

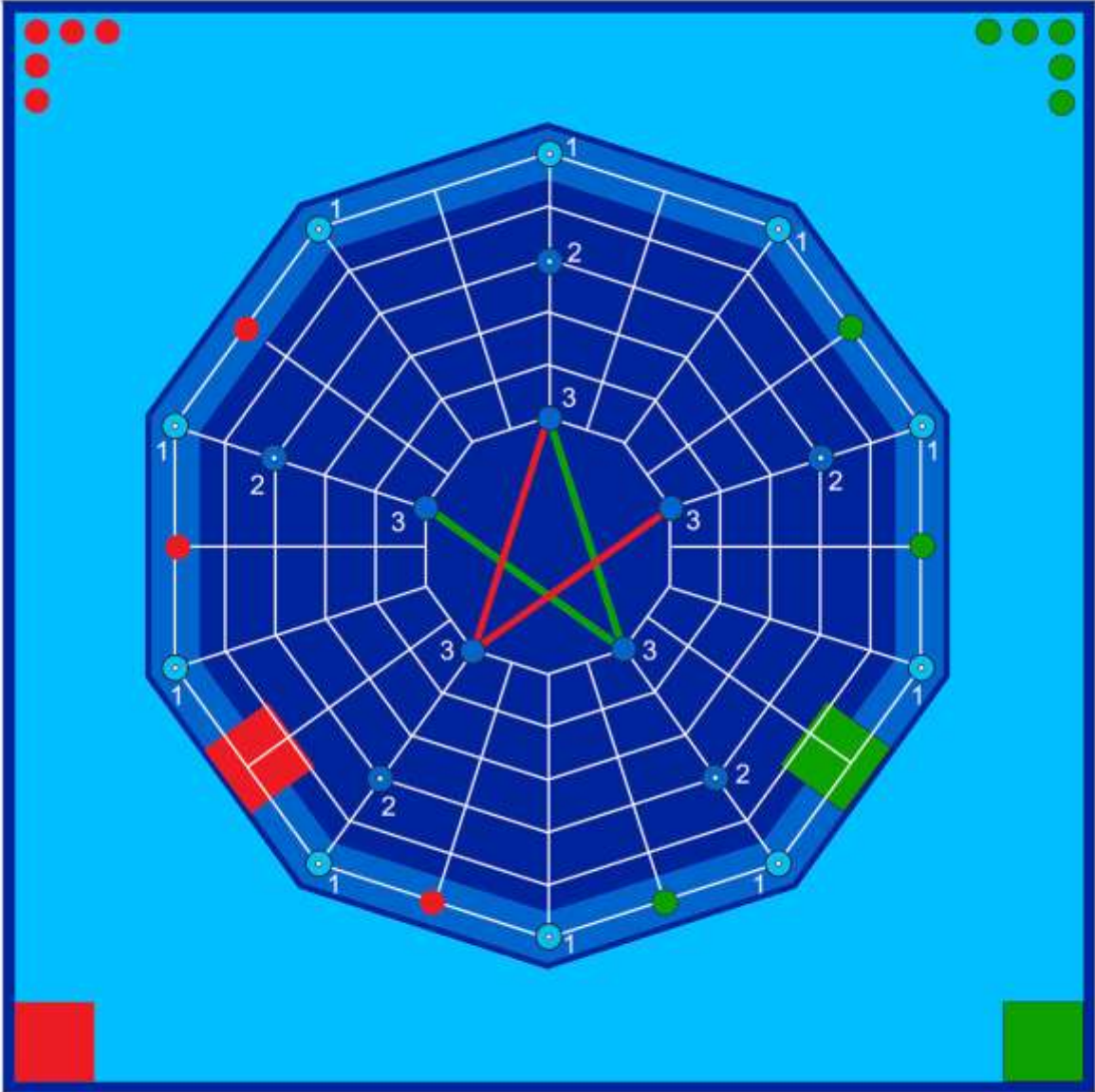
THE  
ROBOCON  
DIARY  
2007

# Preface

For the past couple of years IITD has been actively participating in Robocon, an annual national robotics competition. 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. After the year long effort of our team members who worked with great enthusiasm made IIT Delhi proud by bagging the first position in the competition. We believe these documents will be helpful to those who aspire to participate in Robocon and most importantly to gain knowledge in the field to Robotics.

