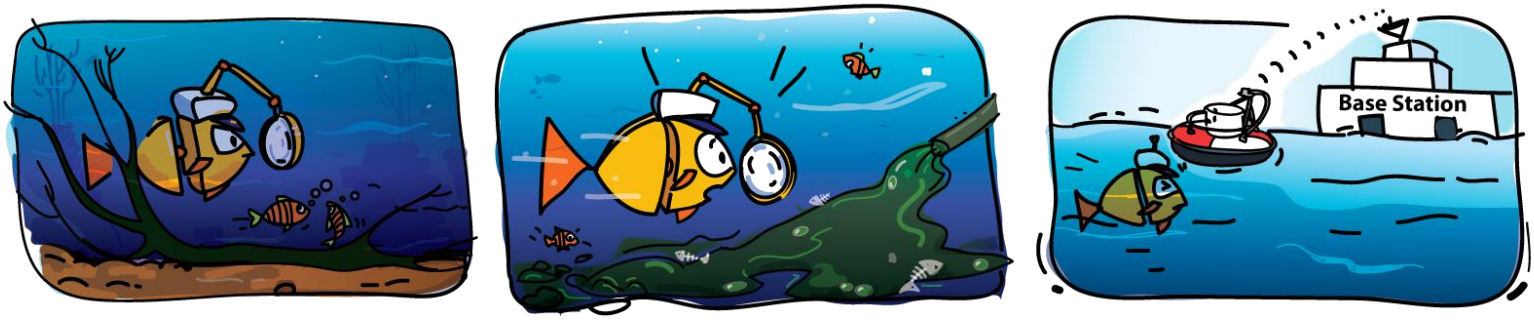

Patrol Fish

The Aquatic Robot

RULE BOOK

e-Yantra Team

December 9, 2019

Table of Contents

Chapter 1: Introduction

The Ganges (or Ganga), the largest river in India, provides water to about 40% of India's population across 11 states, serving an estimated population of 500 million people with more than any other river in the world. But this source of life now severely polluted with human waste and industrial contaminants, poses significant threats to human health and the larger environment.

As engineers , what can we do to help in the Swachh Ganga mission. We know, monitoring the state of a system is an essential part of trying to get it to a desired target. In the Swachh Ganga mission getting data about the health of the water body, i.e. the measurement of concentration of impurities, temperature etc is essential for creating a more effective plan of action.

This is the challenge we pose in e-Yantra Robotics Competition (eYRC-2019-20) in a unique theme titled **Patrol Fish**. In this theme we help you unleash your imagination and discover your talent in 3D designing to build a bio-inspired fish robot that is capable of traversing in water to collect data about a water-body's health and transmit it to a buoy. We divide the theme into a number of tasks to build the Patrol-Fish in a step- by-step manner making the process more interesting for you.

Challenges in this theme include: 3D designing and fabrication, PCB designing, Microcontroller programming, wireless communication etc. Teams may take inspiration from the variety of fishes in the aquatic world and can recreate the locomotion of that fish while designing their robot.

After building the bot,we need to navigate it in an arena defined by the e-Yantra team. The team that performs the task fastest with minimal penalties as per rules will be the winner. **We believe this theme to be a novel way to get e-Yantra students to explore the water world for new challenges..**

All the best!

Chapter 2: Theme Description

In this theme, the Patrol fish designed by the team needs to swim through a defined course and trigger "Anchored Buoys" on its way. The course is defined by the position and orientation of "Gateways". The team also designs a wireless joystick to control the Patrol Fish Robot.

The Arena

The Patrol Fish swims in a **Circular Pool** in which the floor seats the arena artwork shown in Figure 1. Refer the full scale image of the arena given in Task 2 for better understanding of terms below.

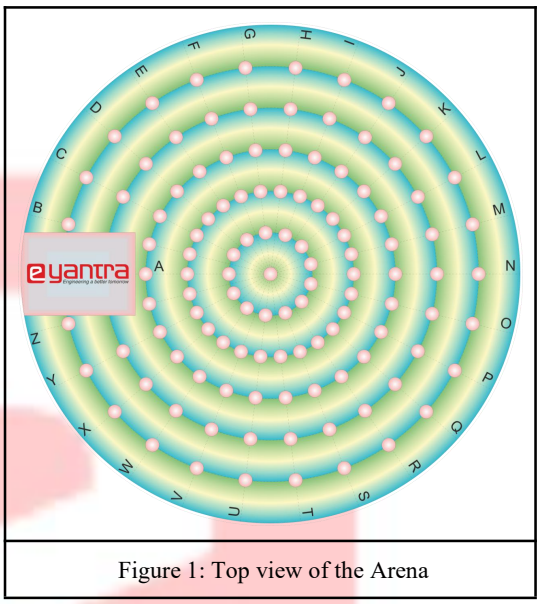

Figure 1: Top view of the Arena

The Home Zone: The Start and End Zone
The big *red shaded rectangular area with the e-Yantra Logo* shows the start and end zone for the Patrol Fish.

