel.
8. Riveting was difficult as all the load had to be beard by the rivets. The aluminium rivets used to bend very often. We used Mild Steel for riveting as its tough and doesn’t bends easily.
9. Turning the robot on one side was easier as compared to other side as the motor was only on one side of the robot. The turning on the difficult side was made easier by practicing and trying various techniques of turning

2.9.3 PROBLEMS FACED IN PUNE

One highlight of our stay in Pune has to be this! Due to an apparent short circuit, a few components of the driving motor had stopped working. The motor was a US company product not available in India anywhere, and we had less than 24 hours before our first match. It was under these conditions that the motor was opened, analysed, and was indigenously repaired so well that it never occurred to us that the device had actually ever stopped working!

Even though we didn’t win, our design of the lifting mechanism of the manual robot was admired by co-competitors and judges alike.

2.10 Electrical Design of Various Circuits

One major progress made in this year was the modularization of circuit boards for performing various tasks.

2.10.1 The motor driver board[Fig 2.4]

Consisted of circuitry for two "sabertooth" motor drivers, capable of running four motors, and three mosfet drivers, for small current rating motors.

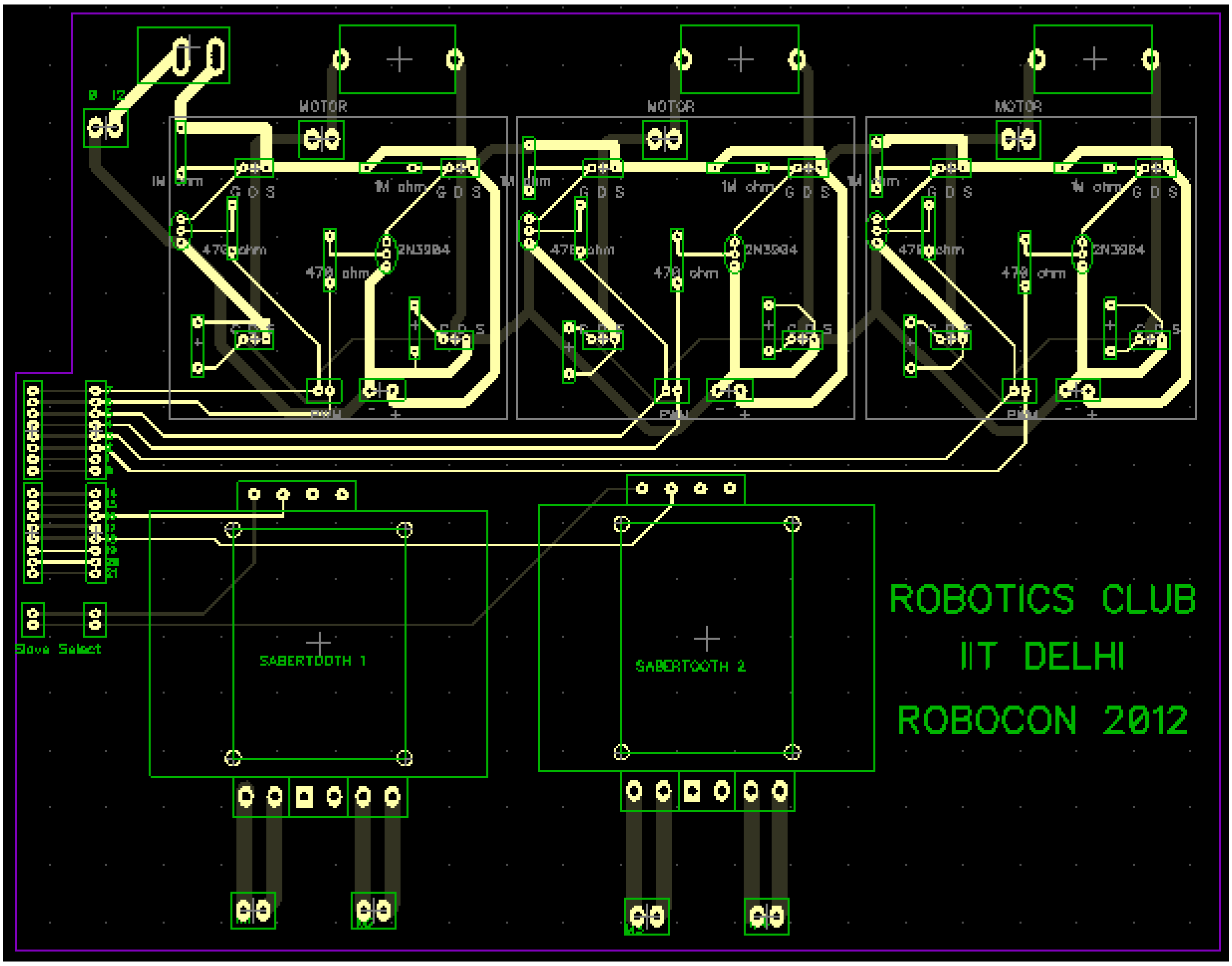

FIGURE 2.4 Motor Driver Board:

