Rescue Simulation (former CoSpace)
Team Description Paper
NYCasuals

Members

Chan Zun Mun Terence, zunmun@gmail.com
Leong Kit Ye, sherylleongkitye@gmail.com
Azalia Azzahra, azaliaazzahraofficial@gmail.com

Mentor

Soh Wei Kuan, soh_wei_kuan@moe.edu.sg
Institution: Nanyang Junior College
Country: Singapore

Contact Person: Soh Wei Kuan, soh_wei_kuan@moe.edu.sg

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Abstract— This document describes and explains with elaboration Team NYCasuals's strategy in participating in the RoboCupJunior Rescue Simulation (former CoSpace) challenge. All present and future works are discussed in this document.

I. INTRODUCTION

Team NYCasuals is a robotics team from Nanyang Robotics Club (NYRC). Our club believes that passion, dedication and resilience are the drivers to success. Our team is passionate about robotics and enjoys the process of self-directed learning while experimenting with the CoSpace platform. We were inspired by our seniors who managed to claim the title of world champion for 3 years in a row, and we aspire to emulate their success. Our goal in 2019 is simple: we shall defend their legacy. At the same time, we are looking forward to the creative strategies that the other national champions employ, and learn from them.

II. PROGRAMMING LANGUAGES USED

1) C
2) C++
3) Python

III. PROGRAMMING APPROACH

Via teamwork, collaboration, strategic planning, and guidance from our seniors, Team NYCasuals's program is the fruit of all members' technological and coding knowledge.
The programming approach consists of a few steps:
1) Brainstorm a concept
2) Write pseudocode
3) Write the actual code
4) Compile the code and execute the program
5) Test the program in CsBot Rescue
6) Debug the code
7) Optimize the code

IV. STRATEGIES

A. Detecting Objects

The robot's colour sensors are used to seek nearby objects.When an object is found, the robot stops moving and flashes its LED for 3 seconds to collect the object.

B. Avoiding Traps

In World 1, the colour sensors are used to detect boundaries. In World 2, the X and Y coordinates indicate the location of the traps. Wheel values are set to negative to avoid traps.

C. Avoiding Walls

When the ultrasonic sensors detect a wall,the wheel values are set to negative so that the robot moves backwards.

D. RRGGBB collection

When a robot collects 2 red, 2 green and 2 black objects, it gains 180 bonus points. Our program aims to capitalise on this by collecting at most 2 of each.

E. Sweeping

The chances of the robot encountering an object is increased using a âAŸsweeping' function, where the robot's wheels have different speeds at each interval. This allows the robot to move in a left-right manner which is much more efficient than simply moving straight forward. This is implemented using the robot's compass and a separate variable.

F. Wall Tracing

By using the robot's ultrasonic sensors, we can program it to follow walls. This is only applicable to certain maps, such as one with many objects around a wall.

G. Avoiding Borders in World 2

We use the robot's X Y coordinates, as well as the compass to avoid the World 2 borders.

J. Angle Turning

With a destination angle in mind, the robot turns either clockwise or anticlockwise (whichever is shorter) to it. This is coded using if - else statements.

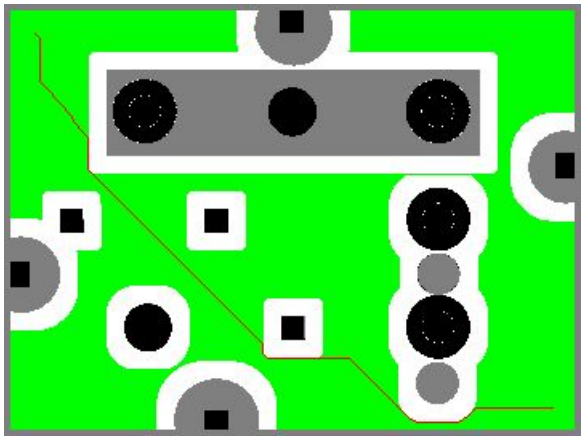
K. A* Search Algorithm

The A* algorithm is used on the generated grid to determine the Single-Source Shortest Path (SSSP) from a source node to a destination node.