The Nodes
The *small circular red shaded circles* shows ***Nodes*** at which ***Objects*** may be placed. The naming convention for Nodes is as follows:
<The sector line letter><The ring number>
Exception: ***Node 0*** is the node at the center of the arena.
The sector line letter value ranges from **A to Z** as labeled in the arena
The ring number ranges from **1 to 5** from inside to outside**.**
i.e. All possible nodes are:

0, A1, A2, A3, B<1-3>, B5, <C-Y><1-5>, Z<1-3>, Z5

Details of arena design

- Dimension of **flex sheet is 2000mm x 2000mm**.
- Diameter of actual **circular arena is 1800mm.**
- Distance between two consecutive nodes on the sector line is **150mm.**

The Objects

Two kinds of objects can be placed on the arena:

A. **Anchored Buoys**:
The object the Patrol Fish needs to trigger. **The Anchored Buoy** is a structure to be placed on the floor of the pool. The structure has two major parts:

- **Tower** (orange and white cylinder shown in Figure 2, 3, 4) that indicate when the Patrol Fish robot triggers the sensor. The dimension of the cylinder of the Buoy is **70mm ± 5mm in diameter and 170mm in height.**

A circuit board in the tower of the buoy has a latch circuit that switches the LEDs ON as soon as hall effect sensors senses the field of the magnet on the Patrol Fish and **leaves it on for the rest of the run**.

- **The Sensor Module** (green cuboid shown in Figure 2, 3, 4) is where the Hall Effect Sensors will be placed. So all hall effect sensors on the buoy must be placed within this rectangular sheet of dimension **40mm x 50mm**. The buoy senses the trigger from the Patrol Fish when the magnet on the the Patrol Fish come close to this module.

  There is flexibility in the position and orientation of the sensor module with respect to the tower but the entire Buoy must fit within a rectangular boundary as shown in Figure 3. Dimension of the Rectangular cross-section is **75 mm x 135 mm**. Figure 3 and 4 also shows examples of other valid designs.

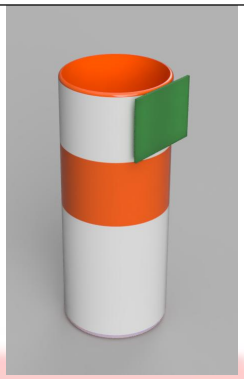

Figure 2: The Anchored Buoy
(one possible design of the Buoy)

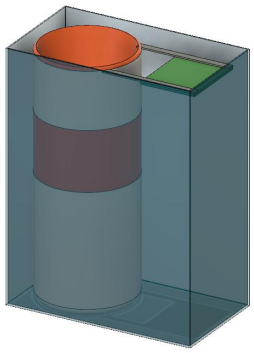

Figure 3: The dimension constraint on the design of the buoy.

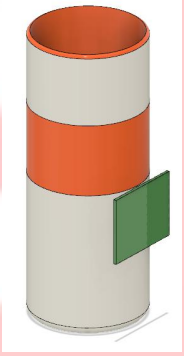

Figure 4: Example alternative valid design of the Buoy.

Figure 5: The Gateway 1
(only one half of the pair is shown)

B. **Gateways**:
The pair of objects that the Patrol Fish needs to go through **in the assigned sequence** and also **in the direction specified**. Further explanation can be found in Theme Rules (Arena Setup Configuration Table). Figure 5 shows the model the Gateway 1. Dimension of the cylinder should be **70mm ± 5mm in diameter and 170mm in height.**

The Tasks

A. Swimming through the Gateway
Swimming through gateway is counted as successful when the whole Patrol Fish body completely goes through the Gateway.

B. Triggering the Anchored Buoys
It is considered a successful trigger of the buoy when the Patrol Fish makes contact with the Buoy and the Buoy indicates the trigger by glowing the LEDs on.