2.10.2 Power Board[Fig 2.5]

Consisted of power outlets for all devices in a robot, with four 24V supply terminals, six 12V supply terminals, another two isolated 12V supply terminals (mainly used for the arduino), four 5V, and four 6V supply terminals, with specific fuse for each terminal.

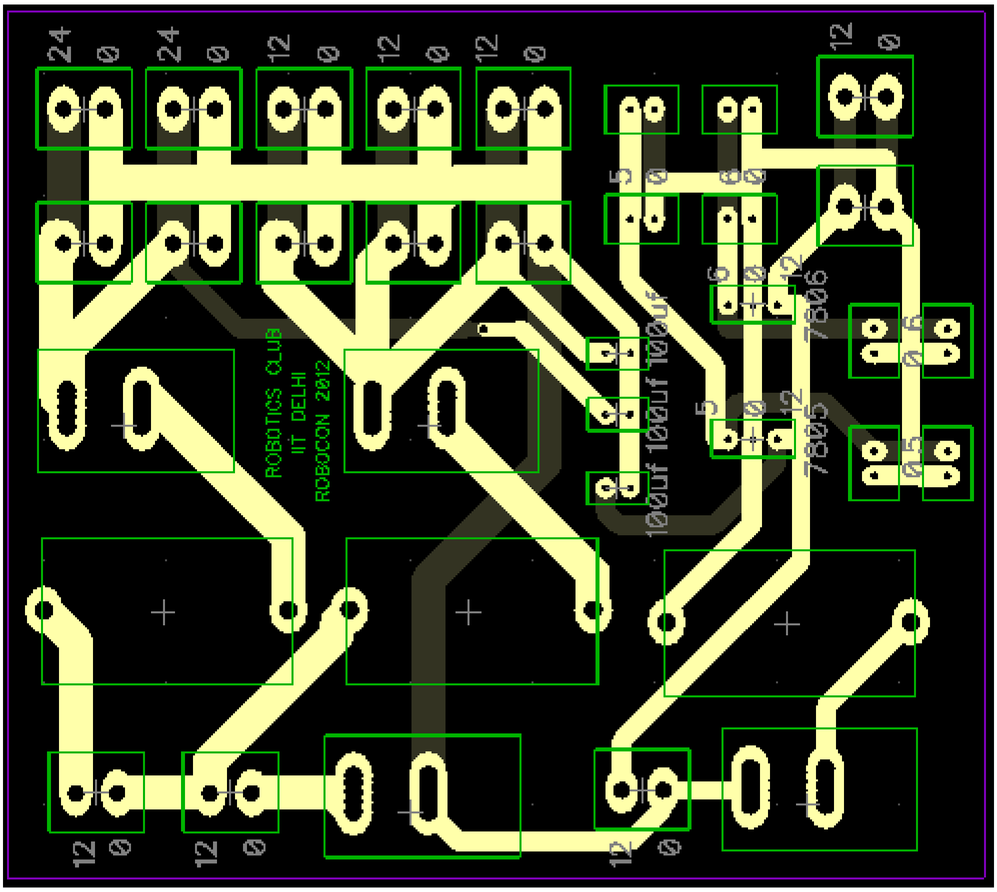

FIGURE 2.5 POWER BOARD

2.10.3 The Sensor Plate[Fig 2.6]

Consists of 8 opt 101 sensors and 8 leds each of red and blue colour, all powered through a 12V power source. Input: 12V power supply Output: Sensor values of each opt 101

