Swarm Intelligence Based Maze Solver

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OUTLINE

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- Problem Statement
- Introduction
- Methodology
- Result
- Conclusion
- Demo

MOTIVATION

What's the shortest path to reach the center of this maze?

PROBLEM STATEMENT

- Demonstrate the concept of swarm intelligence
- Solve a maze using swarm robotics
- Establish an effective communication between two robots

INTRODUCTION

- Group of robots operate without any form of centralized control
- Use local methods of control and communication
  - Local control – autonomous operation
  - Local communication – avoids bottlenecks
  - Scalable – new robots can be added, or fail without need for recalibration
  - Simplicity – cheap, expendable robots
- Self-organization

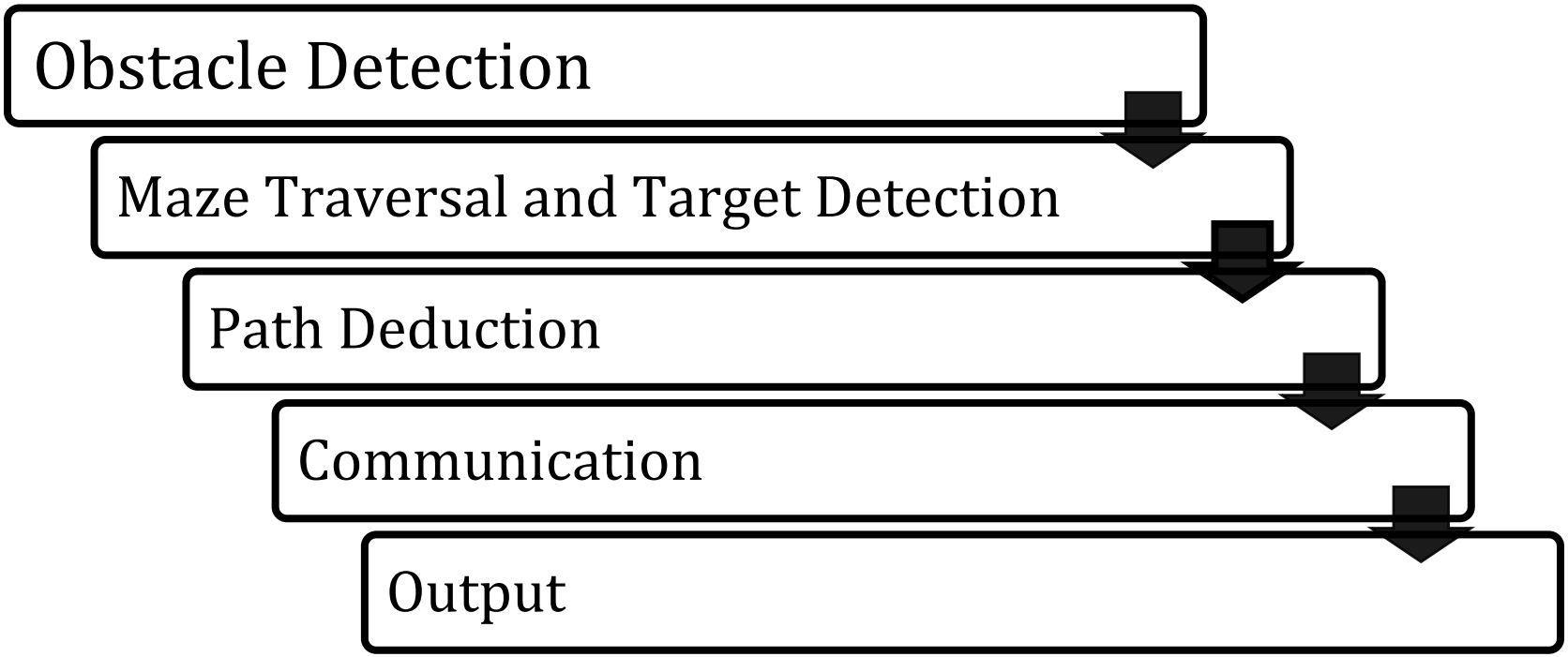
APPLICATIONS OF SWARM

- Search And Rescue (SAR) Operation
- Disaster Relief
- Landmine Detection and Further Operations