## **THE TEAM OF ROBOCON 2007**

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The Game Field

# Asia-Pacific Robot Contest 2007

## Hanoi, Vietnam

### THEME AND RULES

### INTRODUCTION

*The legend of Ha Long has it that, “Once upon a time, soon after the Viet people established their country, invaders came. The Jade Emperor sent Mother Dragon and her Child Dragons down to earth to help the Viet people fight against their enemy. Right at the time invaders’ boats were rushing to the shore, the dragons landed down on earth. The dragons immediately sent out from their mouths a lot of pearls, which then turned into thousands of stone islands emerging in the sea like great walls challenging the invaders’ boats. The fast boats couldn’t manage to stop and crashed into the islands and into each other and broke into pieces.*

*After the victory, Mother Dragon and Child Dragons didn’t return Heaven but stayed on earth at the place where the battle had occurred. The location Mother Dragon landed is nowadays Ha long Bay and where Child Dragons descended is now Bai Tu Long.*

*Ha Long is the wonderful and skilful masterpiece of the Creation and of nature that only Vietnam was bestowed. Ha Long has become the pride of not only the locals but also of all Vietnamese people when it was twice recognized as the World Natural Heritage by UNESCO for its geographical and geomorphologic values. With its unique beauty, Ha Long is one of the most ideal destinations in Vietnam.*

*The rules of Robocon 2007 are built basing on this legend of Ha Long. A team of robots(symbolizing dragons) will carry the blocks having the shape of cylinder(symbolizing pearls) to build various kinds of islands symbolizing “Ha Long”; and “Bai Tu Long” .The first team to complete the building of “Victory*

*islands”( in the shape of letter V in the centre of the Game Field) will be the winner.  
Duration of the game is three minutes.*

## **GAME DESCRIPTION AND RULES**

### **OUTLINE and OBJECTIVE of the GAME**

Red team and Green team will operate Manual Machines (symbolizing Mother Dragons) and Automatic Machines (symbolizing Child Dragons) to put the “Pearls” on the “Islands”. The team which puts the “Pearl” on top of an “Island” gets the “Island”.

The first team to complete the shape of letter V with the “Islands” at the centre of the Game Field is considered “VICTORY ISLANDS!” and will be the winner. In the case that neither team accomplishes “VICTORY ISLANDS!”, the team that scores more points wins.

Duration of the game is three minutes.

### **1. TEAM MEMBERS**

- 1.1 Each team shall comprise of four (4) members consisting of three (3) students and one (1) instructor, from the same university, polytechnic or college. However, only these three (3) students are permitted to enter the Game Field.
- 1.2 Team members must be enrolled in their University/Polytechnic at the time of the international contest. Exceptions are allowed for those who were enrolled in a University/Polytechnic at the time of the domestic contest.
- 1.3 Postgraduates are not eligible to enter the competition.

## 2. THE GAME FIELD and OBJECTS

- ▶ The game is played on a square Game Field (14000mm x 14000mm), which is surrounded by a wooden fence (100mm height-30mm thick);
- ▶ The floor of the Game Field is made of 20mm thick ply-wood, and is fully coated with emulsion paint;
- ▶ It consists of a Manual Area and an Automatic Area.

### 2.1. Manual Area

The Manual Area surrounds the Automatic Area, and is painted light blue with emulsion paint;

There are two (2) Manual Machine Start Zones and Pearl Storages in this area.

#### 2.1.1. Manual Machine Start Zone

Manual Machine Start Zone is in square shape (1000mm x 1000mm) and is located in the Manual Area. There are two Manual Machine Start Zones. They are painted with emulsion paint, red for Red team and green for Green team.

#### 2.1.2. Pearl Storage

Pearl Storage for each team is located at the corner of the Game Field. Before the start of each match, fifteen (15) pearls are arranged available in each storage. (*See attached drawings for more details*)

### 2.2. Automatic Area

Automatic Area is placed in the centre of the Game Field. It is in the shape of 10-side regular polygon and is coated with blue emulsion paint, which is surrounded by a wooden fence 100mm height and 30mm thick (See the attached drawing for more details);

Inside of the Automatic Area, 6 guidelines with 660mm distance are arranged parallel with the 10-side polygon and 20 guidelines are arranged radially. The guideline is made of white, non-shiny sticker with width 30mm;

*(See attached drawings for more details)*

The Automatic Area consists of 3 zones namely Automatic Machine Start Zone, Ha Long Zone (Outer Zone), Bai Tu Long Zone (Inner Zone).