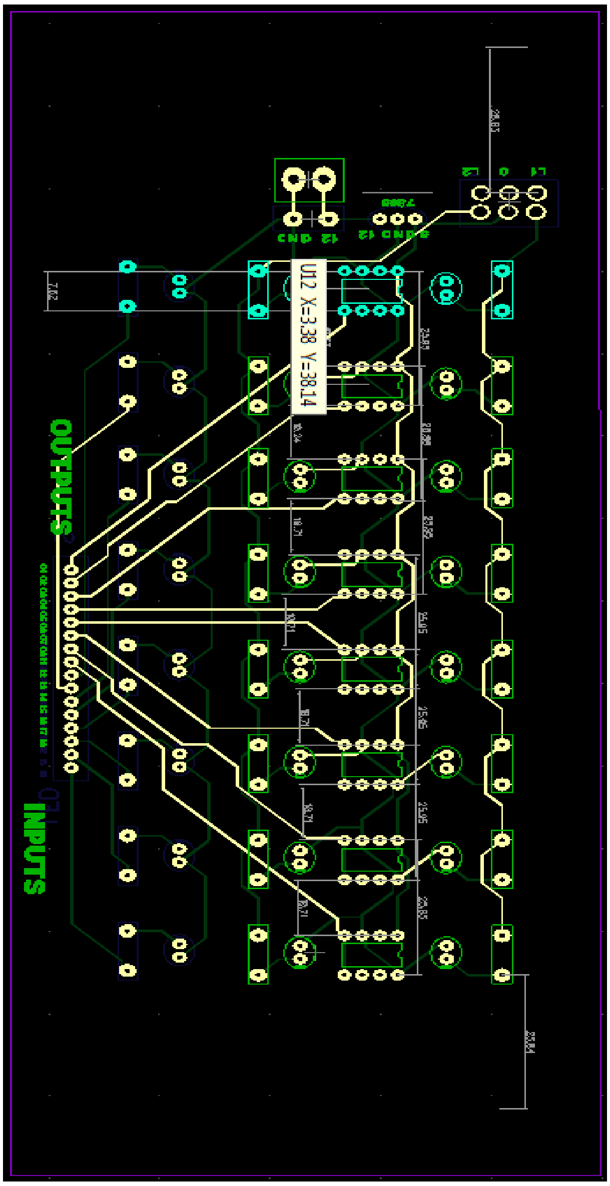

FIGURE 2.6 SENSOR PLATE

2.10.4 The ArduinoShield[Fig 2.7]

Fits right over the Arduino development board.

The pins have been designed according to our requirements.

For e.g. The 16 pins together at the bottom right are for LCD

The 8 plus 8 plus 2 on the right hand side is for the motor driver board

Groups of 3 pins, with one Vcc, One Ground, and One digital input pin for reading values of encoders.