PURPOSE OF SWARM INTELLIGENCE

- Efficient use of Resources
- Autonomous Navigation
- Work Division
- De-centralization
- Unknown Terrain Navigation

METHODOLOGY



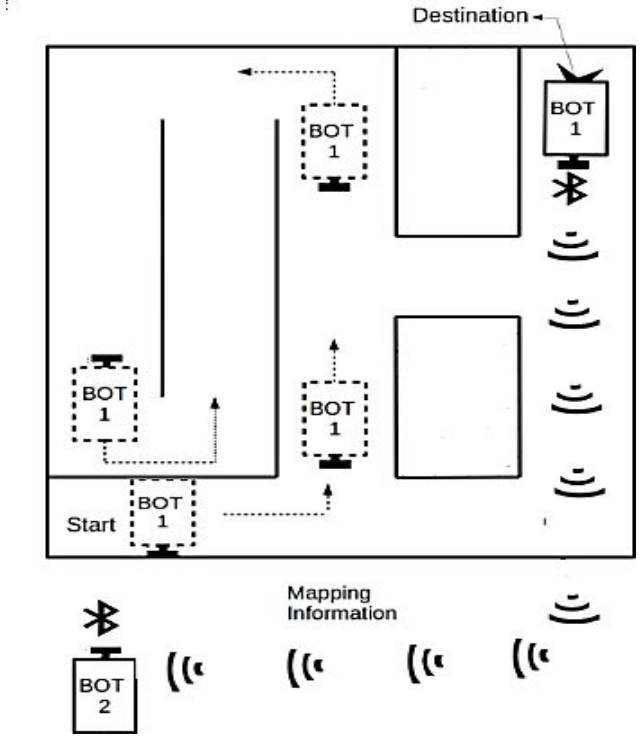
METHODOLOGY (System Overview)

First Robot

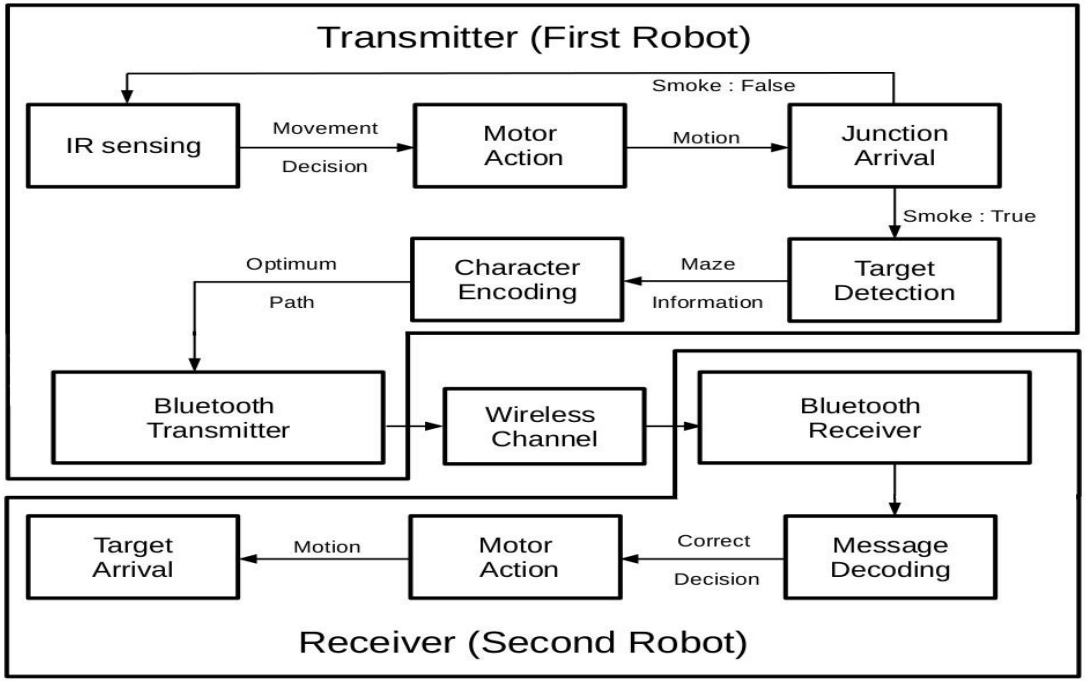
- Traverses the whole maze from start to finish
- Implements **Left Wall Follower Algorithm**
- Relays maze mapping information