#### 2.2.1. Automatic Machine Start Zones:

There are two (2) Automatic Machine Start Zones, one (1) for each team. They are shaped square (1000mm x 1000mm) and painted with emulsion paint, red for Red team and green for Green team.

#### 2.2.2. Ha Long Zone: (Outer Zone)

Ha Long Zone is in the outmost ring of the polygon and is coated with blue emulsion paint. Ten (10) cylinder ISLANDS (360mm in diameter, 230mm H) for pearls to be put on shall be located in this Zone.

*(See the attached drawing for the details)*

Before starting the game, five (5) pearls shall be placed in this zone for each team (as in the drawing).

#### 2.2.3. Bai Tu Long Zone: (Inner Zone)

The Bai Tu Long Zone is inside the Halong zone.

The Bai Tu Long Zone shall be coated with dark blue emulsion paint. There are ten (10) ISLANDS (360mm in diameter, 230mm H) in this zone. *In the centre of this zone, the shape of letter V using 3 islands for red and green team is respectively drawn with straight-line (width 30mm).*

*(See attached drawing for more details)*



### 2.3. Peals

The Pearls are in the shape of cylinder (Inner diameter = 100mm, Outer diameter = 300mm, Height = 200mm, Weight = 300g). Pearls are made of high-density polystyrene and are coated with emulsion paint red, for the Red Team, and green, for the Green Team.

(See attached drawing for more details)

## 3. MACHINES

Each team must design and construct by itself Manual and Automatic Machines to compete in the contest. For each match, the number of Automatic Machine(s) is no more than three (3) and only one (1) Manual Machine is allowed for each team.

### 3.1. Manual Machine

- 3.1.1. The Manual Machine has to be operated via remote control using a cable connected to it or remote control using infrared rays, visible rays or sound waves. Controlling using radio waves are also not allowed. Operators are not allowed to ride on their Manual Machine.
- 3.1.2. When operating via cable, the connecting point of the cable to the machine must be at least 1000mm from the ground. However, the length of the cable from the Manual Machine to the control box must not exceed 3000mm.
- 3.1.3. There is a size limit (1000mm L x 1000mm W and 1500mm H) for the Manual Machines at the Manual Machine Start Zones when the game starts.
- 3.1.4. Once the game starts, The Manual Machine's size and form may be changed but its height is limited to 2000mm. Furthermore, Manual Machines are not permitted to separate 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 Zone and Outer Zone only.
  - 3.1.8. Manual Machines are not permitted to enter or extend over the Inner zone, the opponent's Automatic Machine start zone and opponent's Pearl Storage
  - 3.1.9. Manual Machines are not permitted to touch its own team's Automatic Machines.
  - 3.1.10. Manual Machines are not permitted to touch opponent's Automatic Machines in the Automatic Area.
  - 3.1.11. Manual Machines are not allowed to prevent the opponent from taking the pearls at opponent's Pearl Storage.
  - 3.1.12. Manual Machines are prohibited to move directly / indirectly the opponent's pearls in the Automatic area, except for pearls which have been placed on the islands (refer to clauses 4.2.2 and 5.2).
  - 3.1.13. When Manual Machines of both teams interfere with each other, the referee will decide the right way to go for each team.
- 3.2. Automatic Machine(s)
    - 3.2.1. Every Automatic Machine must be autonomous after being started by team members.
    - 3.2.2. Once a game begins, all automatic machines should be started one by one. Each Automatic Machine must be started by one operation.