It is considered as **perfect execution** when the Patrol Fish *triggers all the Buoys* and *goes through all the Gateways in the specified sequence* and *returns to home position*. Figure 6 shows an example configuration with a green line showing the course the Patrol Fish must take to achieve a perfect execution.

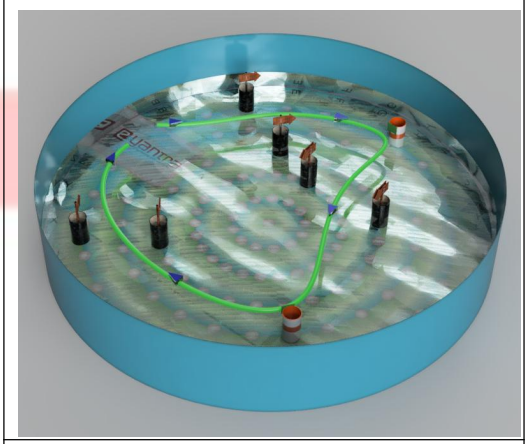

Figure 6: Example configuration with a green line showing the course the Patrol Fish must take.

Chapter 3: Building the Arena

Each team has to prepare the arena. Preparing the arena consists of three major steps:

1. Printing the arena design on flex sheet
2. Preparing the pool and the arena setup
3. Building the Anchored Buoys and the Gateways

Note: Teams are not allowed to make any changes in the arena design. Any team making unauthorized modifications will be disqualified from the competition.

Printing the arena design on the flex sheet

The Arena design to be printed on a flex sheet is shown in Figure 1. Each team must print this flex design according to the instructions given in the PDF file named Flex Printing in Task 2.

WARNING:
Please be careful while handling the flex sheet - avoid folding it like a bed- sheet since the resultant folds will cause unnecessary problems. One way of "flattening" flex if it has been compromised is to hang it for a few hours in the sun, it tends to straighten out. Never attempt ironing it or applying heat of any kind, it may be a fire hazard.

You should print the arena design given in Task 2 in a flex sheet of dimension 2000mm x 2000mm.

Cutting the Circular Arena

The actual arena for the theme is in a circular shape. So you need to cut the flex sheet after printing it. Guide lines are provided in the flex sheet to cut the circular part of the arena. Teams are requested to cut the arena properly as shown in Figure 7.

Figure 7: Cutting the flex sheet

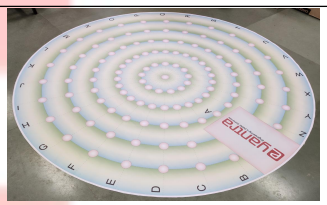

Figure 8: Patrol Fish Arena

After removing the unused part of flex sheet your arena will look as shown in Figure 8.

Preparing the pool and the arena setup

You need to purchase the 6ft baby pool as given in Task 2. Note: For initial testing of waterproofing and stability/buoyancy of Patrol Fish robot in water you can use aquarium, large bucket or similar water container.

Important Note:

- Pool requires a large amount of water approximately up to 400 litre. Pool should strictly be filled with water up to the height of 14cm during final submission.
- It is best this pool should be located in a exterior or well drained area and not indoors.
- Pool filled with water should be kept in a area which won't disturb others. Also pool makes the place damp below it and starts leaking water after some days.
- Please maintain cleanliness and hygiene in and around the pool.
- Also water should not be kept in the pool for long. This may lead to breeding of mosquitoes.
- Dettol or water disinfectants may be used for keeping the water for long days in a pool or/and keep it covered to avoid accumulation of dust and impurities.

While filling pool with water you need to hold the pool walls from collapsing. Fill the water in the pool up to 14cm. Make sure to straighten the pool floor after the water rises a few centimeters because removing wrinkles after the water is 14cm deep, is very difficult. After filling with water, you can place the circular arena flex inside the pool water as shown in Figure 9.

Figure 9: Setting up the Arena

While placing the arena in the pool make sure that circular arena sinks inside the water and there are no wrinkles or trapped bubbles in the arena.

For emptying the pool you can use an aquarium motor pump (Amazon link provided for reference) which is available in market.

Building the Anchored Buoys and the Gateways

The easiest method of building the buoy is mentioned below, you are allowed to use your own ideas for building these but **must strictly follow the dimension** mentioned in the Theme Description- The Objects.

Figure 10: Plastic Bottle after cutting.