Second Robot

- Traverse in shortest possible path



METHODOLOGY (Functional Block Diagram)



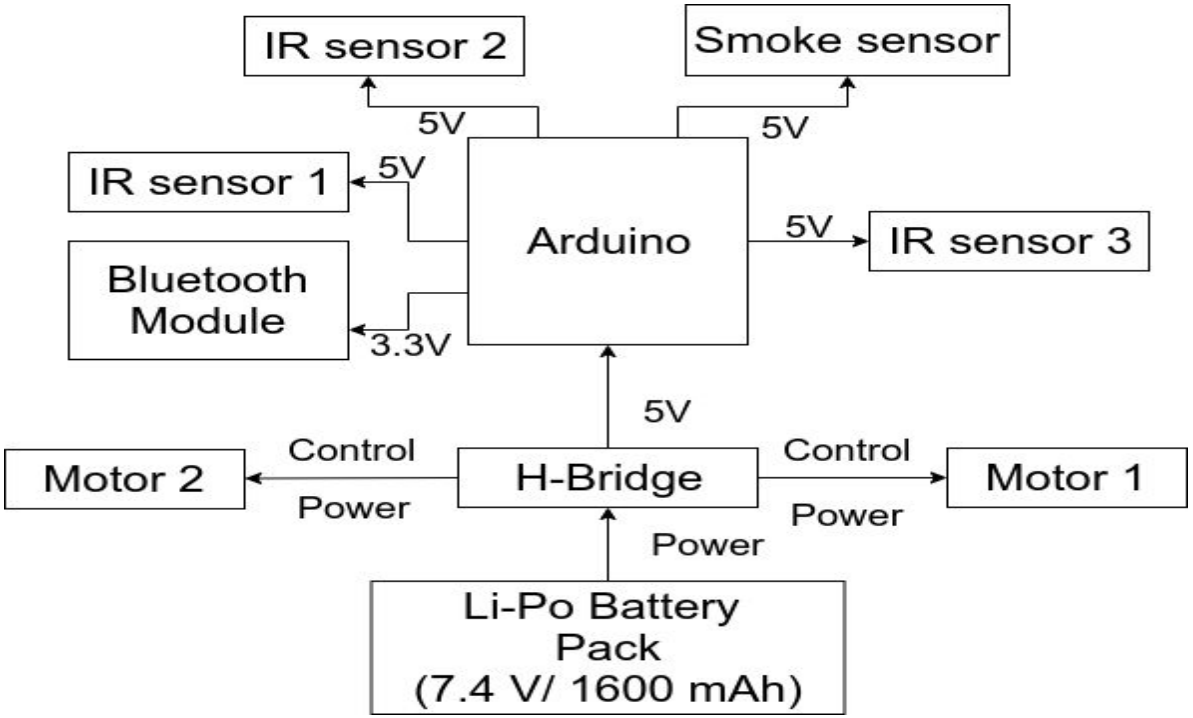
METHODOLOGY (Functional Overview-First Robot)

- The **first robot** traverses the entire maze. (non-optimal path)
  - Implements left wall following algorithm.
- Detects the target.
- Sends the optimized path to the second robot.

