THE

ROBOCON

DIARY

2008

Indian Institute of Technology Delhi

April 15, 2008

PREFACE

Since 2003 IIT Delhi has been actively participating in Robocon, an annual national robotics competition. So far IIT Delhi has become champion once (in 2007), reached semi-finals four times (in 2003, 2004, 2006, 2008), and was in quarter-finals once (in 2005). Robocon is more about learning than about competition and winning. We learnt a lot, not only in the field of robotics but also about project management and most importantly about team work. We believe this document will be helpful to those who aspire to participate in Robocon and most importantly to gain knowledge in the field to Robotics.

ACKNOWLEDGEMENT

The team members of Robocon 2008 sincerely acknowledge the financial and logistic support provided by Prof. Surendra Prasad, Director of IIT Delhi, and his complete administrative and supportive teams without which the participation in Robocon would not have been possible. The support of Prof. A. Sharma, Dean of Students, and Prof. S. Mathur, BRCA President and Associate Dean of Students, in helping us getting funds from IIT's account for purchasing the components required for fabricating the robots, and also in allowing us to work in the Robotech Room of SAC is highly acknowledged. The Robocon team members would also like to thank Prof. S.K. Saha, the team mentor and Facutly-in-Charge for his guidance. Assistant Registrars of the Accounts and Stores and Purchase Sections, Mr. R.K. Gupta and Mr. Nanak Chand, respectively, are also thanked for speedy actions on Robocon matters. The team and the institute would like to thank IFM, Bangalore ifm electronic for providing 12 photo sensors worth Rs. 50,000 for use in Automatic robots. Thus there is an endless list of people from different departments and sections of this institute without whose supports and blessings the participation in DD-MIT-Robocon 2008 would not have been possible.

This diary is compiled by Mr. Ripudaman Singh
in association with Sanjay, Parag and Danvir.

PERFORMANCE IN ROBOCON 2008

- Awarded the BEST MANUAL ROBOT amongst the non-finalists
- Reached Semi-finals and stood 4th out of 38 teams
- Only IIT team to reach super-league of 12 teams

THE TEAM OF ROBOCON 2008

Prof. S.K. Saha	(Team mentor & Faculty-in-charge)
Jainesh Sinha	(Team Coordinator)
Chinmay Agarwal	(Electrical Coordinator)
Ripudaman Singh	(Electrical)
Gaurav Mittal	(Mechanical)
Sanchit Arora	(Computer Science)
Hemant Kumar	(Mechanical)
Mohit Sharda	(Mechanical)
Prateek Agrawal	(Electrical)
Shashank Singla	(Electrical)
Jatin Pasrija	(Electrical)
Gaurav Aggarwal	(Electrical)
Vijay Kumar	(Electrical)
Danvir Singh	(Mechanical)
Sanjay Dhakar	(Electrical)
Abhijeet Rathore	(Mechanical)
Parag Jain	(Electrical)
Mayank Kakodkar	(Mechanical)
Pawan Kumar	(Mechanical)
Vyom Jain	(Mechanical)
Kishore Kumar	(Mechanical)
Vivek Goyal	(Computer Science)
Arpit Goel	(Computer Science)

GOVINDA

ABU ROBOCON 2008, PUNE, INDIA
THEMES AND RULES

Introduction

The contest theme is based on Indian mythology related to Lord Krishna (a Hindu deity) and the festival of Dahi-Handi, celebrated annually in northern part of India. Born as a prince and brought up into a cowherd family, Krishna is often referred to as "Govinda". As children, Govinda and his friends used to raid kitchens in search of milk, butter (Makhkhan) and cheese (Paneer). They also used to tease young girls (Gopis) carrying pots (Matka) filled with water, milk, butter, or cheese on their heads.

A common practice in rural India is to suspend these pots (containing Cheese, Butter and Milk) from beams high in the ceiling out of reach of cats. During the day when the men were busy in the fields and the womenfolk busy with outdoor chores, the naughty and adventurous Govinda along with his band of friends would form a human pyramid to reach these pots and help themselves to the contents.

The Festival of “Dahi-Handi” During this festival, large earthen pots filled with milk, curds, butter, honey, fruits and coins are suspended at a height of 20-40 feet from the ground. Young men and boys (Govindas) form a human pyramid by standing over each other's shoulders. When the pyramid is tall enough, the topmost person in the pyramid would reach out and break the pot to claim its contents as well as the currency notes tied to the rope by which the pot hangs. This prize money is distributed among those who formed the human pyramid.

Game and Rules

“The Objective”
Two (2) opposing teams (a Red team and a Blue team) will operate Manual machines and Autonomous machines and attempt to get at the pots of butter placed at a height and remove the large cube of Butter (*Makhkhan*) from the bowls. A few of the machines would also attempt to “Steal” the Earthen Pots (*Matkas*) containing balls of Cheese (*Paneer*) being carried by the Young Girls (*Gopis*). Points are earned when the Butter is removed from the Bowls placed at a height. Points could also be earned when a Pot and/or Cheese is transferred to a Basket. The team which picks up all the three butter cubes directly from the bowls and holds them in the air will be declared “GOVINDA” (the winner) and the game will be over. If no team becomes “GOVINDA”, the team which accumulates more number of points within the specified time of three (3) minutes will be declared as the winner.

Definition of words and their representation in the game:
Words in bracket are translation in Hindi language

1) Butter (*Makhkhan*)
Butter is represented by a 200 mm cube of low density polystyrene painted Yellow for the Central Bowl. For the Side Bowl, the cube is of the same size and is painted White.

Fig. 1 Butter (*Makhan*)

2) Earthen Pot (*Matka*)
A hollow thin walled cylindrical Pot made up of light weight plastic material with a wide mouth on the top.

Fig. 2 Earthen Pot (*Matka*)

3) Cheese (*Paneer*)
The Cheese is represented by a light weight miniature basket ball which rests on the mouth of the pot with most of it visible above.

Fig. 3 Cheese (*Paneer*)

4) Basket (*Tokri*)
The basket represents the rectangular area on the game field surrounded by a 50 mm wall. Pots and Cheese are to be deposited here. The color of Basket is Red for Red team and Blue for Blue team. There are two (2) Baskets for Red team and two (2) Baskets for Blue team.

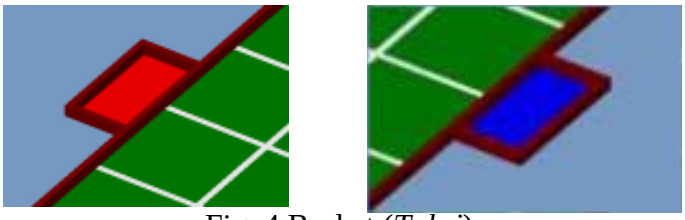


Fig. 4 Basket (*Tokri*)

5) Central Bowl (*Handi*)
This Bowl is placed in the centre of the game field. Yellow colored Butter cube is placed in it.

6) Side Bowl
There are two (2) Side Bowls, one in each half of the game field. White colored Butter cubes are placed in these Bowls.

7) Girls (*Gopies*)

The Girls are carrying Pot containing Cheese on their head. Girls are represented by towers with provision to rest the Pot and Cheese on the top.

Side Bowl Central Bowl Girl

Fig. 5 Side Bowl, Central Bowl, Girl

1.0 Teams

1.1 Each team shall comprise of four (4) members consisting of three (3) students and one (1) instructor, all from the same university, polytechnic or college. Only the three (3) students are permitted to enter the Game Field.

1.2 Team members must be enrolled in their University/Polytechnic/College at the time of the international contest. Exceptions to this rule are those who were enrolled in a University /Polytechnic /College at the time of the domestic contest.

1.3 Postgraduate students are not eligible to participate in the competition.

2.0 The Game Field with various Objects: (Refer Fig. 6)

The game is played on a game field (sized 14500 mm x 13000 mm), which is surrounded by a 100 mm high and 30 mm wide wooden wall. The floor of the game field is made of 2 mm thick vinyl sheet. The field consists of a Manual Area in pacific blue colour, an Autonomous Area in green colour and Common Areas coloured red and blue for respective team.

2.1 Manual and Autonomous Areas

The Manual machines can move freely in the Manual Area but cannot enter the Autonomous Area. The Autonomous machines can move freely in the Autonomous Area but cannot enter the Manual Area.

The Autonomous Area is H-shaped (overall size 9500mm X 8000mm) and surrounded by a wooden wall of 50 mm height and 30 mm in width. There is a grid of lines in the Autonomous Area and these lines are made of 30 mm wide White, non-shiny tape.