- 3.2.3. After all Automatic Machines are started, the team member(s) responsible for starting the machines must leave the Game Field.
- 3.2.4. Once a machine(s) start(s), team members are not allowed to touch the machine(s).
- 3.2.5. All of the Automatic Machines should fit within the size of 1000mm L x 1000mm W and 1500mm H at their Start Zones before starting.
- 3.2.6. The Automatic Machines' size and form may be changed but limited to 2000mm Height and 1500mm Width (measurement shall be made at flat projection by any direction).
- 3.2.7. Once the game starts, the Automatic Machines can be separated (but the number of automatic machines is no more than 3).
- 3.2.8. Anything that separates from an Automatic Machine is considered to be another Automatic Machine, and therefore must also be autonomous.
- 3.2.9. There is a 'certain place' around the Automatic Machine Start Zone for each team that opponent's Automatic Machine without Pearl cannot enter within 30 seconds after the game began. See drawing for the details.
- 3.3. Retry of Automatic Machine(s)
  - 3.3.1. For Automatic Machine(s), a "retry" is permitted once per game for each team.
  - 3.3.2. After a "retry" request is granted by the Referee, team member(s) must bring the Automatic Machine(s) back to Automatic Machine Start Zone and restart the machine(s) as soon as possible. Automatic Machine(s) that is granted retry should follow Rule 3.2 Automatic Machine(s).
  - 3.3.3. On "Retry", any parts of the machines should not be replaced. Also, power sources of the machines should not be refilled nor added.

3.3.4. When a “Retry” results in a change in the score or violation of the rules, it is up to the referees to rule on the situation, including with regard to 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 during the games.

3.4.2. Allowed power supply for Machine(s) shall not be exceeded 24VDC.

3.4.3. Power supply that is considered dangerous or unsuitable by the Contest Committee shall not be permitted.

#### 3.5. Weight

All Manual and Automatic Machines including their power sources, cables, remote controller and other parts of each machine shall be weighed prior to competition. The total allowable weight of all machines for each team to be used throughout the contest must not exceed 50kg.

### **4. MATCHES**

#### 4.1. The Duration of Matches

4.1.1. Before the match begins, setting of the machines shall be completed within one (1) minute after receiving the signal for setting.

4.1.2. Each match shall last for three (3) minutes.

4.1.3. However, the first team to achieve “VICTORY ISLANDS!” wins the match regardless of the point collected by the opponent. The match ends when “VICTORY ISLANDS!” is achieved.

#### 4.2. Competition rules

- 4.2.1. The Manual Machines may either go to their Pearl Storage for taking and placing the pearls onto the islands located in the Halong Zone for scoring or they can put the pearls at suitable position so that the Automatic Machines can take these pearls for scoring more points on islands located in the Inner Zone.
- 4.2.2. Manual Machine is not allowed to take or moves pearls which have been placed successfully on the island by the opponent. However, it can change the position of these pearls to score point or place them to another island.
- 4.2.3. Automatic Machine(s) is allowed to take the pearl(s) to be available on the Game Field or pearl(s) given by its Manual Machine for further scoring at Inner Zone.
- 4.2.4. Manual or Automatic Machines success in placing their pearl(s) on the top of opponent's pearl(s) which is already located on the island(s), then the opponent's point(s) at that island shall be lost and point(s) shall be added to the successor pursuant to the peal(s) that they scored accordingly.

4.3. Points Awarded

4.3.1. The team gains point when they successfully put their own pearl on top of each island. However, pearls contacting any part of their own machines will not be counted for points.

4.3.2. Points are awarded as follows:

	<b>Location</b>	<b>Points</b>
i)	The Outer Zone Ten(10) islands on the first guideline : (counted from outside to inside)	1
ii)	The Inner Zone Five (5) Islands on the third guideline : (counted from outside to inside)	2
iii)	The Inner Zone Five (5) Islands on the sixth guideline : (counted from outside to inside)	3

#### 4.4. VICTORY ISLANDS!

“VICTORY ISLANDS!” is achieved when following two conditions are satisfied;

- 4.4.1. Team’s pearls are placed on top of the 3 islands specified for each team in the centre of the Inner Zone creating the letter V;
- 4.4.2. At least team’s 2 pearls are placed including the topmost pearl on these islands and none of the pearls has contact with their own machines.

#### 4.5. Deciding the Winner

The winner of the match will be decided based on the following conditions:

- 4.5.1. The team first accomplishing “VICTORY ISLANDS!” will be the winner;
- 4.5.2. In the case that neither team accomplishes “VICTORY ISLANDS!”, the team; that scores more points wins. This is done by adding up all the points awarded and subtracting points for violations;
- 4.5.3. In the case of a draw, the winner of the match will be decided by the following rules, in the order listed bellows:
  - 4.5.3.1. The team having more pearls on top of 3 - scored Island in the inner zone wins the match;
  - 4.5.3.2. The team having more pearls on top of 2 – scored Island in the inner zone wins the match;
  - 4.5.3.3. When no clear winner can be selected by the above order, the referees and the judges will decide the winner.