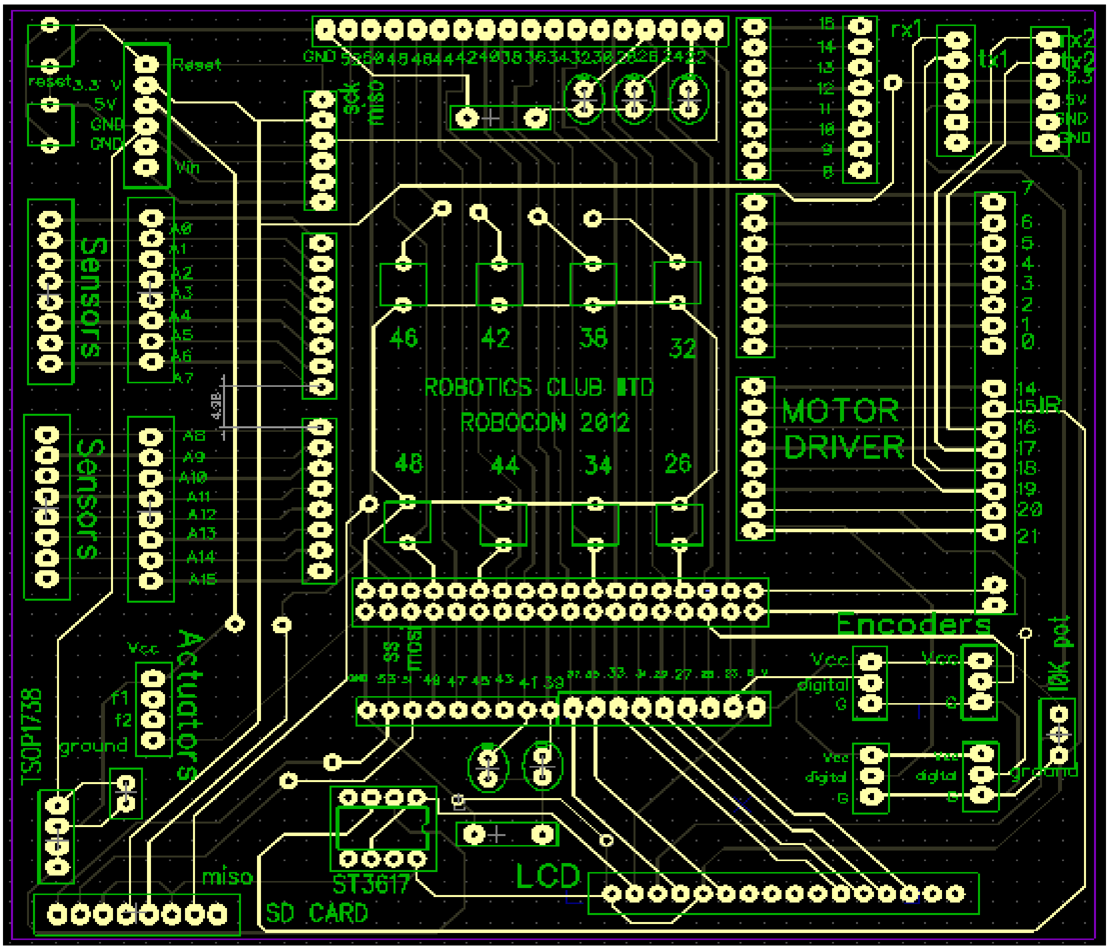

FIGURE 2.7 The Arduino Shield

2.11 Timeline of Preparation

December – Time for some action!

Everyone was eagerly waiting for the Majors to end, because that was the time when the real action would begin. Fabrication was to start in November end and expected to be completed within first 2 weeks of December. Meanwhile, the manual drive had been ordered and was also expected to arrive in December. Designing of Manual was incomplete and could begin only once the drive arrived since we did not have its CAD model.

On the electrical side, as soon as Majors ended, work had begun on perfecting line following for the four wheel drive. PCBs had been designed for the final Mosfet Driver circuit and libraries for the Arduino were written (since we were working on a new platform this time, we had to write all the libraries from scratch).

Other progress on electrical end included successful testing of encoders and distance sensors (Banner) and designing, printing, soldering and testing of all major circuits (sensor plate, shield for Arduino, Mosfet drivers, and Power Board). We wanted to include MCB switches in our power board this time, but even after a lot of searching, suitable MCBs which could be soldered on PCBs could not be found. By the end of December, Auto was electrically complete and had only little mechanical changes to be made.

In the meantime, the field team did excellent work and the field was ready by mid-December. Seeing the complete field filled in even more enthusiasm in us, and everyone was now just eager to see the robots running on that newly made, almost sparkling field!

Motor menace continues..

When the BLDC motors finally arrived (around mid-December), we first tried to avoid ordering the corresponding controllers by building a controller on our own using Mosfets. We were to some extent successful in building the controller, but it turned out to be unreliable on testing. We even tried to obtain the controller from the Mechatronics Lab, but for some reason our model of the motor did not work well with that controller. Our problems were heightened by the lack of a suitable connector, which forced us to use makeshift arrangements to make connections to the motor terminals. This led to even more unreliability and wastage of time and effort. By the end of December, the order for Maxon controllers was placed and expected to reach in January first week. Till then, we decided to try out another BLDC controller (Turnigy, from HobbyKing), which was much cheaper than the Maxon one. Testing with these was done in December end, and they seemed to work satisfactorily. But it was clear that these could not be used in the final circuit as they could not reverse the motor. Also, these controllers behaved peculiarly on start-up, and this made it very difficult to synchronise all 4 motors at start-up (all 4 motors would start rotating at different times in a random fashion). Again, significant time and energy went into making them work properly.

Work done till the end of December:

Auto robot: Fabrication and electrical design implemented. Testing had begun.

Collector robot: Fabrication was delayed till January, mainly because of unprofessionalism shown by the manufacturer. Electrically, all components had been individually tested except for the BLDC motors whose controllers had arrived in the end of December. This was a major setback.

Manual robot: No substantial work had been done. Work could only begin once the drive would arrive. Anyways, the manual robot was not our priority at this stage.

January:

January had just begun, and winter holidays had ended. Auto was out of the fabrication stage, and had matured to its testing phase. It was run every night, for hours at end, with Kunal and Piyush perfecting every single turn, rectifying every little error with perseverance. With all the makeshift connections of the BLDC motors, and the Turnigy controllers, the Collector was ready to be tested for stair climbing. On the very first run, what struck us was the amount of vibrations the system had. While it attempted to climb up the stair, the bot seemed to be in an uncontrolled state of motion, even destroying parts of the field in the process. Controlling it electrically, that too without proper controllers for the motor, seemed impossible. It was becoming evident that this mechanism might not work.