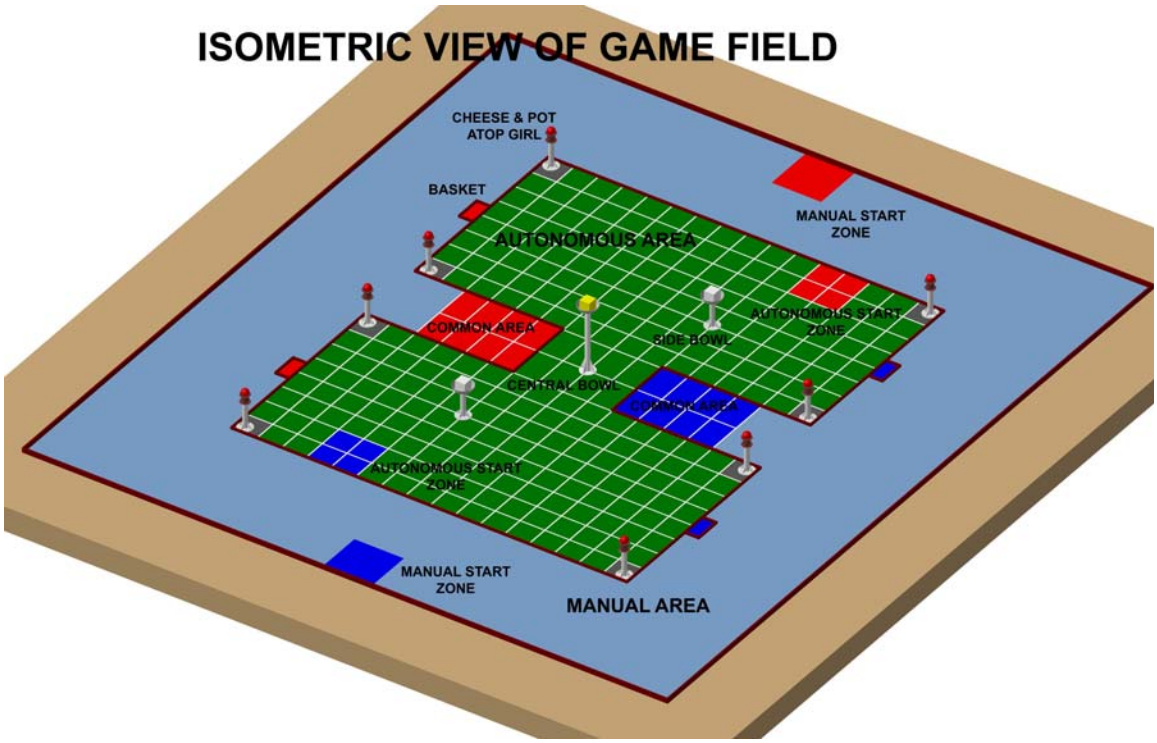


Fig. 6 Isometric View of Game Field

2.1.1 Manual machine Start zone

Manual machine Start zone is a square (1000 mm x 1000 mm) and is located in the Manual Area. There are two (2) Manual machine start zones. One, coloured red, is for the Red team and the other, coloured blue for the Blue team.

2.1.2 Basket

The Basket is a rectangular area (500 mm x 250 mm). Pots and Cheese
"Stolen" from the Girls are deposited here. There are four (4) such Baskets and each of these Baskets is surrounded by a 50 mm high and 30 mm wide wooden wall. The Basket coloured Red belongs to Red team and coloured Blue belongs to Blue team.

2.1.3 Autonomous machine Start zone

Autonomous machine Start zone is a square (1000 mm x 1000 mm) and is located in the Autonomous Area. There are two (2) Autonomous machine Start zones. One, coloured red, is for the Red team and the other, coloured blue for the Blue team.

2.1.4 Common Area

The Common Area for each team (2000 mm x 1500 mm) has a fence of 50 mm height and 30 mm width along its three (3) sides. The Common Area has white grid lines as per Fig. 6. Red Common Area is for Red team and Blue Common Area is for Blue team.

2.2 Objects

2.2.1 Girls

As per Fig.6, the Girls stand at four (4) corners of each half of Autonomous Area. There are eight (8) Girls in total. Each Girl is placed in at the corner of 500 mm x 500 mm Grey square. Each Girl is carrying Pot with Cheese ball. The top of the Cheese ball is at a height of 750 mm from the surface of the game field.

2.2.2 Grey square around the Girls

Each Girl is placed in the corner of 500 mm x 500 mm. Portion of the Manual machine can enter the air space above this Grey Square. The Manual machine cannot touch the floor in this Square.

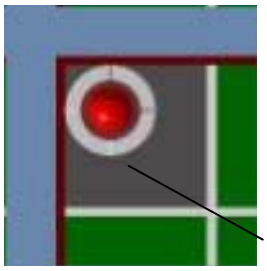


Fig. Grey Square

2.2.3 Central Bowl

Central Bowl is in the centre of the game field. The Bowl is fastened to the top of tower. The Butter cube with Yellow color is placed in this Bowl. The top surface of this cube is at a height of 1500 mm from the floor of the game field.

2.2.4 Side Bowls (Fig.5)

There are Two (2) Side Bowls in the Autonomous Area. Bowls are fastened to the top of towers. Each of these Bowls carries one White Butter cube. The top surface of these cubes is at a height of 750 mm from the floor of the game field.

2.2.5 Pot (Fig. 2)

The weight of pot is 430g (±20 g). The pot is to be painted with brown plastic paint all over.

2.2.6 Cheese (Fig. 3)

The diameter of cheese ball is 150 mm and weight is 150g (± 20 g). For material and surface texture refer the sample provided. Air pressure in the ball should be maintained so that it bounces to 750 mm (± 30 mm), if dropped from height of 1000 mm on a concrete surface.

2.2.7 Butter (Fig. 1)

Each butter will be made up of a 200mm cube of low density polystyrene. The butter cube painted Yellow will be placed in Central Bowl and the butter cube painted White will be placed in each Side Bowls. The weight of each Butter cube is 130g (± 20 g). The polystyrene density is 16 kg per cu. Meter.

3.0 Machines

Each team must design and construct by itself Manual and Autonomous machines to compete in the contest. Each team is permitted to use only one (1) Manual machine and three (3) Autonomous machines.

(See section 3.5 for weight restriction)

3.1 Manual machines

3.1.1 The Manual machine could be operated through a cable connected to it or remote control using infrared rays, visible rays or sound waves. Wireless radio control is not permitted. Operators are not permitted to ride on their Manual machine.

3.1.2 When operating via cable, the point where the cable is connected to the machine must be at least 900 mm above the ground. The length of the cable from the Manual machine to the control box should at least be 1000 mm or more but not exceed 3000 mm.

3.1.3 When in the Manual Starting zone, just before the game begins the size of the Manual machine cannot exceed (1000mm L x 1000mm W x 1000mm H). Once the game begins the Manual machine may change its form but the size of the Manual machine cannot exceed the size of a cube of 1500 mm during the game.

3.1.4 Manual machines are not permitted to split into Two (2) or more units at the start of the game as well as during the game.

3.1.5 Only one (1) member of each team is allowed to control the Manual machine in the game field.

3.1.6 Team members are not allowed to touch the Manual machine once the game has begun.

3.1.7 Manual machines are permitted to operate in the Manual Area and Grey Square, and, under certain conditions, (see section 4.2.2) in their own Common Area. These machines cannot enter the Autonomous Area.

3.1.8 No part of the Manual machine or its operator can intrude into the Autonomous Area and the opponent's Common Area as well as opponent's Basket including the space above.

3.1.9 A Manual machine is permitted to come into contact with its own team's Autonomous machines only when it (the Manual machine) is in its Common Area.

3.1.10 Manual machines are not permitted to touch any of the opponent's Manual and Autonomous machines.

3.1.11 When Manual machines of the opposing teams interfere with each other, the referee will decide and redirect the machines appropriately.

3.1.12 Space for pasting stickers /tags (by Organizers of the contest) is to be provided on Manual machine. This space should be the size of 150 mm x 100 mm.

3.2 Autonomous machines

3.2.1 Autonomous Machines can enter Autonomous Area, Grey Square, its own Common Area and Basket including the space above.

3.2.2 Autonomous Machines cannot enter Manual Area (excluding Basket) and opponent's Common Area including the space above.

3.2.3 Every Autonomous machine must operate autonomously.

3.2.4 Starting up Autonomous machines
3.2.4.1 Only one team member is allowed to start the autonomous machines. The third member can assist in carrying, placing and aligning the machines.
3.2.4.2 Each team has 60 seconds to power up its Autonomous machines from the time the referee announces “Power up”.
3.2.4.3 The Autonomous machines could then be “powered up or booted up” and be in a “sleep mode”.
3.2.4.4 After the power up time of 60 seconds is over, the referee or announcer will count down from 5 and the game will start at the end of countdown.
3.2.4.5 Once the game starts, all Autonomous machines should be “started” one by one, and the task of starting all must be completed within 20 seconds from the “start signal”.
3.2.4.6 Each Autonomous machine must be “started” from the “sleep mode” through a single operation only.

3.2.5 After all the actions of starting Autonomous Machines are completed or 20 seconds after the starting signal, the team members responsible for handling and starting the machines must leave the game field immediately.

3.2.6 Once the Autonomous machines start, team members are not permitted to touch the machines except in the case of “retry”.

NOTE: All participating teams are requested to carefully study Rules 3.2.7, to
3.2.11 and understand the implications of the same before they plan their strategy and the designs of their machines.

3.2.7 The entire set of Autonomous machines of a team should fit within a cube of 1000 mm before the game begins and when the machines are in the Autonomous Start zone.

3.2.8 Each autonomous machine’s size and form may undergo a change during the game, but each machine should fit into a cube of 1350 mm thereafter. Each autonomous machine should not exceed this limit during a game.

3.2.9 Autonomous machines cannot split or separate into two or more units.

3.2.10 The number of Autonomous machines is limited to three (3) maximum.

3.2.11 Two (2) or more Autonomous machines touching each other in the start zone will be considered as one machine.

3.2.12 Space for pasting stickers /tags (by Organizers of the contest) is to be provided on all Automatic machines. This space should be the size of a post card. (150 mm x 100mm)

3.3 “Retry” of Autonomous machines.