### **5. VIOLATIONS AND DEDUCTION OF POINTS**

- 5.1. Once a game begins, the following actions will be regarded as violations and one (1) point will be deducted for each violation.

- 5.1.1. Manual Machine or its operator enters or extends over Inner Zone and opponent's Automatic Machine Start Zone.
- 5.1.2. Manual Machine touches its own team's Automatic Machines.
- 5.1.3. Automatic Machines without Pearl entering the places defined in Rule 3.2.9 within the first 30 seconds of the match.
- 5.1.4. If above violations continue intentionally, one (1) point will be deducted for every five (5) seconds.
- 5.2. Two (2) points will be deducted for each of the following actions:

Manual Machine takes or moves the opponent's pearls which have been placed successfully on the island by the opponent. However, points are not deducted if these pearls are replaced in that or other island before the game ends.

## **6. DISQUALIFICATION**

The following behaviours shall be considered for disqualification of the whole team by the referees.

- 6.1. Causing or attempting to cause damage to the Game Field, its equipment, or the opponent's machines, including the arrangement of the opponent's Pearls at opponent's Pearl Storage.
- 6.2. Team's members touch their own Machines intentionally.
- 6.3. Manual Machine directly or / and indirectly blocking, touching, attacking the opponent's Automatic Machine in the Automatic Area.
- 6.4. Manual Machine takes or changes the position of the opponent's pearls which are placed in the Automatic area, except for pearls which have been placed on the islands (refer to clauses 4.2.2 and 5.2).
- 6.5. Start before the starting whistle (or signal) of the referee more than once

6.6. When 3 points are collected by violation as defined in clause 5.1

6.7. Performing any act against the spirit of fair play.

## **7. SAFETY**

7.1. All machines must be built so that they will not harm the operators, the referees, match officials, audience, opponent's equipment and the game field.

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.

## **8. OTHERS.**

8.1. For any other behaviour 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 the rules will be announced by the Contest Committee and be updated on website as the "FAQ": [www.vtv.org.vn/robocon](http://www.vtv.org.vn/robocon).

8.3. All teams are encouraged to decorate their machines in their own styles using the symbol of a dragon.

8.4. Only hand-made machines are allowed in the contest.

**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 teams' 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.**



## **APPENDIX**

### **A1. MATCHS**

The contest is played according to the format below:

- ▶ Preliminary round in groups: round robin
- ▶ Winner from each group shall advance to the Quarter-Final stage.
- ▶ Quarter-finals: knock out
- ▶ Winner from each Quarter-Final shall advance to the Semi-Final stage.
- ▶ Semi-Final Stage: knock out
- ▶ Winner from each Semi-Final shall advance to the Final
- ▶ Final: Knock out

### **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**

The transport company, specified by the committee, will ship your machines to the playing venue in Hanoi, Vietnam. Details will be announced later.

**A4. Games Field's Color Code**

<b>No.</b>	<b>Description</b>	<b>AutoCAD Color Index (ACI)</b>	<b>RGB - Pantone</b>		
			<b>R</b>	<b>G</b>	<b>B</b>
1	Manual Machine Area	140	0	191	255
2	Outer Automatic Machine Area	152	0	82	165
3	Inner Automatic Machine Area	164	0	31	127
4	Green Team		13	177	75

# **MECHANICAL DESIGN**

## **The Manual Robot**

The structure was made by assembling 1<sup>1/2</sup>” aluminium channels. We designed a 4-bar mechanism to lift the blocks from the stock area and gripper mechanism to hold the blocks while transporting to the main tower. The height of the gripper was such so as to hold three blocks at a time. The blocks would be carried in 2-2-3 pattern.

## **The 4-bar Mechanism**

- At that time our mechanism was the pulley system as this was the mechanism suggested by every team selected to make final robots for the Robocon.
- The main problem with the pulley system was that the gripper holding the blocks couldn't be made to remain straight throughout its motion from ground to tower.
- The mechanism then adopted was that of the 4-bar which had also being given a thought in Robocon-2005.
- The 4-bar mechanism not only helped to make the blocks horizontal throughout its motion but was also stronger and more compact than the other system.
- The precision was needed to do what we desired to get. Even a slightest error could have caused a great problem.
- The clutch wires were connected between the main shaft of the 4-bar and the shaft connected to the motor at the main base.