And then we let our imagination flow once again. It was like designing all over again, but this time we did not calculate. We directly implemented, working on our intuitions. Dhruv came up with the idea of using the Banebot motor, hoping that it would provide a torque high enough to lift the bot and make it climb the step. The motors were mounted such that first the front wheels of the bot were lifted, placed on the step and then the bot moved forward and lifted the back wheels to come up and completely rest on the stair. The idea worked. Vibrations were significantly reduced. It climbed the stair with ease. But the problem of controlling it electrically still remained. We had to automate the whole process and we were short of time. Lack of time meant limited testing, and the system could have failed in the final game if not tested properly. Also, in this mechanism the bot tilted to about 40 degrees while climbing, and this would lead to a lot of instability, especially because of the design of the turntable. Thus, the whole team decided to leave the idea of stair climbing altogether. It was a jolting yet pragmatic decision. Now only minimal changes needed to be done in the design of the Collector.

Hence, by the end of January, we were finally ready with our Collector robot mechanically. However, considering the number of parameters we needed to control, it would take some time to finalize on the complete electrical design- the IR sensors, the encoders, the IFM sensors, opt101 sensors, etc. Auto robot had gone through vigorous testing and by now seemed ready for Robocon. Besides, the manual robot was fabricated during this month

February - finishing touches:

By mid-February, the practice for Manual bot had started. Auto had been faithfully running all through, even being displayed to and praised by the Director and other faculty members on 26th January. Collector, despite its recurrent mechanical problems, had finally started taking shape, and was too being subjected to rigorous testing. During this last month of preparation, our lives only revolved about Robocon. It was all that mattered to us. Academics had taken a backseat long back, now even sleep stopped mattering! We would remain in the Club all night, trying to debug that one error, getting that faulty circuit to work, setting that shaky mounting right, screwing that loose bolt, soldering that broken wire (and putting heat shrink on it!). All the time we had on our hands, was devoted to our robots. Everything else became secondary. At this point of time, we would like to bring to light, the necessity of minimizing any change in the mechanical design of robots without proper analysis. When the effort of 6 months seems to be going down the drain, it is only natural for one to reach to hasty conclusions, just to make the robot work. However, since these decisions are done without much analysis, they are most often flawed and end up making the robot even more inefficient.

The Gant Chart:

Following are snapshots of our Gant Chart. The first Gant Chart[FIG 2.8] shows our plan of action. The second Gant Chart[FIG 2.9] shows how did the events pan out in reality.