3.3.1 For Autonomous machines, a “Retry” is permitted once per game for each team.

3.3.2 Autonomous Machines granted retry must be started by single operation one by one. When the Autonomous Machines are in the Start Zone, they should satisfy the conditions mentioned in 3.2.7, 3.2.10 and 3.2.11
The team members who are responsible for handling and re-starting Autonomous Machines must leave the game field immediately once the action of restarting is completed or after 60 seconds from a Retry is granted by a referee.
3.3.3 Retry will not be granted for the Autonomous machines which are holding cheese, pot or butter.
3.3.4 On "Retry", no parts of the machines should be replaced, power sources of the machines should not be recharged. One cannot add a power source also.
3.3.5 When a "Retry" results in violation of the rules, it is up to the referees to rule on the situation, including the validity of the "Retry".

3.4 Power Supply for Machines

3.4.1 Each team shall prepare its own power supply for all its machines.
3.4.2 Voltage of the electric power supply for machines shall not exceed 24V DC.
3.4.3 A Power supply that is considered dangerous or unsuitable by the Contest Committee shall not be permitted. When compressed air or springs etc are to be used they should be charged after the game starts using the power supply pre-mounted on the Machines.

3.5 Weight

All Manual and Autonomous machines including their power sources, cables, remote controller and other parts of each machine shall be weighed prior to the competition. The total allowable weight of all machines and above accessories for each team to be used throughout the contest must not exceed 50 Kg. The total weight of 50kg doesn't include spare batteries with the same shape, same weight and voltage.

3.6 Machine specifications
Size and weight of each machine will be measured before the competition. Machines that are not made in conformity with this Rulebook will not be allowed to participate in the Contest.

4.0 The Competition

4.1 Matches

4.1.1 Each match shall last for maximum three (3) minutes.

4.1.2 The team which picks up all the three butter cubes directly from the bowls and holds them in the air will be declared "GOVINDA" (the winner) and the game will be over.

4.1.3 Otherwise, the team which scores the maximum points at the end of 3 minutes will be declared as the winner.

4.1.4 In case of tie, the winner will be decided as per the following order of priority
4.1.4.1 The team which has picked and held Yellow butter cube in the air till the end of the game.

4.1.4.2 The team which has picked and held two white butter cubes in the air till the end of the game.
4.1.4.3 The Team which has picked and held one white butter cube in the air till the end of the game.
4.1.4.4 The team which has captured more numbers of pots along with cheese balls.
4.1.4.5 The team which has captured more number of cheese balls
4.1.4.6 The team which has captured more number of pots.
If there is a tie after that also, the referee should decide the winner.

4.2. Competition Rules

4.2.1 Points are scored when Autonomous and Manual machines transfer the Pots and Cheese from the Girls to the Basket as follows.
4.2.1.1 Autonomous and Manual machines of Red team must transfer the Pots and Cheese to the Red colored Basket.
4.2.1.2 Autonomous and Manual machines of Blue team must transfer the Pots and Cheese to the Blue colored Basket.
4.2.1.3 Points are scored when Yellow and/or White Butter cube is picked up and held in the air by an Autonomous Machine.

4.2.2 The Manual machines cannot enter the Common Area (and assist an Autonomous machine) until they have transferred at least one (1) Pot or Cheese (or both) from the Girl to the Basket in order to enter the Common Area and assist an Autonomous machine.

4.2.3 Manual machines are NOT permitted to touch, remove or move the Pot or Cheese once they are placed in the Basket of the opponent's team color. There is a penalty if they do so.

4.2.4 Autonomous machines are permitted to steal or move Pots or Cheese placed in opponents Basket. Then they should deposit the stolen material in their own colored Baskets to earn points.

4.2.5 Manual Machines are not allowed to touch the Butter cube. Only the Autonomous Machines are permitted to handle the Butter cube.

4.2.6 Once Autonomous Machine picks up the Butter, it should make sure that it retains the Butter in the air till the end of the game.

4.2.7 An Autonomous machine of a team can touch its Manual machine only when its Manual machine is in the Common Area.

4.2.8 An Autonomous Machine can gain points by picking up Cheese or Pot or Butter that are dropped on the floor of its own Common Area or Autonomous Area. A Manual Machine can gain points by picking up Cheese or Pot that are dropped on the floor of the manual area, Grey Square, or its own Common Area.
If autonomous machine picks up the butter cube lying on the floor of its own common area or autonomous area and holds it in air and completes the other conditions for "GOVINDA", it can gain full points for that, but the game will continue for 3 minutes and the winner will be decided on the maximum number of points earned by a team.

4.3 Scoring

4.3.1 A team gains points when it successfully collects Pots and/or Cheese into its own Baskets by its Manual / Autonomous machine or when Butter cubes from the Bowls are successfully picked up and retained in the air by an Autonomous Machine.

4.3.2 Points are awarded as follows:
4.3.2.1 Pickup and retention of Yellow Butter by Autonomous machine = 12 points
4.3.2.2 Pickup and retention of White Butter by Autonomous machine = 6 points
4.3.2.3 Presence of Pot with Cheese on its top in Basket = 3 Points
4.3.2.4 Presence of Pot in Basket = 1 point
4.3.2.5 Presence of Cheese in Basket = 1 Point

5.0 Violations and Deductions of Points

5.1 Once a game begins, the following actions will be regarded as violations and three (3) points will be deducted for each occurrence.

5.1.1 A violation occurs if a Manual machine touches Cheese or Pot placed in the opponent's Basket intentionally.

5.1.2 A violation occurs when a Manual machine or its operator enters, or a portion of machine or operator extends into the air space inside Autonomous Area and opponent's Autonomous machine start zone as well as the opponent's Basket's air space. The exception is Grey Square around the Girls where portion of machine can enter but not the operator's.

5.1.3 A violation occurs when Manual machine or its operator or any part of them touches the floor of grey square.

5.1.4 A violation occurs when a Manual machine touches its opponent's Autonomous machines.

5.1.5 Autonomous and/ or Manual machine cannot snatch the Butter Cube and/or Pot and/ or Cheese held by the opponent.

5.1.6 The act of intentionally dropping or changing the positions of butter cube, cheese, pot so that it becomes difficult for other team to score.

5.1.7 If above violations continue intentionally, three (3) points will be deducted for every five (5) seconds of duration of violation.

6.0 Disqualification

The following behaviours shall be considered for "disqualification of the team" by the referees for that particular match. 9 points will be deducted from the total score of the disqualified team for that match.

6.1 Causing or attempting to cause damage to the game field, the equipments on the field, or the opponent's machines and the objects such as Cheese, Pot, Girls, Bowls and Butter.

6.2 Members of a team touching their own machines intentionally.

6.3 Manual machine or its operator intentionally blocking, touching or attacking the opponent's Autonomous machine directly or / and indirectly.

6.4 Manual machine picks up or moves the opponent's Pots and Cheese placed in the Basket intentionally.

6.5 More than one (1) False Start in a match (machines being started before the referee signals a start.)

6.6 Performing any act against the spirit of fair play and friendship between participating teams.

6.7 Persistently using the cable to guide or pull the Manual machine will lead to disqualification from the match.

6.8 Intentionally attacking the opponent's Manual machine with own Manual machine will lead to disqualification.

6.9 The team that does not follow the instruction or warning of the Referee will lead to disqualification from the match.

6.10 Autonomous Machine entering the opponent's Common Area or the space above it will lead to disqualification.

However if Autonomous machine moves or falls into the opponent's common zone by accident it should be removed immediately as per referee's instructions. (The referee is empowered to determine whether it is an accident or not.) Retry can be allowed after that.

6.11 Manual Machine or any part of it intentionally entering the opponent's Common Area or the space above will lead to disqualification.

6.12 Three violations would lead to disqualification from that match.

7.0 Safety

7.1 All machines must be built such that they will not harm the operators, the referees, and match officials, members of the audience, opponent's equipment and the game field. Explosives, fires and hazardous chemicals shall not be used.

7.2 To ensure safety, when using a laser beam, it must be less than a Class 2 laser, and used in a way that will not harm any operators, the referees, match officials, audience, opponent's equipment and the game field.

7.3 When using optical sensors teams must consider the fact that there will be very bright lights on the game field for video recording and broadcasting purposes.

8.0 Others

8.1 For any other ehaviour not specified in the rules, referees are given full authority to make the decision and the decision is final in the event of a dispute.

8.2 Any amendments to these rules will be announced by the Contest and will be uploaded on its website.

8.3 All teams are encouraged to decorate the machines to reflect the culture, aesthetics and styles of their respective countries.

8.4 All machines must be designed and made by student teams – ready made commercial machines will be disqualified from being used. Teams are not allowed to have any sponsor logo on their robots.

8.5 When requested by the Contest Committee, each participating country will be asked to provide information on their machines, including the videotape, which explains the structure and the movement of the participating team's machines. The Contest Committee will verify whether each participating machine complies with the rules through viewing the videotapes, prior to the shipment of the machines.

8.6 The allowable margin of error to the Objects in this Rulebook wherever not mentioned is ± 5% both in weight and size.

9.0 Questions regarding theme and rules

Website: <www.roboconindia.com>
E-mail : <robocon2008@roboconindia.com>

10.0 FAQs

The "FAQ" shall be updated on www.roboconindia.com/faq. Robocon 2008's Theme and Rules was drafted by the consultative council including these members:

Prof. C. Amarnath – Indian Institute of Technology, Bombay
Prof. Susmit Sen – Indian Institute of Technology, Kanpur
Prof. Subir Kumar Saha – Indian Institute of Technology, Delhi
Prof. Prakash Joshi – Maharashtra Institute of Technology, Pune
Prof. Anant Chakradeo – Maharashtra Institute of Technology, Pune
Prof. Chaitanya Kachare – Maharashtra Institute of Technology, Pune

APPENDIX

A1. MATCHES
The contest is played according to the following format: Preliminary Rounds: Round robin within groups.
Winner from each group shall advance to the Quarter-Final. Quarter-finals: Knock out matches. Semi-Finals: Knock out matches. Finals: Knock out match.