- A motor was used at the base to produce enough torque to pull the clutch wires which helped to lift the gripper to a certain height.

## **The Gripper Mechanism**

- This was the main feature of the manual robot after the 4-bar. It was used to properly grip the blocks during their transportation from the stock area to the main pole.
- This time instead of using one gripper we used two grippers side by side which increased rather doubled the pearls (blocks) carrying capacity of the robot.
- E-channel was used to grip the blocks. Its height was little less than that of the three blocks.
- The 4-bar was connected to the wrist which was further connected to the e-channels.
- The prime work to be done was to get the e-channel to open to desired width and then close enough to get the proper grip on the blocks.
- To achieve what is mentioned above a clutch wire was connected to one of the e-channel which was pulled or pushed by the motor as was done in the 4-bar.
- Only one of the e-channel was made movable while other remain fixed.
- For better gripping we used foam on the arms of the gripper.

## The Maxon Motors

As was the practice of last couple of years we used maxon motors for the robots. These are high quality state of the art motors imported from Switzerland. The motors we had were 24v D.C. motors of selected gear ratios.

<b>Gear ratio</b>	<b>Quantity</b>
913:1	2
24:1	6
66:1	3
190:1	1
116:1	1

- The motors with gear ratio 66:1 and 24:1 were used for driving the robots.
- The 190:1 motor was used for driving the 4-bar mechanism.
- The 116:1 motor was used for driving the gripper mechanism.

## **The Automatic Machine**

- Before the manual robot was finished, the work on the automatic machine had already been started.
- It was decided to make 2 autonomous machines in order to capture maximum islands in minimum time possible.
- Two totally different designs were used. Both of them moved in the field using line followers.
- Basically the key mechanism involved in the first automatic was the vertical rollers and for the second automatic was the gripper.
- In the Auto I, the vertical rollers moved to drop the (pearls) blocks one by one. We could control how many blocks are to be dropped at one island.
- In the Auto 2, the gripper moved in vertical direction with help of a pulley and guides.
- The machines could be programmed differently as per the strategy.
- Casters were used along with main wheels.

## **The Defense Robot**

- For the first time we used channels. Three telescopic channels in series and two rows of such kind were used.
- To reduce the weight one of the row of channels was removed.
- The channels were joined using riveting.

- We dimensional constraints on the robot as its designing started after the other autos were designed.
- A microcontroller was used for it to program it as per the strategy.
- It moved in a straight path and was not flexible in changing directions.
- Many design feasibilities were also looked upon.

## **The Electronics story**

- In the manual robot we used relay switching for controlling the motors. The left and right turns were achieved by counter rotation of two wheels.
- Basically the circuit consisted of OR gate which were made using diodes. The relays were switched using 24 V supply from the batteries. The remote was also custom made and was working quite well. (except for a few problems, mentioned later).
- In the automatic robot - The brain of the robot was PIC 18F4550 microcontroller. The PIC microcontroller boasts of many features like inbuilt ADC ports. It also has sufficient RAM and flash memory. Any feature of program whether speed control or delays was done through this only. Also more than sufficient no. of IO ports was available.
- The PIC microcontroller was getting input from the sensor plates through its IO pins. After processing this information it sends the output to H-Bridges through another set of IO pins.

- The H-Bridges require three kind of signals. One for direction, then brake and finally PWM (refer below) for both the motors.

### **‘SENSING’ the way**

- To get to the islands we needed to sense the ways so the idea was to follow the white lines on the field to reach to the islands.
- Line follower consists of an array of sensors in a line which tells the position of white line. Sensors basically consist of LED and photodiodes. Photodiodes differentiate white and blue color.
- So we made the microcontroller circuits, and gave their inputs from the sensors. Their output was given to the motors using H-Bridges. Basically it is the technique called PWM (Pulse Width Modulation) which drives the motors at a frequency of 23000Hz. Everything went fine with this new arrangement and we were able to increase speed of autonomous robots.
- We also worked upon the ATMEGA microcontroller and the encoder technology. Although we were able to make use of encoders here in our lab, but could not make them functional at the venue.
- Also in the Automatic One robot, we had put two IR sensors, to count the number of blocks that passed through the rollers, but they didn't work over there due to temperature problem.