Materials required for preparing the Gateway and Buoy:

- 9 x 1 liter Plastic Bottles (or functionally similar material). PTFE or wide diameter plumbing pipes may also be used as an alternative. *Plastic Bottle is used in the procedure explained below.*

For building Anchored Buoys and Gateways cut the top part of plastic bottle. The bottle should be cut 17 cm from the bottom as shown in Figure 10. Cut 9 such bottles for using as buoys and gateways.

Arena will consist of 6 gateway and 3 buoy. For distinguishing buoy and gateway you can apply different colour patterns to it.

For placing The Anchored Buoy and The Gateway in the pool you will have to add ballast of at-least 500gm inside the bottle. So that it **doesn't float**.

Anchored Buoy will have a hall effect sensor circuit for detecting a magnetic field which you will design in Task 2.

You can place the hall effect sensors anywhere on the buoy. But electronic circuit of the sensor along with battery will be placed inside the bottle. Some possible position for hall effect sensor is shown Figure 2, 3, 4. Make sure that battery and electronics do not get in contact with the water in the pool and the ballast (if metal ballast is used inside the bottle).

Chapter 4: Robot Description

Hardware Specifications

- The Patrol Fish robot must have a method to switch the robot ON/OFF on the robot that is easily found by a person not from the team.
- The Patrol Fish should have a magnet or magnets; these magnets are used to trigger the buoy.
- Teams have to design their joystick module to control the Patrol Fish robot wirelessly.
- Teams have an opportunity to gain bonus points for creativity and functionality of the Fish.
- The entire Patrol Fish Robot must fit in a box (400mm x 300mm x 135mm).
- The Patrol Fish Robot must use minimum 2 and maximum 6 micro Servo motors to help in propulsion/direction control of the Patrol Fish.
- The Fish Robot can be powered only through Li-ion battery provided to the teams in the robotic kit and cannot use any other power source.

Software Specification

- e-Yantra has provided all teams with Arduino IDE - a free software for programming and burning hex files to microcontroller.
- As per e-Yantra policy, all your code and documents are open-source and may be published on the e-Yantra website.

Chapter 5: Theme Rules

Arena Configuration Setup Table

Initially, the Patrol Fish Robot is placed at the Home Zone in the Arena. And The objects are placed according to the **Arena Configuration Setup Table.**

Sl. No.	Buoy Position	
1	H5	
2	Q4	
3	---	
Gateway Number	**Position 1** Pass Clockwise	**Position 2** Pass Anti-Clockwise
1	E3	D5
2	G2	K3
3	W3	V5

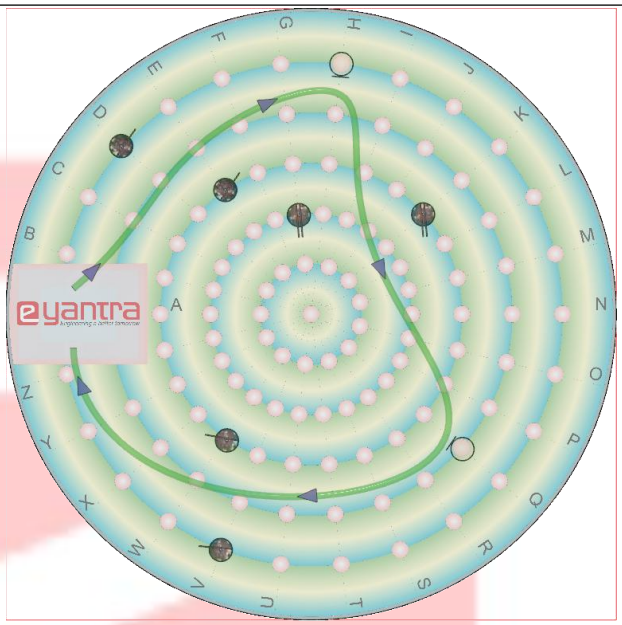

Figure 11: Example Configuration

Table 1: Example Arena Configuration Setup Table with Figure (Figure 11)

Setting up the Arena according to the Configuration Table

The configuration table defines the setup of the Buoys and the Gateways.

The nodes mentioned in the Buoy Position list shows the nodes on which the Buoys must be placed. There is freedom in the orientation of the Buoy but the center of the tower must completely cover the red circle representing the node position.