A2. AWARDS

Prizes shall include awards for the winners, runner-ups, best idea, best technology, and best design and ABU Robocon award, Sponsors' awards.

A3. COSTS of PRODUCTION and CARRIAGE A3.1 Cost of Production
The ABU Robocon Organizing Committee shall provide USD 1000 as a subsidy for machine construction to each committee member organization.

A3.2 Cost of Carriage
A transport company, specified by the committee, will ship your machines to the playing venue in Pune, Maharashtra, India. Details will be announced later.

A4 Samples being sent to all the participating broadcasters

1) Cheese (Paneer) – A miniature basket ball of 150 mm diameter (One (1) sample)
2) Bowl for keeping Butter (Makhkhan) Cube (One (1) sample)
3) Vinyl sheeting (2 mm thick) color shades for Autonomous area, Manual area, Red and Blue Start zone, and Grey square.

MECHANICAL DESIGN

Our strategy was to have one manual and three autonomous robots. So here goes the list of the robots we made:-

1. THE MANUAL ROBOT (Fig. 7)

The Manual Robot designing started in the month of December, 2007. **Mohit Sharda** and **Pawan Kumar** were the students involved in finalizing the design of the robot.
The main features of the design were as follows:-

- The skeleton consisted of a low base structure with wheels placed along the axis passing through the centre of mass of the robot.
- The robot had two identical but separate grippers so that it could pick up two pairs of pot and cheese ball at the same time.
- The gripper was designed to move up and down vertically with the help of a pulley mechanism as opposed to the previously used method of rotating the entire gripper arm about a shaft with the help a thread wound around a motor shaft.
- The gripper was designed to use the shape of the “gopi” to lift it. It didn’t apply much force but just lifted the “gopi” using the extended flap of the “pot” and also upper protection was provided so that the ball didn’t fly away. This was done to make gripper as light as possible.
- The motor and the pulley used to lift the gripper was placed at the top of the robot structure this time instead of placing it at the base as was done previously.

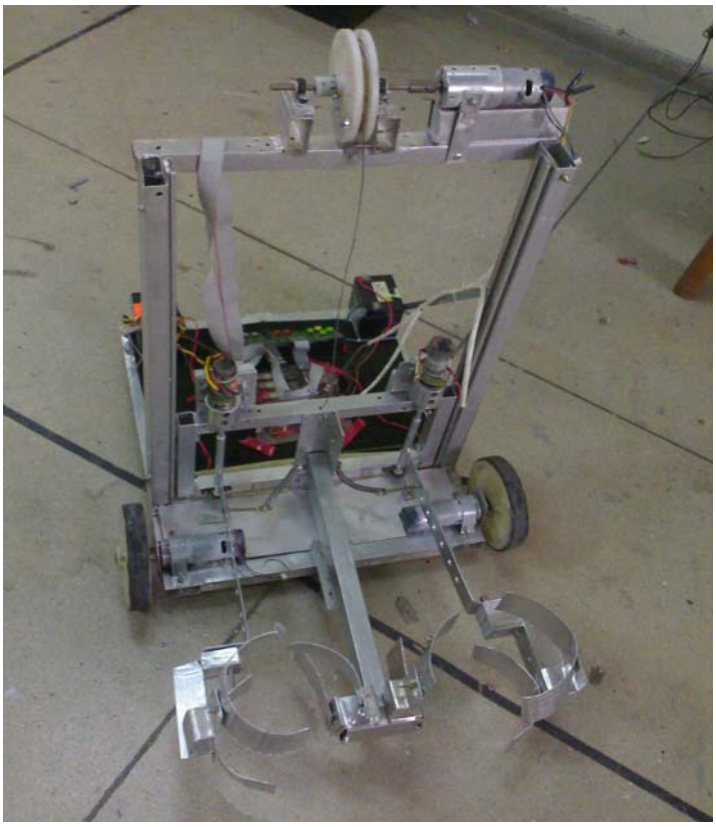


Fig. 7 The Manual Robot after completion

2. THE AUTONOMOUS ROBOTS

As was decided, three autonomous robots were fabricated. They are as follows:

2.1 THE JACK (Fig. 8)

- It was the robot under **Gaurav Mittal.**
- This robot was supposed to be the one that would lift up the third robot (the Krrish) in order to pick up the "yellow cube" at the centre of the field.
- The mechanism used, as the name suggests, was same as that of a car jack mechanism.
- The thrust required to lift the arms was to be provided by a motor (with gear reduction of 900:1) integrated with external gear reduction.

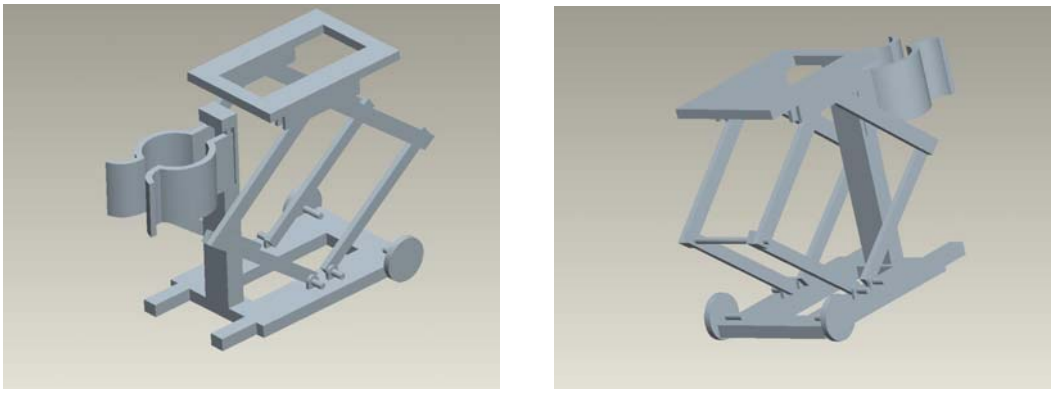


Fig. 8 Initial Design of Jack

2.2 THE HE-BOT (Fig. 9)

- This robot was under **Hemant.**
- It contained two grippers, one for picking up the "white cube" and other one for picking up the "gopi".
- The fact that the lifting motion of one of the gripper was controlled by that of the other gripper's required the use of only one motor. There were two separate motors for the opening of the grippers. The closing of the gripper was under spring action which brought back the gripper to its closed position once the motors were switched off.
- The gripper designed to pick up the "gopi" was same as that used for manual machine.
- A docker was also provided for the proper alignment of the robot with the pole. Though its alternative use was discovered on the game field where it was used a defensive weapon to push the "gopis" of the opponent team out of the basket.

2.3 THE KRRISH (Fig. 10)

- This robot was under **Jainesh.**
- The robot was supposed to pick up the "yellow cube" by climbing on top of the "Jack" and later on pick up a "white cube" too.
- As required the robot contained two grippers, one for the "yellow cube" and other for "white cube".
- The grippers were specially designed to lift the cubes efficiently with the help of strong grip provided by sandpaper. They were not lifted up and down, rather were rotated about a shaft to the required extent (the angle fixed mechanically) in order to pick the "cube", lift it up and then move away.

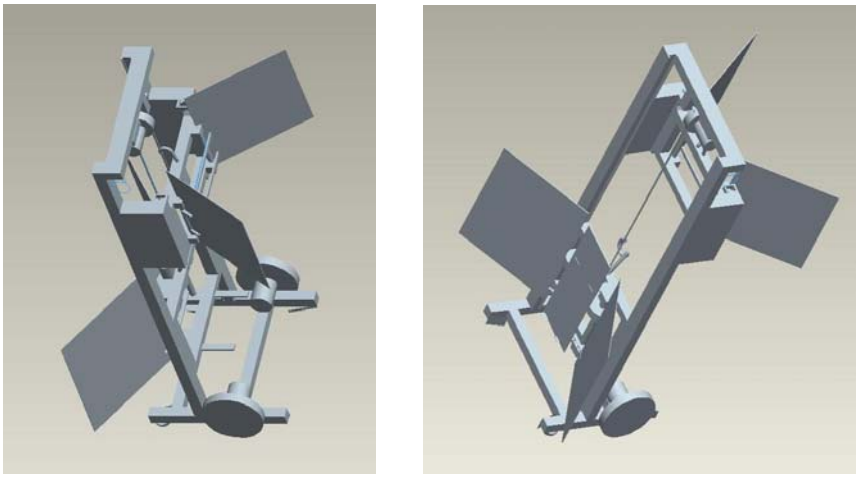


Fig. 9 Initial Design of He-Bot

- The base of the robot was chair-like to facilitate its lift up by “Jack”.
- It contained two dockers. One of them was specially designed with rollers put on the inside so that the robot could smoothly climb up the “central pole” without any mechanical contraint.
- Though the robot was initially a two caster system but was later on made a one-castor system to improve its navigation as the previous setup was providing some difficulties.