**To getting up to this stage a lot of sleepless nights were spent. But a lot more were going to come.....**



## **SEMESTER I, 2006**

- The main designing part was done during the period. The fabrication could not start as nobody could devote a great deal of time to robotics.

## **WINTER BREAK, 2006**

- This is the period when we can fully devote our time to the activity.
- The main fabrication part of the autos was almost completed during that period.
- Many trips to the market were made in search of new alternatives.
- This was just to ensure that we have sufficient time for the testing which is an essential part.
- Like it was done last year we got our circuits printed but only this time it was done on time. So unlike last time a time was devoted to testing which improved our performance drastically.

## **SEMESTER II, 2007**

- Even though we were quite behind the earlier decided schedule but we were doing far better than we did the last time. This was possible only because of the experience. The things we had learnt from the past.
- As college had started everybody's devotion of time had reduced a bit.
- Now the coordination part of the electrical and mechanical side was needed as it was the time to do the testing. We learnt each others restrictions as what was possible mechanically was not always feasible for electrical people to work upon it and vice-versa.

- We had a big problem of total weight of the machines. It was exceeding the limit. So we did everything possible to reduce the weight. Few grams here and there finally made the robots to come under total weight of 50 kg.

## MIT PUNE

- **First Look** – We were given a practice field exactly the same as the one that would be used for the final matches. But there was just one such field for all the teams present. Many teams arrived late over there and they were obviously under heavy disadvantage.  
Most of the teams had manufactured two automatics unlike us. One of the best teams like Nirma and Bombay also had same design for all the machines. This might have given them advantage regarding fault analysis problem solving, we had to do twice the work they did.
- **Assembly** – The first work done after reaching there was the assembly part. We hadn't dismantled them at the time of packing earlier, so more or less they were in a pretty good shape. While unpacking we made sure that no one even gets a glance of our defense machine before its use was absolutely necessary. Nirma also took out their defense robot on the last day.
- **Sensors** – The temperature out there was quite high as compared to what we were working with in Delhi. This made our sensors to work in a very arbitrary manner. Last year we had a similar problem but it was due to ambient light and in this case it was the heat. We

covered the sensors circuit board by wrapping a black t-shirt around it.

- **Readymade Sensors** – Many teams out there were using readymade sensors. They did not research on them much.
- **H-Bridges** – IITB was using custom-made H-Bridges. For them it might have costed less than Rs. 50 which costed us above Rs. 500.
- **First Match** – The first round of the very first match was a disaster. None of our machine worked. Not a single one moved. The battery clips of the Auto II had broken. The wheel of the manual was not attached to the motor and was not moving at all. Auto I was not in a working condition as well. This was major concern as at that time the whole game was dependant on working of any one of the two machine Manual or Auto II. Somehow we came out of the situation.
- **Motor** – We were solely dependant on motors and their performance. Had not they been the Maxon Motors we might have lost long time ago.
- **Auto II** – The machine had lot of failure attempts on the field. The thread holding the gripper and responsible for its movement gave up during couple of matches.
- **Resources** – We were short on resources. When the wheel had failed some people went off to the market in

search of a new wheel. We faced a problem when we were not familiar with the place. We had to even use their workshop.

- **Technology** – We realized we were not that good on technology when we saw the technology used by the Bombay team. They used laser guided system and gyroscope in their automatic robots.
- **Sturdiness** – We did not the most sturdy robots out there. The Manual machine was not stable. But Puran was trained in a manner that he could handle anything and he did so by operating the Manual.
- **Strategy** – The only thing we were strong on was strategy. We spent a great deal of time on the discussion of the strategy. Mainly we discussed how to put the defensive robot to the best possible use. We were working with restrictions imposed due to our designs. The defense robot could only move in a straight path. We could not suddenly accelerate it. We had to program it increase its speed slowly.
- **Day 1** – The situation was out of control. Nothing was working except the manual robot. Our line sensing crashed due to the problem of ambient light. Although we had laid much stress on the casing of our light sensors, but still we couldn't prevent that light from entering into the sensors. Our infra red sensors stopped working due to immense heat at the venue ( The temperature was about 38 degrees). Everything seemed crashing on us. The second depressing factor was the preparation of IITB team. Their robots were so professional,

which made us feel that we were nowhere. Their automatic robots were working fine since the very first day. Everybody was having a gut feeling that even after so much preparation we will face a heavy humiliation.