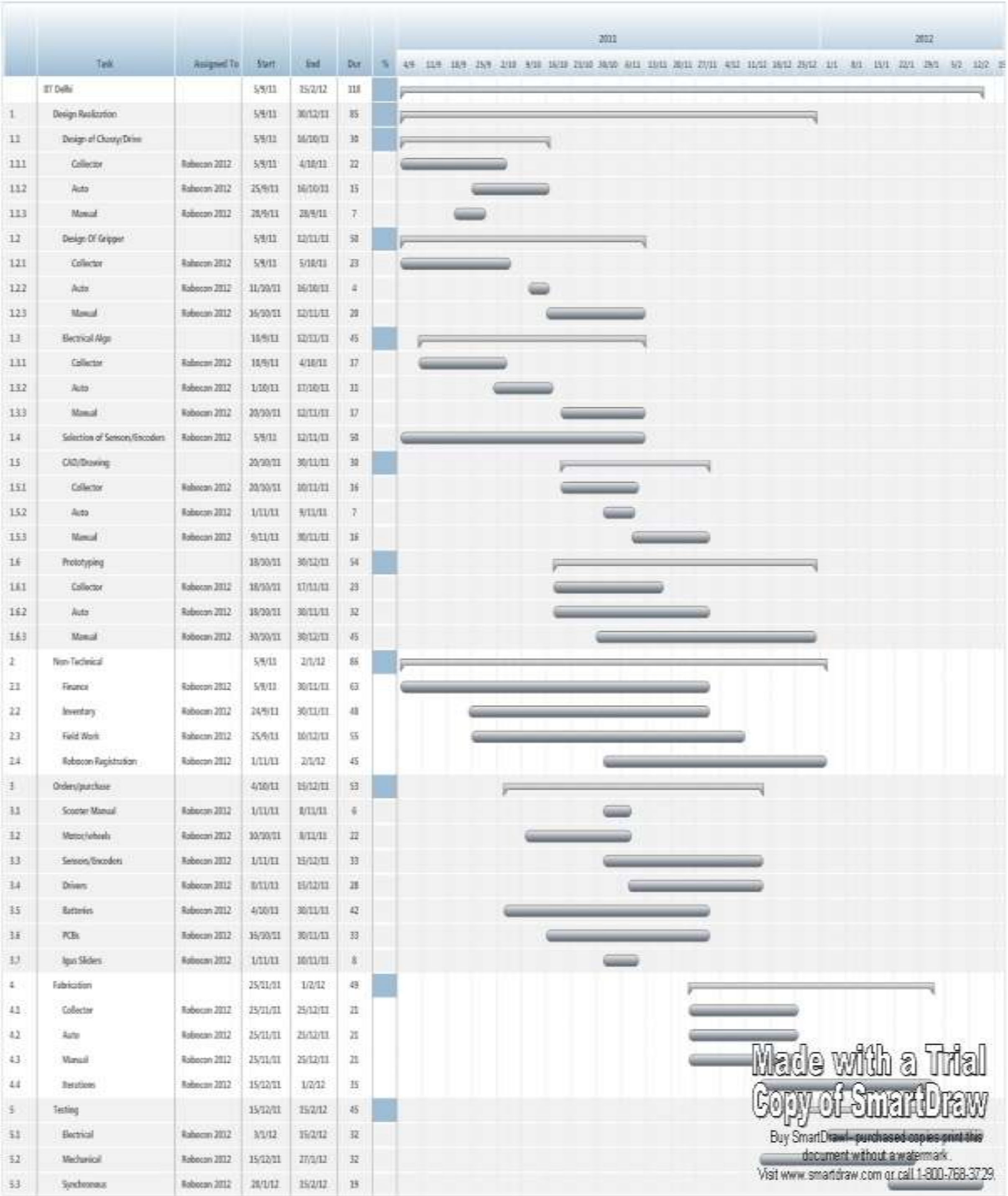

FIGURE 2.8 PLAN OF ACTION

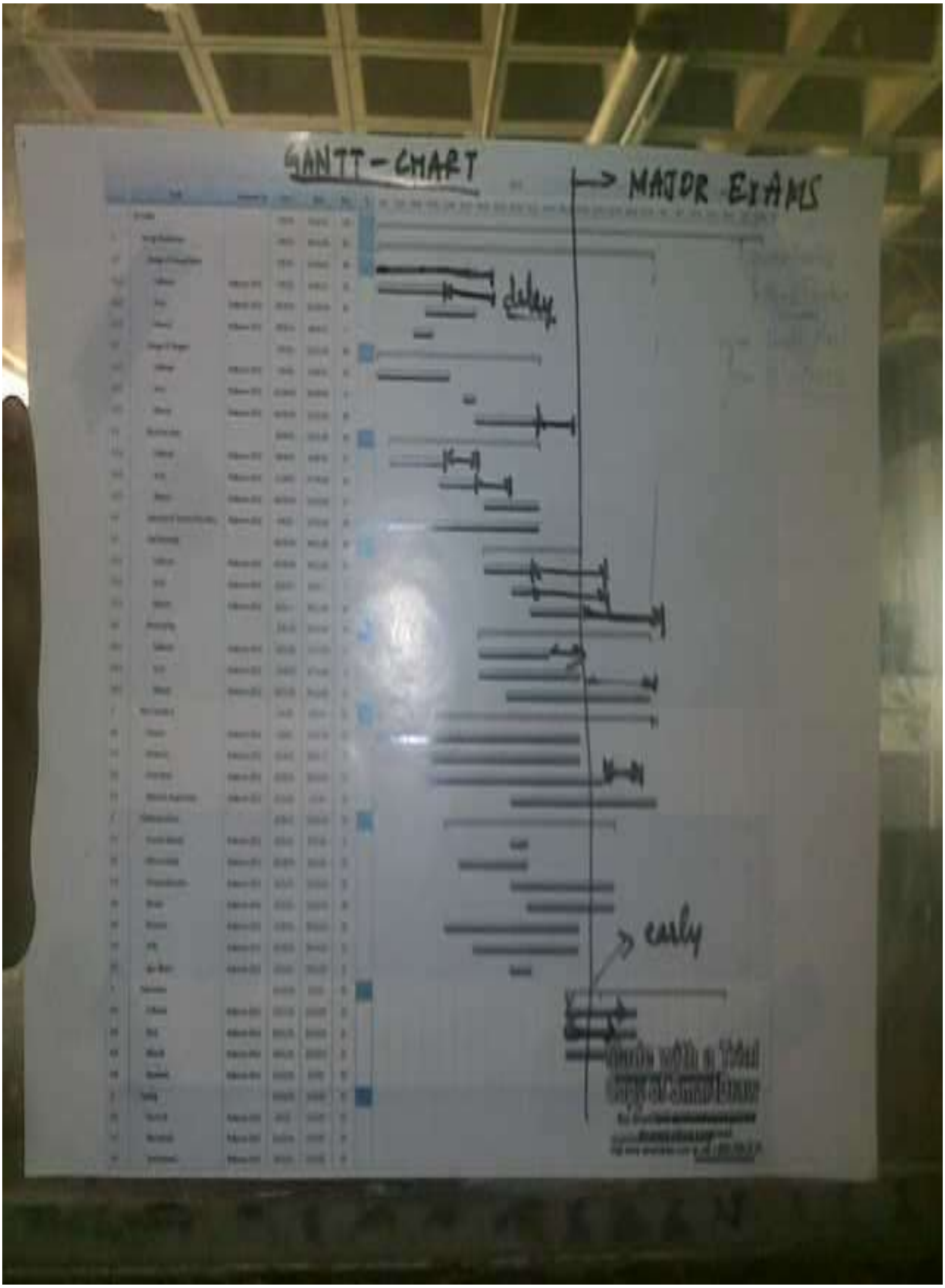

FIGURE 2.9 ACTUAL FLOW OF ACTION

The packing:

Consider building something for six months and then dismantling it. Not a very easy thing to do. The packing of robots begun by dismantling the robots. Each robot was assigned to those members who had extensively worked on it. The task was a tedious one, with every small component being labelled properly to avoid any mistakes in re-assembling them in Pune. It was during this packing time that we realized how important it is to label each and every component in a system.

Time for the Real Journey:

The journey we had been waiting for all these 6 months. Confident of our robots, with hopes high, we did not think about winning or losing, we only wanted to give our best. The train journey though wasn't tiring at all. After all we had nothing to do, something that was happening after such a long time! Once this enjoyable and refreshing journey ended, we knew it was time for action again. We had reached 2 days ahead of time and started assembling the robots the very night we reached.

Managing Disasters!

All the robots were assembled and ready before the practice slots were allotted. But then misfortune hit us, and a short circuit made the only driving motor of the manual absolutely useless. Without the Manual, we would have to lose the game before even beginning it. We were in a crisis. We were lucky enough to have a spare of the motor, but it did not work properly. After slogging for hours, we did debug the motor. But meanwhile, the distance sensors of Auto (Banner) turned out to be sensitive to the colour of the field boundary. In the practice field back in the Club, we had overlooked the colour of the field boundary. This meant different thresholds were required for different coloured boundaries, but the sensors could be calibrated to only a single threshold. Thus, we had to resort to hard code and made the code distance and time based.