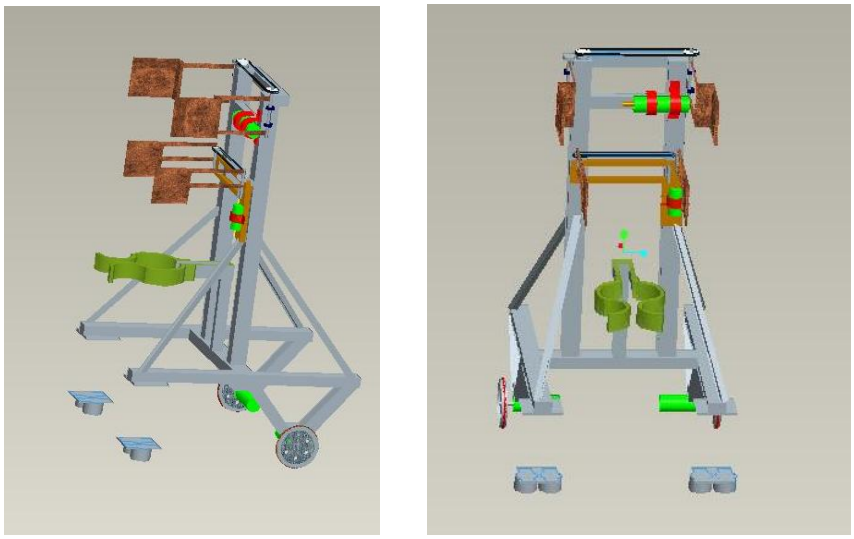


Fig. 10 Initial Design of Krrish

ELECTRICAL DESIGN

INITIAL PLANNING

- The robot navigation was to be on **encoders** as well as on **line following mechanism**. Encoders were to be the primary feedback with sensors acting as a secondary feedback.
- The **photo-sensors/light sensors** were to be purchased rather than home-made unmodulated sensors due to ambient light effects suffered by them which had troubled the Robocon team in the past years too.

- An **LCD (Liquid Crystal Display) (Fig 11)** was to be interfaced with the main microcontroller as a debugging tool.

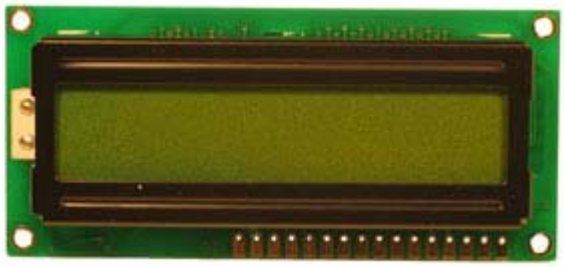


Fig. 11 Liquid Crystal Display

- The **motor drivers** were also to be procured as the H-Bridges used previously weren't that robust owing to their low current carrying capacity.
- More motors were to be ordered.
- Initially it was decided to use an **ARM processor (Fig 12)** as the main controller board for the robot but the idea was later on dropped as the programmer for the same could not be procured.

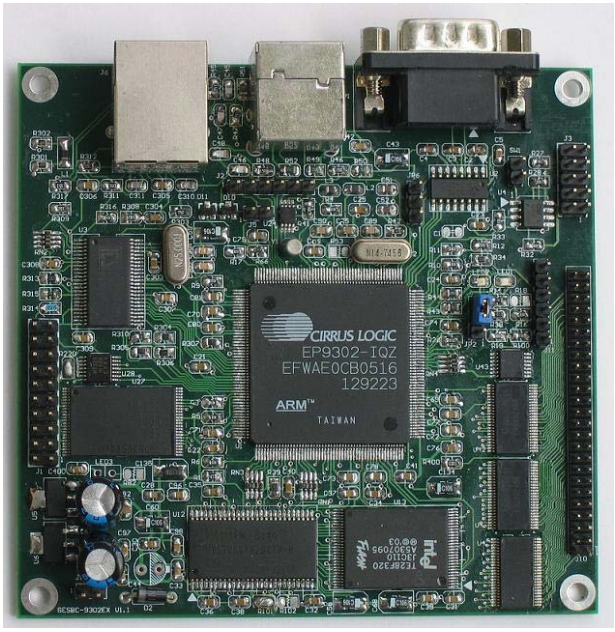


Fig.12 The ARM Processor Board

<u>Work Done in December, 2007</u>

- ***Manual Machine Drawings:*** Vyom Jain and Pawan prepared the drawings of the manual robot in Pro-E (Professional Engineering software) and got the print outs of its basic skeleton and grippers that we had to be manufactured.
- ***Manual Ciruit Finalized:*** It was decided to use the same relay based circuit for the manual as was used for the international competitition in Vietnam in 2007.Below are given the **PCB drawings of the manual circuit (Fig. 13) and its remote control (Fig. 14).**

- ***Test Robot:*** The test robot, consisting of a square structure with two motor driven wheels and a castor wheel, was assembled to be used by the programming wizards for testing of their encoder based navigation algorithm.

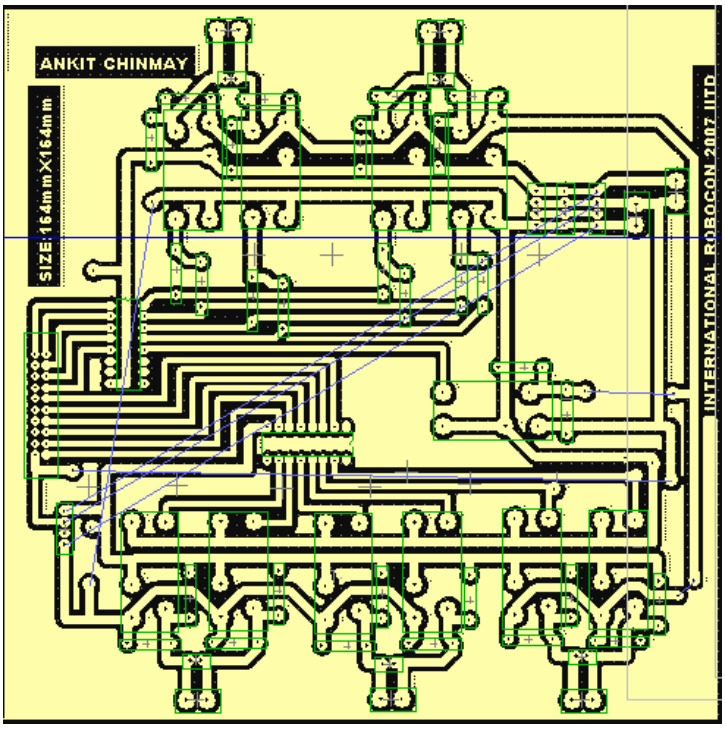


Fig. 13 Relay based motor driving circuit for the Manual Robot

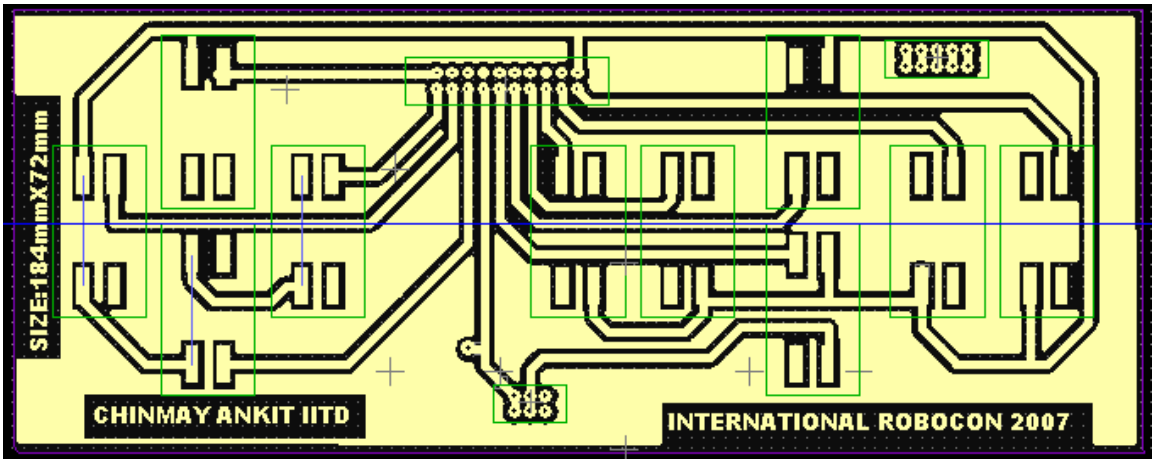
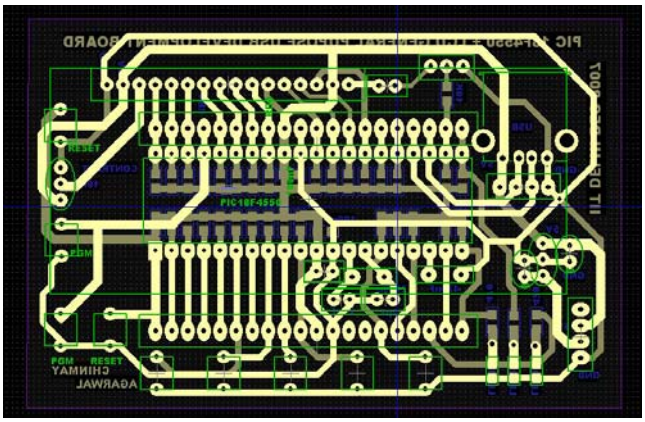


Fig. 14 Remote Control PCB for the Manual Robot

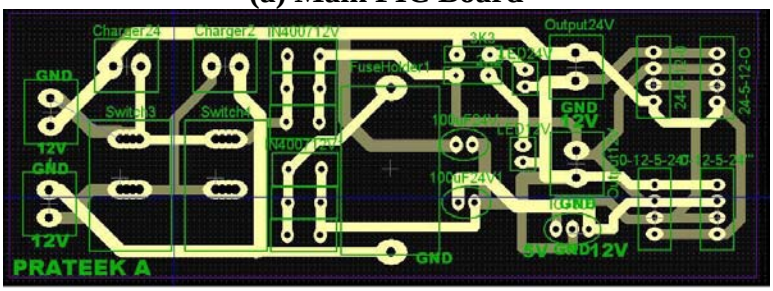
- ***Motor Driver (Fig. 15):*** Meanwhile, many components were ordered through internet. The motor drivers were the first to be procured. The motor driver was capable of driving two motors and had a high upper limit of current (15 Amps). They were interfaced with PIC microcontroller through **UART (Universal Asynchronous Receiver/Transmitter) port.**
- ***New PCBs:*** Another **PIC circuit board (Fig.16a)** was designed using **DIPTRACE (software)** and manufactured. This circuit had the PIC microcontroller chip with all of its pins accessible outside. It had a port for the LCD to be directly plugged onto it. Further a few switches and status LEDs were added to the board to provide for extra functionality. It was

much smaller in size than the ones used in previous years. Further a new **power supply PCB (Fig.16b)** was also fabricated too.