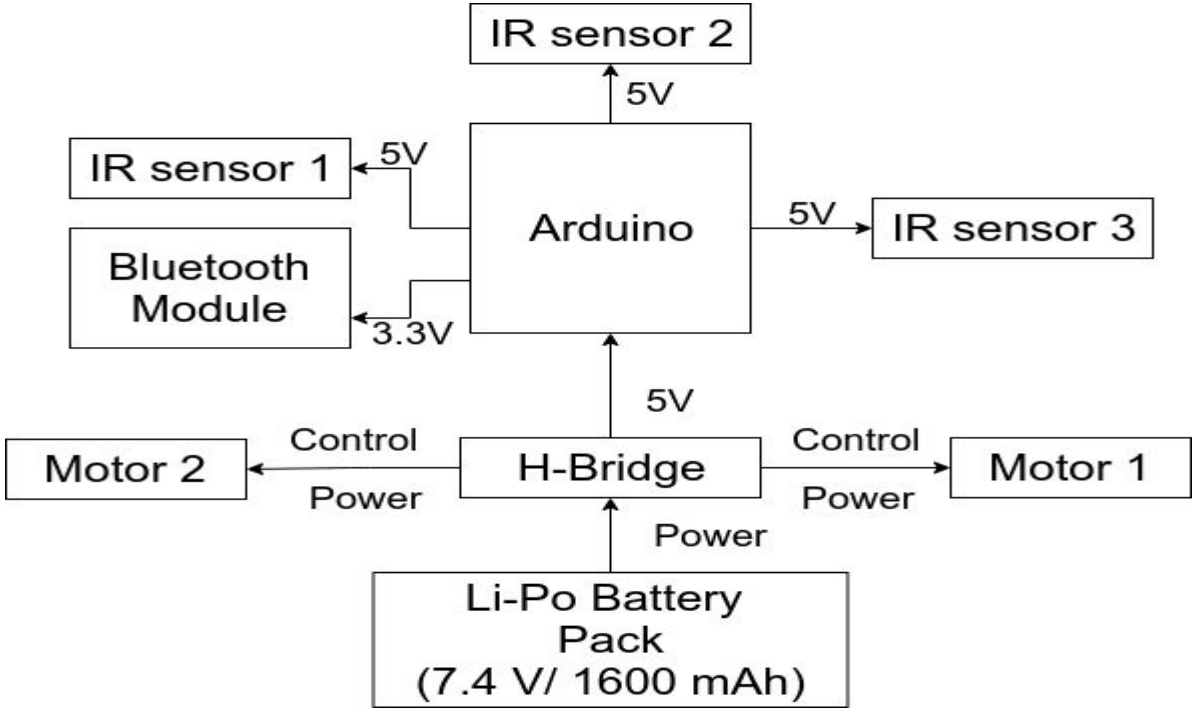
METHODOLOGY (Functional Overview-Second Robot)

- The second robot receives the optimized path from the first robot.
- Traverses the maze in the shortest path possible.