Problems even started cropping up in the Collector. One of the sensors stopped working in the line following sensor plate, and later on, the motor driving the vertical igus was also damaged due to excessive stall current. Besides, two of its spare motors didn't work at all. In hindsight, we believe a lot of problems could have been solved had we been more careful with the handling of the robot. Besides, we were exceeding the weight limit for the robots, and so had to shorten the gripper arm of the Collector. Surprisingly, removal of one of the arms of the initial design caused the turntable to rotate way faster and also solved the issue of four point contact. Despite these small problems, the practices of Collector, Auto and Manual kept going on in full swing.

Auto had started showing signs of unreliability, which amazed all of us. Auto was our team's pride, and it was almost unbelievable to see it not being able to perform the tasks which it had been doing seamlessly for the past two and a half months.

Ultimately, it was the unexpected failure of the Auto robot that did us in. Without the Auto robot working, there was never really chance for us to score many points in the match. Besides, due to different lighting conditions, the IR communication mechanism between the Collector robot and the Manual robot didn't work, which easily cost us 60 points in the first game, and another 30 in the next. We were finally placed 19th among the 66 registered teams.

2.12 Principles and Software Used

1. The most important principle involved in the designing of electrical designs was the use of closed loop systems. For a system with a linear time invariant response, a closed loop system makes a system more stable and reduces the error in the output when compared to an open loop response. Hence, the idea was to use as many sensors as possible so that the present position of the robot, (which is the output of the system) provides feedback to the microcontroller which uses this to make corrections in possible errors that may have occurred.
2. The concept of data fusion: To improve the efficiency of the robot, feedback was obtained from multiple sources, (the opt101 sensors, IFM sensors, encoders) and this data was fused together to narrow down the number of positions of the robot.
3. All circuit designing was done using DipTrace[1], a product of Novarm, Ltd.
4. The optical sensors for line following used were opt101[2], manufactured by Texas Instruments. Datasheet
5. The optical sensors used for other object detection were IFM [3] sensors
6. The encoders used were optical and a product of Vex Electronics[4].