Fig.15 Motor Driver



(a) Main PIC Board



(b) Power Supply Board

Fig. 16 PCB Drawings

- ***Algorithm:*** The basic algorithm was prepared for the robot to navigate on the encoder mechanism. The basic count of ticks, given out by the encoders attached to the motor in proportion to the degree of rotation, was successfully performed through the PIC microcontroller.
- ***LCD:*** The 16*2 LCD was successfully interfaced with the PIC board. It was supposed to be used for de-bugging processes. The various press switches provided on the board were used for making modifications in constants used in the navigation algorithm of the robot without the need to program the PIC microcontroller again and again.

Work Done in January, 2008

- ***Manual Machine:*** In the beginning of January, manufacturer had been provided with the drawings and asked to manufacture the manual robot as soon as possible. After the main skeleton was prepared, the assembly of the robot started taking place. Several changes in terms of the gripper design were made as the manual robot starting taking some concrete shape. The protection that we had initially provided for the ball that was picked along with the pot was changed as it was not too efficient in retaining the ball and the ball kept on falling now and then. Finally a plastic protection was provided in the gripper as a remedy to the problem.
- ***Automatic machines***: The automatic machines were also sent for production. The mechanical guys spent half of their time in Khayala, where the robots were being manufactured. The skeleton of all the robots were ready till the end January. The jack was given the preference as its testing was the most crucial.
- ***The Jack*****:** The initial design of the robot was made robust after the initial testing. Its arms which were earlier made of aluminium were found not to have the required strength needed to pick another robot. So the whole structure was made again, this time with mild steel. The static testing done using mild steel turned out to be successful as the robot picked up about 15 kg of weight which was a good figure. Other aspects of the robot were then emphasised upon. The blocking aspect was considered. The blocker motor and blocking channels were also thought upon.
- ***The He-Bot*****:** This robot was almost ready by the end of this month. The switches and few other things though still remained to be finalised. According to the initial plan, this robot was to be navigated using both the encoders and photo-sensors.
- ***The Krrish:*** The skeleton was ready till the end of the month. This was quite late as Jainesh couldn't pay much attention to it. The jack which was the topmost priority took most of his time.
- ***LCD Menu:*** A positive thing that came out of the first half of January was that a menu system was implemented in the LCD +PIC microcontroller board. This menu helped us to tune the constants on the spot without having to program the microcontroller again and again. The menu contained all the constants ranging from the speed of the wheels, the number of revolutions it need to move or the time for which it should move etc.
- ***SD Card:*** Apart from the LCD as a debugging procedure, SD card was required to be interfaced with the microcontroller so that proper values of the feedback could be recorded and looked upon. Hence it was also incorporated in the design.
- ***Algorithm and tuning:*** The initial algorithm made in the month of December was implemented in this month on the test robot. The algorithm needed to get the theoretical calculations as close as possible to the actual measurements. There were two constants involved – one in calculation of forward distance and other in calculation of the orientation of the robot. These constants were tuned for the test robot by trial and error method.
- ***Research in control algorithm:*** Meanwhile, we had to find some ways to provide feedback and hence, complete our control algorithm required for proper navigation of the robot. Papers were studied as well so as to model the system and hence provide necessary feedback for the robot to move in a straight line on the basis of encoder. However little success was achieved in this regard.
- ***Line-detecting sensors:*** Since the algorithm for navigation of the system based on encoders wasn't been finalised, there was a need to buy the line-detecting sensors that could be used for line following. The sensors were bought from **IFM, Bangalore**. The initial testing of these sensors was done by the end of this month.

Work Done in February, 2008

Selection of the Manual Operator: There was an urgent need to find a new manual operator as Puran (earlier manual operator) wasn't available for practice as well as for the competition. The plan was to preferably select a first-yearite for the job as he would have at least three more years for participation.

So, towards the end of January, the repairing of the last year's manual robot was done so that all the new Robotics Club members could try their hands on operating the robot and the selection for the manual robot operator could also take place.

- ***First trial:*** The trials on the robot went on for about two or three days but the selection couldn't take concrete shape. Side-by-side, the work on the new Manual robot was being hurried up so that the practice of the operator on the new robot could start as early as possible. We were already behind schedule and the robot was absorbing much more tome than expected. But then by the first week of February, the robot was ready and working.
- ***Initial Selection by Puran:*** One day all of the first year students were called and were given some tips by Puran. Then they were asked to run the robot along the periphery of the part of the game field that had been built in front of the Robotics Club Room. Puran observed them closely and selected Danvir Singh and Sanjay Dhakar from amongst them. Puran advised them how they should practice every day from then onwards as the competition depends heavily on the control of the robot by the operator besides the design and ability of the robot.
- ***Final Selection:*** After a few days Sanjay backed out as he was more interested in the electrical design work and could not devote time to the manual robot practice. Abhijeet Rathore, who was not able to come on the day of selection, came into picture and he too began practicing on the robot. For a day or two the main focus of the practice was navigation of the robot on a single 12 Volt battery rather than two *12V batteries.

Development of Manual Machine and Operator:

- ***Changes in Gripper:***
  - The gripper motors that had initially been assembled on the robot were unable to grip the pot and cheese ball with the required force. Thus the gripper was removed and some changes like welding of the coupler and shaft and change of motors was done.
  - The gripper for the robot was changed so that it would pick up the pot and cheese not only from the flange but also gripped the pot from the sides. For achieving this, an aluminium sheet, bent into a curve to grip the pot easily, was attached to the gripper. It was so designed that the robot was able to pick up fallen cheese ball from the ground also efficiently.
  - However the maximum height to which the gripper could be lifted was not enough to be able to easily lift the pot and ball from the top of the gopi. Thus modifications were made by removing some part from the top of the bot so that the gripper could be lifted further up.
  - In the end, in order to allow the gripper to open fully and not hamper the rotation of the wheel when it was opened at the minimum height, grippers made of mild steel replaced the gripper made of aluminium which further lead to increase in its strength by many-folds.
- ***Models of Pot and Cheese:*** Then as modifications in the gripper were completed and the robot started working, the task of picking up the pot and the cheese ball models, which Mayank had got from the market, from the pole and placing them in the basket placed on the

floor also started. But the pot that had been made of cardboard and a plastic CD case was not too successful as it was not of the required weight. Though we tried to increase the weight by adding some scrap aluminium pieces to it but the cardboard flange was not able to withstand the weight that fell on it when we picked up the pot and ball by the robot. Thus pots made of wood were ordered.

- ***Circuit Problems:*** The manual circuit unexpectedly gave a lot of problem. This circuit was used in the International Robocon last year as well but no problem was reported during that time.
    - Firstly, there was a problem with power circuit used as interface between the batteries and the main circuit. There was a fuse being used in the circuit which limited the amount of current flowing in the circuit. Removing the circuit rectified the problem.
    - Secondly, the relays demanded a lot of current that the PCB copper wires couldn't withstand. This problem was only identified after two circuits had stopped working. So multiple paths were provided for the current to flow. The ground and 24-V lines were the most affected. So, multiple wires were soldered in order to provide parallel paths for the current.
- ***Clutch Wire***: The clutch wire that we had used for lifting the gripper was also not reliable as it was constantly wearing off bit-by-bit and had broken a few times. Thus we decided that we would have to change the wire after every match during the competition.
- ***Organised Practice:*** The serious practice of the Manual robot was then started. Time taken in completing different tasks during the practice sessions were recorded so that the improvements taking place in the manual robot operation by both Abhijeet and Danvir could be known.
- ***Maximising the output:*** Possible problems and their solutions were discussed and sorted out during this time. The maximum number of points that we could score in a match were simulated and discussed. Tasks like picking up a ball from the ground, in case the pot fell during the game, and placing them in the basket were practiced. To maximize the number of points we could score with the manual robot, we also practiced the task of placing a pot and cheese ball pair on top of another.
- ***Final Stint:*** Danvir and Abhijeet were also prepared for the anti-cheering they could have to face during the matches from the audience. Thus extensive practice went on till 3rd March and we discussed our different strategies and maximized our strengths. On 4th March, the robots were packed and were readied for their journey to Pune.

Motor Fiasco: This was a major hurdle faced in the month of February. Suddenly, motors began to break down. The motors used for the gripper in manual machine were changed many times as the motors used earlier didn't work well. Some of the Maxon motors used last year were found dead. They didn't react on applying voltage on its terminals. Various motors were used and changed for the two grippers of the He-Bot. There was a shortage of motors for the grippers of the Jainesh's robot. We had only 6 of the driver motors which were to be used for the 3 automatic robots. Even the driver motor broke down in the last half of the month though it was successfully repaired by Chinmay using parts from an already damaged one. We just hoped that this chain of breaking of the motors would stop as we had no extra motors that could be used as a replacement.