- **NIGHT OUT 1** -- Next day morning prelims were scheduled, and we had nothing in our hand except the manual robot. But our minds worked and then came the idea of covering our line sensors with a black cloth. It was Sushant's black T-shirt that came to the rescue, that suddenly our Automatic 2 started working exceptionally well. Our hopes lightened. We had kept our defense robots hidden, so that others could not get any idea about our strategy, and till the end we managed to surprise the other team with our defense techniques. So finally everything appeared fine except the automatic 1 which was showing some problems even in our lab.
- **DAY 2 PRELIMS** – The first round of the very first match as mentioned earlier was a disaster due to many problems as mentioned above. But surprisingly we made such a strong rebound, that we won the next two rounds of the same match with such a huge margin. After that match the whole team regained confidence and cleared all of the prelims with a very huge difference of points and more importantly, not losing even any one of the round of all the preliminary matches.
- **NIGHT OUT 2** '**block them off**'– The day went well and everybody was wondering how could everything be going so smoothly, and then came the biggest problem we faced during the entire competition. The shaft of the right driving motor collapsed. We tried really hard but the shaft could not just hold the tyre. The only solution we were left with was to use small tyres. And then came the day three.

- **DAY 3** And we did compromise with the small tyres. We cleared the last prelim with victory but we were not happy at all. It was calculated that we will straightway lose the game if we did not use big tyres. And then came Varun Mittal to the rescue. He filed the shaft in such a way that, the shaft, to our surprise, held the tyre so nicely, that it appeared as if there was no problem at all. We all got an instant high, and everybody was sure that we will at least make it to the semis.

**Quarter Final** – We were quite sure that we would the quarters at least. And we did that with no problem at all. We didn't even use our defense technique in that match and still we won by such a huge margin, that everybody became aware that even we were the contenders for the championship.

**Semi Final-** And then came the semifinals. Our match was grouped with MIT Pune. Their automatic robots were working, so we decided to launch our defense into action. And our defense did much more than we had expected. Not only it blocked their both automatic robots, but also became the cause for their negative points. We won quite comfortably and spearheaded IITD into the finals.

## **FINAL(s)**

Then came the finals, which we all had been waiting for since the very first day. And guess who was our opponent...

It was the IITB, the favorites of the competition. Although we had a slight chance of winning but we didn't lose our hopes. We made sure everything was in place and launched our robots into the field. This was the time when everything had to perform. And it indeed did. Even our automatic 1, which was inactive during the entire competition, kicked off and

straightway scored 3 most crucial points. And then came our defense robot to the rescue. It completely shattered the hopes of IITB by blocking their biggest strength...their automatic robots. But our automatic robots worked extremely well, and with the added strength of our manual robot, despite the first match being drawn, we lifted THE ROBOCON TROPHY.

**HURRAY!!!**

We won the final Robocon India 2007. Thanks to our team's sincere effort.

### **Lessons Learnt**

1. **Manual Machine:** the major lesson we learnt was that we used a remote made of push buttons which gave a lot of problems. So for the international competitions, we will be using the joystick remote.
2. **Circuit board** – we used hand soldered circuits. Though they didn't give any problems as such but we will still try to fabricate them.

### **Automatic Machine:**

- **Sensors** :- Though we were able to win the competition but still sensors gave a lot of problem in ambient light conditions. It was only half of the field where we could work properly. So we have to make modulated sensors for the line following. Also we can not buy these sensors from market as they depend on the environmental as well as field conditions

a lot. The proof of the same is the failure of Nirma in the national competitions.

- **Wiring** :- Another major problem was that there was too much wiring involved in connecting various sensors to the main circuit board. So we will be making up different modules which will have its own microcontroller which further will be linked to main m/c through SPI interface. This will greatly reduce the wiring.
- **Motors**:- this time we will be using motors that have in-built encoders in them. This will be used in gripper mechanism as well as for driving the robot. The encoder will form an alternative for the line following.