3. Conclusions

Preparation for Robocon is a very demanding task. It tests your technical and practical skill no doubt, but most of all, it tests your endurance. The competition demands robust robots which can work under different lighting and different temperature conditions. Thus, it is necessary that the robots be subject to sufficient trials before they can be declared fit for matches. If we are to look back and decide on what we gained from the effort put in, perhaps the answer would be one thing- the desire for perfection. It is this desire that drives you to do your work in the best possible manner. It is this desire that drives you to plug all possible holes and improve every possible aspect of your effort. We didn’t gain so much on technical grounds as we did in our attitude towards perfection. Another most crucial aspect would be the necessity of coordination in the team and team spirit. A positive team spirit charges you up and brings out the best in you, the lack of it drains out any energy you would have in yourself.

Here’s wishing the Robotics Club IIT Delhi all the luck for its future endeavours.

References

1. http://www.diptrace.com
2. http://www.ti.com/lit/ds/symlink/opt101.pdf
3. http://www.ifm.com/products/us/ds/OF5052.html
4. http://www.vexrobotics.com/276-2156.html

APPENDIX

A. LIST OF SUPPLIERS

The following is a list of suppliers from whom we procured our products for Robocon 2012:

1. Maxon Precision Motor India Pvt Ltd.
   4, subhodayam, 3rd floor , Banglore-560094
   Ph. 9538771755

2. Robokits India
   2nd floor-35, Rudra Square, Judges bunglow cross road, bodakdev, Ahemdabad-3802015
   Ph. 7878967626

3. Perfect Screw Bolt CO.
   3474-A, subzi market, chowkhauzqazi, Delhi-110006
   Ph. 23282415

4 KITS AND SPARES
   No.9, 17th main , 1st cross, hall II stage indiranagar,
   Banglore-560008

5 Nex Robotics
   Office no. 1, riddhi-siddhi heights, plot no. 59,
   Navi-Mumbai-400708
   Ph. 9833553020

6 Shyam Metals
   3556, chawri bazaar, Delhi-110006
   Ph. 23287768

7 Jai Bharat Machining Works
   C 74, Mayapuri,
   New Delhi-110064 ph. 9711005803

8 Anita Electronics
   551/15, Bhagirath palace, chandinichowk,
   delhi-110006

9 ShriBalaji Metals
   34, Raghu shree market, ajmeri gate, delhi-110006
   Ph. 23233980

10 Munirika General Store
63A, Laxmi Market, New Delhi-110067
Ph. 26174826

11 Unified solutions
4778/26 IInd floor, aggarwal market, qazikhas, Delhi-110006

12 Nath Enterprises
1253/5 Ist floor, chandnichowk, Delhi-110006

13 Walia furniture house
19, janta market, munirika, New Delhi – 110067

14 Plywood centre
14, munirika market, main road munirika, N.D.-67

15 Super machinery stores
3481, hauzqazi, Delhi-110006

16 D.M. Electronics
21/1140, Bhagirath palace, chandnichowk,

17 Melaramcharan das
4660, ajmeri gate, opp. chawri bazaar metro station.

18 HexTronik Limited
support@unitedhobbies.com

19 Tenet Technetronics
8/14 third floor, M N chambers, P T Street,
Basavanagudi,Bangalore-560004

B. Personal Perspective

B.1 The Treasurers Speak (Pankaj Fauzdar and Piyush Dane)

The budget for ROBOCON 2012 was Rs 8,20,000. It was a huge responsibility to maintain and spend such a big amount. But it was a great learning experience too. We bought components from both inside and outside India. Also, we had to maintain record of all the expenditure and contribution by each member. The responsibility of finance was not limited to only money management; it included the arrangement of transport of team and robots to the competition and back to Delhi. The finance people should have the capability to predict the money requirements of club in the near future and prepare for it accordingly. This is a very important and it needs to be done properly. This plays a very important role in deciding a team's fate in Robocon. The finance people should be in regular touch with their seniors and teammates so that they can know about the upcoming money requirements and be prepared for it. Moreover, they should keep briefing the professor in charge of the club at regular intervals and take his advice in managing the budget.

B.2 Gaurav Kumar

Experience of Robocon 2012 was something which shall always remain with me my entire life. Working in a team of 15 members with so much ecstasy and dedication was what I enjoyed the most. Right since we received the problem statement, we were onto it with full flow and enjoyed every big and small milestone throughout the whole journey.
From the experience of Robocon, I conclude that in order to reach the higher limits we always dream of, we should put in our efforts until everything is complete and we should not get complacent just by reaching smaller milestones. We must realize the importance of performance, and there are teams which work extremely hard, so to get at par with them or beat them we should work harder and get motivated by the final goal.