Line Following: Hemant's robot was ready for navigation by this time. The photo-sensors had also been tested. So they were fit onto the robot and the line following algorithm developed last year was used. The tuning of the robot for adequate speed and the feedback constant was done in

one night. So we had the confidence that this robot would definitely work even if the encoder algorithm couldn't be finalised.

Jack: The wait was over. Jainesh's robot was finally completed with both of its grippers, dockers, wheels, batteries and the circuits. It was being statically tested whether Jainesh's robot would be picked up by the jack or not. The test came out to be negative. This test was being performed at a very later stage. The jack couldn't pick up the other robot as the torque being provided wasn't enough. Also the bearing broke out and the shaft began to bend. So some radical changes were to be made in the robot within a week of leaving for Pune. The external gear reduction which didn't prove to be adequate enough to provide the necessary torque was increased by factor of three. The jack was finally able to pick up the other robot but the fabrication was completed too late that navigation couldn't be tested on the jack. Jainesh's robot wasn't tested on the field even once.

The Krrish: This robot was completely fabricated in the first half of the month. This was to move on two caster system and hence, four point system. This system, when tested, wasn't stable at all. It always had a few oscillations resulting due to the shift in the point of contact from one caster to another. The two caster problem wasn't solved till we left for Pune.

The He-Bot: This robot was completely ready with all the circuits and mechanical fitting till the 20th February. The line following on this robot had already been tested. The tasks that remain were that of the initial start zone and also integration of movement of the grippers with the navigation. Firstly, the constants for proper calculation of distance travelled were tuned properly. Then, various start zone algorithm were formulated and properly tested. Then came the integration of the code for movement of the grippers with that of the navigation. This was done only during the last few days before we left for Pune.

NATIONAL ROBOCON 2008, PUNE

- ***Status of robots:*** Before leaving for Pune, the following was the status of our robots
  - Manual Machine was working absolutely fine and the operators were well practiced though final operator had not been yet decided.
  - Hemant's robot was working partially fine but still needed a days work. We needed to tune the constants again after reaching Pune.
  - Jack was only completed. It wasn't working at all. It needed preliminary testing and tuning of the constants before it could be made to work.
  - Krrish was in even worse shape. It still had that two-caster problem.

Assembling of Robots: On the evening of 6th March, we reached Pune. When we reached MIT, we started the assembly of the robots immediately. The Manual Robot was the first to be assembled. Then second in line was Hemant's robot. It was most crucial to get the He-Bot working as soon as possible.

- ***Manual Practice:*** As we got our manual robot on the Practice Field and got it running, the robot gathered a huge number of impressed, astonished and awed glances from onlookers. Our robot was quite fast as compared to the robots of other teams. Our confidence started to build up as we practiced, saw other robots and saw the admiring looks on the faces of others. Danvir and Abhijeet both practiced till late night (rather morning) and got a good feel of the speed of the robot on a longer stretch as compared to the field which we had got made in IIT.

- ***Nirma and MIT's robots:*** We saw the Nirma University robots and were blown off with the speed with which they picked up the 12 point cube from the top of the 1.5 m high pole. Their Manual Robot was also of considerably good speed and could pick up two pot and cheese ball pairs at a time like us. Thus Nirma had a winning combination and our Jack and Krish combination had no scope in front of them.

  Also the robots of MIT were quite impressive. They were able to pick the yellow cube in about 8-10 seconds. Their manual robot was also impressive as it was capable of picking up and keeping 2 "gopis" on top of one-another quite efficiently.
- ***Our progress:*** Meanwhile, we had He-Bot working absolutely fine. It was now capable of picking both of the "white butters" without any difficulty. Only feature that remained to be tested was that of blocking the opponent's basket. We couldn't test this in front of others as this idea could have been easily copied by others leaving us with no extra edge over our competitors. The testing of jack has been started but this was certain that the Jainesh's robot would not be used. The jack would only be used to block the opponents 12 pointer. Our jack had just to be fast and accurate.
- ***Breaking of Manual Robot's Shaft:*** Then on the evening of 7th March, while I and Abhijeet were practicing, the pulley shaft on the top of the robot gave way. The shaft had got sheared around a hole which had been made to connect the pulley to the shaft and broke into two. All of us became tense as this was a serious problem but also thanked God that this had happened before the matches and not during one. Now we made a new shaft of out of Silver Steel which was much stronger and resistant to shear. Though it was very difficult to prepare the shaft as it was nearly impossible to drill it but in the end, we had it ready somehow.
- ***Selection of the operator:*** Till the night of 7th March, it still wasn't decided who would be the manual robot operator, Danvir or Abhijeet. It was getting difficult for the team to decide the operator as both of us were doing fine in operating it. Still both of us continued our practice. Then came the news that Abhijeet had been hurt. A metal piece had pierced his foot and he was bleeding profusely because of which he had to be taken to the hospital. After an hour, when he returned, he told us that he had received few stitches and the doctor had advised rest. Then it all fell on Danvir to operate the robot.
- ***Danvir's mindset:*** "It was final that I would be the manual robot operator. Earlier, both of us (me and Abhijeet) shared the responsibility of practicing the bot and I did not have to bear the whole responsibility that fell upon the operator. It dawned on me that now I would be solely responsible for a huge part of our performance in the matches. As our first match approached closer, my nervousness increased. I had seen the robots of our first competitor, IIT Kanpur Team B and though we knew that our manual robot was much faster than their manual but I was not much confident as the circuit had again created problems earlier that evening and its repair had taken quite some time. But still, I was ready for the matches that were to start next day."

THE MATCHES

The situation was that we would be able to clear the league stage and enter the Super-league stage if our manual worked fine and hemant's bot was able to pick the 6 pointer (white cube). We planned not to use Jack in the league stage. The story of the matches has been narrated by our manual operator, Danvir Singh.

The First Day (March 8, 2008)

- ***The First Match***: The first match was between IIT Delhi and IIT Kanpur Team B. Our chances of winning in that match were good as our manual was quite fast and responsive and the He-Bot was also quite reliable. Our opponent's autonomous bots seemed not to be in working condition.

  As I (Danvir Singh) was standing there in front of everyone before the start of the match, I was dumb-struck to see the number of people present there. I tried to keep my composure and kept my eyes and ears open for the start of the match. As the referee blew the whistle signifying the start of the match, I jumped to action. The first game was easy. I could easily pick up five of the pot and ball pairs and place them in the basket. Though our He-Bot committed two violations but still we won the match by a margin of 15-2 points.

  My confidence increased a lot after that game. Then other two rounds went easily and we won the match by a huge margin. However I made a mistake while placing the pot and ball during one of the rounds and so I practiced more after the match in order to improve my game. Also during the match, due to slipping, it had been difficult to run the robot straight. So that too had to be fixed.

- ***Second match***: the second match was in the evening and we had a lot of time between the first and second match. The grip over the wheels of the manual bot were replaced with new ones having higher coefficient of friction and all the nuts and bolts, specially the screws and Allen bolts between the gripper motor, coupler and housing were tightened, the clutch wire was changed and we were ready for the second match which was to be played against the Maharashtra Academy of Engineering (MAE), Pune. We had observed their bots and were confident that we could easily win with our duo-combo, the manual and He-Bot, if they worked as expected.

  Before the match, I (Danvir Singh) was much more composed compared to the first match. In the match I was successful in placing four pairs of pot and ball in one of our baskets in less than two minutes. But after I had picked up the fifth pair and a ball from the ground and went to place them in a basket, ***disaster struck!*** I was unable to lift the gripper as the bolt between the pulley and shaft had got sheared because the 3mm bolt which had been used was not able to handle the weight of the gripper. I lost my composure. Tension built up. Though we won the first round, we lost the second one as we couldn't use the manual robot which was being repaired.

  Then during the third round, we were ready with the manual robot again. Now everything depended on this round. If we won that game or even drew it, we would have been able to advance to the Super League. Tension could be seen on all the team member faces. I was advised to keep my calm and not to operate the lifting of the gripper on 24 Volts as then the bolt could shear again. As the whistle for the third game blew, I went for the nearest gopi and as I pressed the button for lifting the gripper, ***disaster struck once more!*** I had picked up the gripper on 24 Volts and not 12 Volts as advised, in a hurry and the bolt had again sheared and the lifting mechanism had failed. I couldn't lift the gripper for the remainder of the match. I was dumbfounded as to what I could do now. I observed that He-Bot had picked up the six pointer cheese and the automatic robot of MAE wasn't working. So in order for MAE to win, they had to score 7 points or more with their manual robot and they would win if our manual was unable to score anything.

  Thus if we had to win, then all depended on my ability to think of a way and score or block the opponent and prevent him from scoring. MAE had already scored 4 points and had dropped two balls on the ground due to some reason. Now their bot couldn't pick up the balls from the ground but our bot could. So I hurried the manual robot and picked up the two balls.

Now I was perplexed how I should place them in the basket and my team members were encouraging me on to do something. I wasn't able to clearly hear what my team members were suggesting but a thought struck me.I started ramming the balls held in the gripper on the side of the basket with a hope that the force would move the gripper slightly upwards and the balls could then be rolled into the basket. Finally after a number of failed attempts, I was able to place one ball into the basket. I tried to repeat that with the other ball in the same basket but as I put the other ball in, the first ball was rolled out of the basket into the automatic area. There was no way that I could get that ball now. I cursed myself because I should have placed the ball in the other basket and not the same one and we could have scored one extra point. Now we had 7 points and MAE had only scored 4 points.