Heuristics: The octile heuristic is used as the map is represented in a 2d grid.

```
function heuristic(node)
	dx = abs(node.x - goal.x)
	dy = abs(node.y - goal.y)
	return D * (dx + dy) + (D2 - 2 *
D) * min(dx, dy)
```

2) Achieving smooth straight-line movement: A standard
A* search



L. Trigonometry
Trigonometry is used to calculate turning angles for the robot.
In NYCasuals's program, theta (θ) is defined as the target angle which the robot needs to turn to in order to reach a certain destination. Trigonometry is used to initialise the value of theta so as to direct the robot towards different target destinations in World 2 using the compass. In this case, the function atan (arctangent) in C/C++ is used to determine theta, as the length of the perpendicular sides of the triangle are already known. The value of theta is used to direct the robot towards the different destination nodes. It is also used to move directly to the Super Object.

```
function trigo (targetX, targetY)
diffX := targetX - robotX
diffY := targetY - robotY
angle := atan(diffY/diffX)
```

M. Ultrasonic Sensor Mapping
Since the World 2 map will not be provided during the competition, we utilized the robot's ultrasonic and colour sensors in order to map its surroundings so that it can perform A* search to travel to locations and collect objects. From the robot's ultrasonic sensors, we can determine if a location has obstacles, i.e. when the sensors return a value less than the maximum sensor value of 186. We use these values, along with the PositionX, PositionY and Compass values together with trigonometry to mathematically compute the equation of "lines" radiating from the centre of the robot to the point on the obstacle detected, and mark their respective coordinates of the bitmap as being a wall or empty space.

```
int ptx = (us)*cos(uscomp) + PositionX;
  int pty= (us)*sin(uscomp)+PositionY;
if (us < 186)
	{
		for (int x = max(0,ptx-l);
x<= min(ptx+l,360); x++)
		 {
		   for (int y=max(0,pty-l); y<=
min(pty+l,270); y++)
		     {
		       map1[x][y]=wallcol;
		     }
	}
	}
```

O. Colour Sensor Mapping
For colour mapping, we utilize the robot's colour sensors. Whenever the robot's colour sensor detects a specific colour, we fill a square area surrounding the robot's position with that colour value in our bitmap to represent that they can be found in that general area.

```
if (colourCheck(objValue)){
	colourfill(colValue,
	max(PositionX-squareLen,0),
	min(PositionX+squareLen,360),
```

```
        max(PositionY-squareLen,0),
        min(PositionY+squareLen,270));
}
```

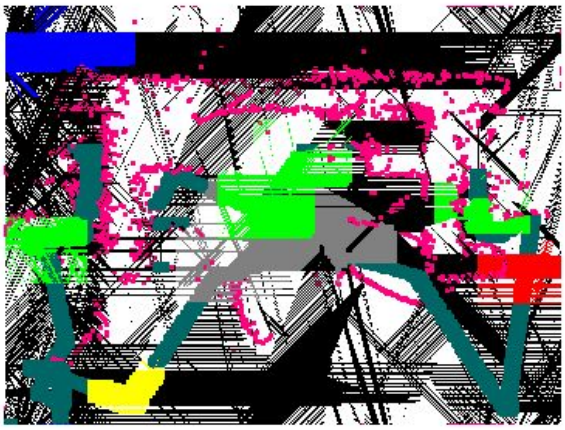


Fig. 5. Visual representation of the bitmap. The different colours represent different features of the map. Black represents that the area has a high probability of having no obstacles.

V. CONCLUSION

This document describes the tactics and strategies that Team NYCasuals uses in the RoboCupJunior Rescue CoSpace competition. As our seniors were the world champion in 2016 to 2018 , Team NYCasuals will do its best to defend its title in RoboCup 2019 Sydney, Australia.