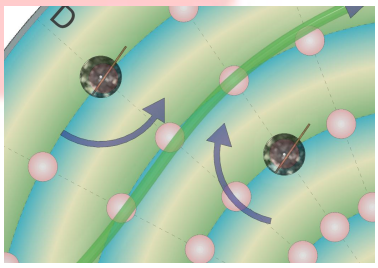

Figure 12: Direction of Gateway

Similarly the two nodes mentioned against the Gateway number shows the positions on which the pair of Gateways must be placed. Again the gateway must completely cover the red circle representing the node position.

Note that as mentioned in theme description, the gateway also specifies the direction in which the fish must go. In the example E3 is written in pass clockwise column and D5 in pass anti-

clockwise column. So the Patrol Fish must go through in the direction as shown in the Figure 12 on the right. Note if the order is inverted, I,e D5 is in Position 1 (Pass Clockwise) and E3 is in Position 2 (pass anticlockwise) the direction will be reversed.

Rules

1. **Arena Configuration Setup Table** will be given before the start of the run.
2. When the team is ready **to start the run**, the Fish Robot should be at start position. A Timer of 600 seconds (maximum time allotted for a run) will start when the Joystick is switched ON, which is indicated by beeping the buzzer on the joystick. The buzzer should beep for 2 seconds.
3. In order **to complete the task**, the Patrol Fish robot has to go through the Gateways in the given sequence and the given direction and trigger all the Anchored Buoys and return to the Home position.
4. The **timer will STOP** when any part of the Patrol Fish Bot enters the home followed by the 3 second beep from the buzzer on the joystick.
5. During 600 seconds of run, if the team wants to **terminate the run** at any point, then the buzzer on a joystick should beep 1 time for a duration of 3 second.
6. Time measured by any other means is not acceptable for scoring. The time measured by the reviewer will be final and will be used for scoring the teams.
7. Teams are not allowed to keep anything inside the arena other than the robot and their Anchored Buoys during the Finals.
8. Once the robot is switched ON, human intervention is not allowed. Teams must control the Patrol Fish Robot wirelessly using the joystick.
9. If a team wishes to re-position the Patrol Fish they must indicate this to the reviewer and if the reviewer accepts the re-position, the team can re-position the Patrol Fish behind the last passed Gateway. Note: There is Re-position Penalty. The timer will not stop during re-position. Any points scored by the team till then are preserved.
10. There is no limit on number of times the Fish Robot crosses a gateway or detects a buoy in the arena. However, the points for each Gateway Crossing/Buoy Triggering will be awarded only once.
11. Triggering of the Buoy is indicated by glowing the LED of buoy by magnet on the fish robot.
12. It is considered as **perfect execution** when the Patrol Fish *triggers all the Buoys* and *goes through all the Gateways in the specified sequence* and *returns to home position without encoring any penalties*.

NOTE:

- **You will be given final arena configuration 24 hours before the submission of Task 5: Video submission along with instructions to complete the task.**
- **In case of any disputes/discrepancies, e-Yantra's decision is final and binding. e-Yantra reserves the rights to change any or all of the above rules as we deem fit. Any change in rules will be highlighted on the website and notified to the participating teams.**

Judging and Scoring System

Total Score = (600 - T) + (PG*100) + (TB*300) - (DB*50) - (CG*50) - (RP*50) + B + CB

T	**Total Time**	Time in seconds taken for the run (Maximum 600) (**considered only after completing at-least one gateway**)
PG	**Passing Gateway**	Points awarded when the entire Patrol Fish body Passes through the Gateway line **in the CORRECT DIRECTION and in the CORRECT SEQUENCE** (Gateway <= 3) i.e. If sequence of passing Gateway is 1, 2, 3 then PG = 3; 1, _, 3 then PG = 2; 1, ~~3, 2~~ then PG = 1;
TB	**Triggering Buoy**	Number of Buoys triggered Points will be awarded when the Patrol Fish robot makes contact with the buoy and the LEDs on the Anchored Buoy glow.
DB	**Displacing Buoy**	Number of Bouys displaced. (Counted as displaced when the node of the Bouy becomes visible)
CG	**Colliding in to Gateway**	Number of times the body of the fish comes in contact with the Gateway while Passing Gate-away.
RP	**Re-position Penalty**	Number of times re-position is requested by team(0 to 3)
B	**Bonus**	100 points awarded if the Patrol Fish a perfect execution
CB	**Creativity Bonus**	Max 400 points may be awarded for creativity. Following will be considered: Fish Robot design and various motion performed

Judges discretion is final and binding.

ALL THE BEST!