After placing the ball in the basket, I hurried the bot towards the other side of the field so that I could pick up some pot or ball should the manual operator of MAE make some mistake. But no, he was about to place a ball and pot pair in his basket which would take his score also to 7 points.

My team members were advising me to block the MAE manual robot and prevent him from scoring. But the rules didn't allow that. I would have committed a violation had I tried to block the other team's bot. So our only hope now was to prevent it from scoring above 7 points.

Thus, I needed to block the next pot and ball and prevent it from picking it up. So, I moved my bot towards the "gopi" nearest to him and stood my bot in front of it. So I totally blocked that "gopi" and didn't allow him to pick up the "pot" or "cheese". The MAE manual operator started moving his robot towards the next "gopi" but I knew that there was not much time left for the game to end. He hadn't even reached the next "gopi" that the whistle blew, signifying the end of the game.

As the points were announced by the referee, we realized that MAE had committed a violation because of which we won the match by 7-4 points. Loud cheering for our team filled the stadium. We had reached the Super League!! Everyone acknowledged my quick thinking during the game and congratulated us.

Before the second day

- ***Fixing the Manual***: Now that day we didn't have any more matches but had a huge task ahead of us of repairing the pulley and shaft coupling. We tried replacing the 3mm bolt with a 4mm one but it also sheared off after some runs. Now we had to think of some other alternative. The hole for the bolt was then widened and a 5mm bolt was used in it so that it could withstand the shearing forces. After that it was fine and the bolt didn't shear off anymore.
- ***Confusion on Draws***: We were under the impression that MIT and Nirma would meet each other in the semis and we would face the winner of that match in the finals if we were able to reach it. But we were wrong. At about 4am on 9th March, before the Super League matches, we realized that we would have to face either MIT or Nirma in the semi finals. Thus we had to hurry up and complete of the modifications of Krrish as well as that of Jack as soon as possible.
- ***Modifications in Jack***: Since it was now decided that we won't risk wasting time on Jainesh's bot to get it working. Also Jack was not in our control completely till that time. So it was decided that upper arms of the jack would be removed and make it light. This greatly helped as now Jack was moving in almost straight line all by itself without any feedback.
- ***SCOE's threat***: Another threat came from SCOE's team which was planning a negative robot to block our 6 pointer one. So we had to get the Jack working in order to stop SCOE

from doing so. We planned to give them a head-to head collision with our Jack in order to stop them mid way.

- ***Planned Modifications in Krrish***: It was planned that after our match with SCOE, we would cut down Krrish which was of no use now, to another defensive robot which would help us win against MIT in the semis. It was a far flung thought and turned out to be a really big mistake.

Second Day (March 9, 2008)

Next day the Super League matches started early morning. Out of the 39 teams that had participated in the League matches, 12 teams reached the Super League out of which only 8 were to reach the quarter finals. Now the 12 teams were divided into 4 groups of 3 teams each, out of which the best two from each group would advance to the quarters. We were grouped with Singhad College of Engineering (SCOE) and NIT Durgapur.

- ***Against SCOE:*** Our first match of the day was against Singhad College. That match we won without much difficulty.
  - One strategy which we used in this match was to place two of the pots and cheese ball pairs in our common area and prevent the other team from scoring as it couldn't steal those pots and balls. This strategy was then imitated by many teams in the following matches and we were given credit by the commentators for that strategy.
  - Also, as we had planned, we had a head-on collision of Jack with the defensive robot of the other team. Their defensive robot however got damaged in the collision and so they weren't able to use it in the next 2 rounds.
- ***Against NIT Durgapur:*** The next match against NIT Durgapur also went without many problems.
  - Towards the end of the second game, one problem that arose was that the clutch wire wound around the pulley was a bit longer than required and because of that it used to slip out of the pulley during its slack state and started winding around the shaft outside the pulley instead later on. Though I (Danvir Singh) was able to fix it without much difficulty and without touching the robot but it lost us some precious time.
  - In the third game, our manual was able to score 21 points as I was able to place seven pairs of pot and ball in the basket due to the huge difference in the speed of our manual robot and the opponent's. This was a significant achievement which brought out the significance of our high speed robot.

- ***Before the Quarter Finals:*** We were able to achieve following with our robots before the quarter-finals:
  - Manual – Danvir was successfully able to pick up at least 4 gopis.
  - He-Bot – It successfully picked the 6-pointer and also blocked the opponents' basket that was near to our starting zone.
  - Jack – It was able to successfully reach and block the 12-pointer within 8 seconds which was the time taken by MIT to reach the central pole.
  - Jainesh's bot – This robot was cut out to make a small defensive robot. Though it has not yet been tested.

- ***Quarter-Finals:*** From the quarter final matches onward, only one round of three minutes was played between the teams instead of three rounds played against each team in the League and Super League matches. Our quarter final against College of Engineering, Pune also went

without much trouble. We were able to perfectly perform the tasks that we had practiced in the test field.

- ***After Quarter-Finals:*** Considering this situation of our robots, we would have tied with MIT for certain or the team with better manual operator skills would have won the game. Had we not made any changes in the code of the robots, the game against MIT would have reduced to the game of manual operators. The team with better operator would have won the competition.
  The MIT had used two strategies in the competition:
  - One with aiming for 12-pointer and other automatic going for a 6-pointer and then blocking our basket. If they used this strategy, we just then needed to repeat the tasks performed in the Quarters.
  - Other strategy they used was two automatics aiming for 6-pointers and both aiming for blocking our 2 baskets. Now to stop them from doing so, we needed another defensive robot to safeguard our 6-pointer, then our He-Bot must protect our own basket from them and the Jack must destroy their basket. Now this needed a complete change in the strategy of all the three robots and we had quite less time to test it. ***At that point of time, we didn't think about or observe what they were going to do against us*** as this saved a lot of our time.

- ***Changes made after the Quarters:*** As mentioned above, the necessary changes were made to all the three robots in order to avoid the second situation. We had panicked and we ***didn't observe what the opponent is planning for us.***

Semi Finals Mess Up

But alas, everything couldn't go on as expected.

- ***Technical Inspection***: The Technical Inspection team disqualified Krrish as they didn't agree that it was the same bot we had brought initially. Though the whole team tried to convince them but to no avail. At the other end, the organizers were cursing us for delaying the match by over 10 minutes. We had to play and solve the jigsaw puzzle of where the parts came from the original robot in order to convince the judges that it was the same robot.
- Tension was building up because we were getting late and it seemed that might have to play the match without Krrish but our strategy was not designed to work without it. But somehow it was felt that even if we played the match without Krrish, we still had a decent chance to win provided the other bots worked according to plan.
- As we entered the field about 15 minutes late, the whistle signifying the state of the match was blown within 30 seconds and we didn't get the customary one minute to prepare the bots in the field. Also due to the huge crowd cheering for the host team, we weren't able to hear the whistle clearly and started a little late.
- Besides that, our autonomous bots didn't work even as expected. Even before Jack started and was able to block the opponent's bots, they had managed to pick up the twelve point cube. Jack didn't work on the first press of the switch. Now all hope was lost. He Bot was also not able to lift the six point cube above the level of the bowl and block the opponent's basket.
- Seeing all this, I also lost my cool and committed a mistake and dropped a pot and cheese ball in hurry. MIT had also blocked one of our baskets. Still I had managed to place two ball and pot pairs in one of our basket. Then as I was about to place the third pot and ball in our

basket, the same problem with the clutch wire that had occurred in an earlier match occurred and it didn't wind around the pulley properly. I kept on trying but it was of no use.

- We had fared badly and lost by a huge margin of 22 points. Gloom took the place of hope and happiness after that match. We had been ousted from the competition and lost the hope of representing India in the Internationals.

After the Matches

In order to cheer our mood, we went out for a stroll but it didn't help much. We didn't feel like witnessing the exciting Final Match between MIT and Nirma University even. After about an hour when we reached back near our team work place inside MIT, we saw that the results were being announced. Nirma had won the Final Match and VIT Pune had been awarded the Best Automatic Robot Performance Award. We had lost interest in the award ceremony too but as they announced the **award for the Best Manual Robot** Performance, we came to know that IIT Delhi had won it. The only solace we got was the reward of our consistent and efficient manual operator, Danvir Singh and the machine too. All of us were mad with ecstasy. All of us ran to the podium and received the award from the Guest of Honour. We cheered our team and pledged to do all it takes to win the competition next year…

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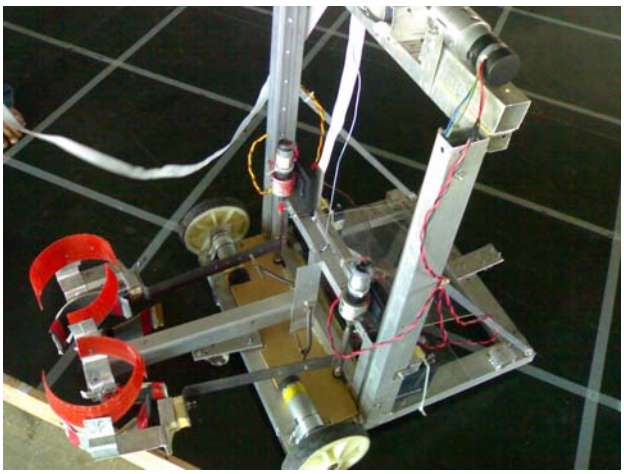
PICTURE OF ROBOTS AND TEAM

Team

Jack



Manual Machine

The Krrish

The He-Bot