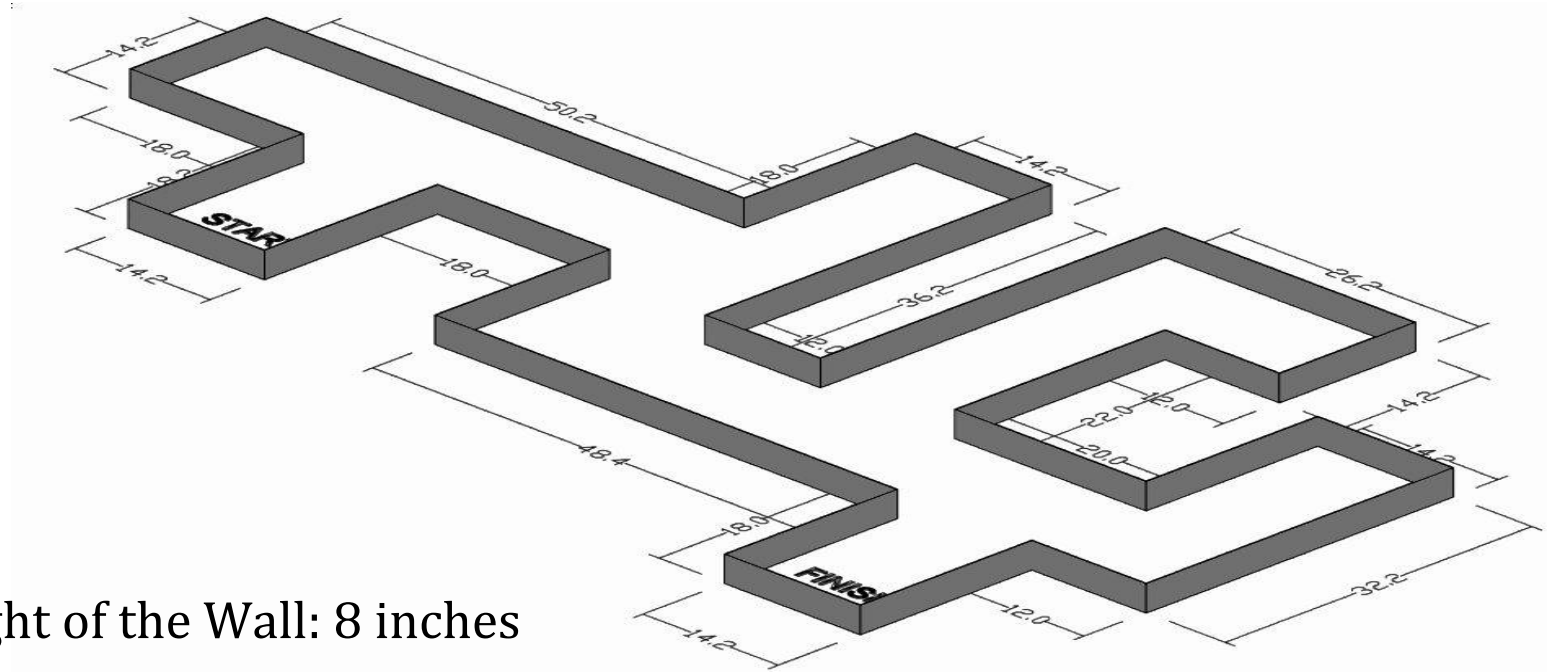
METHODOLOGY (First Robot Schematic)



METHODOLOGY (Second Robot Schematic)



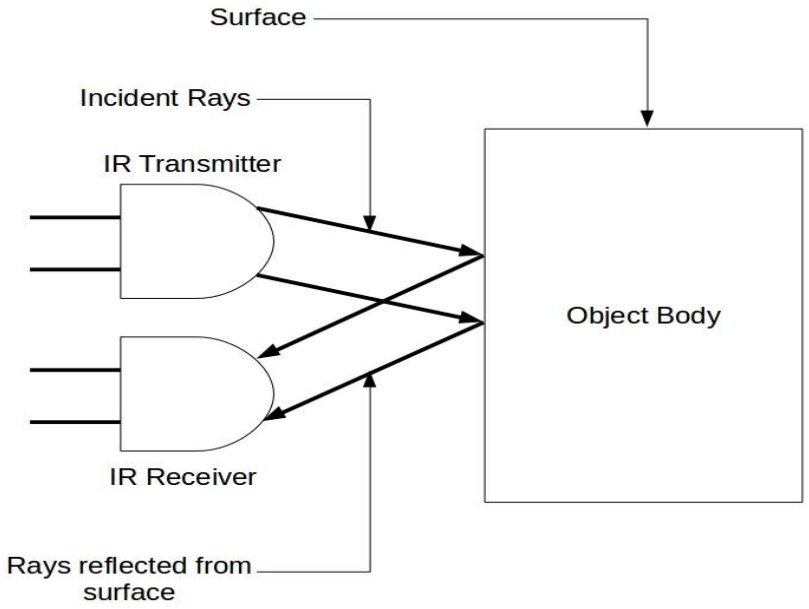
METHODOLOGY (Structure of the maze)



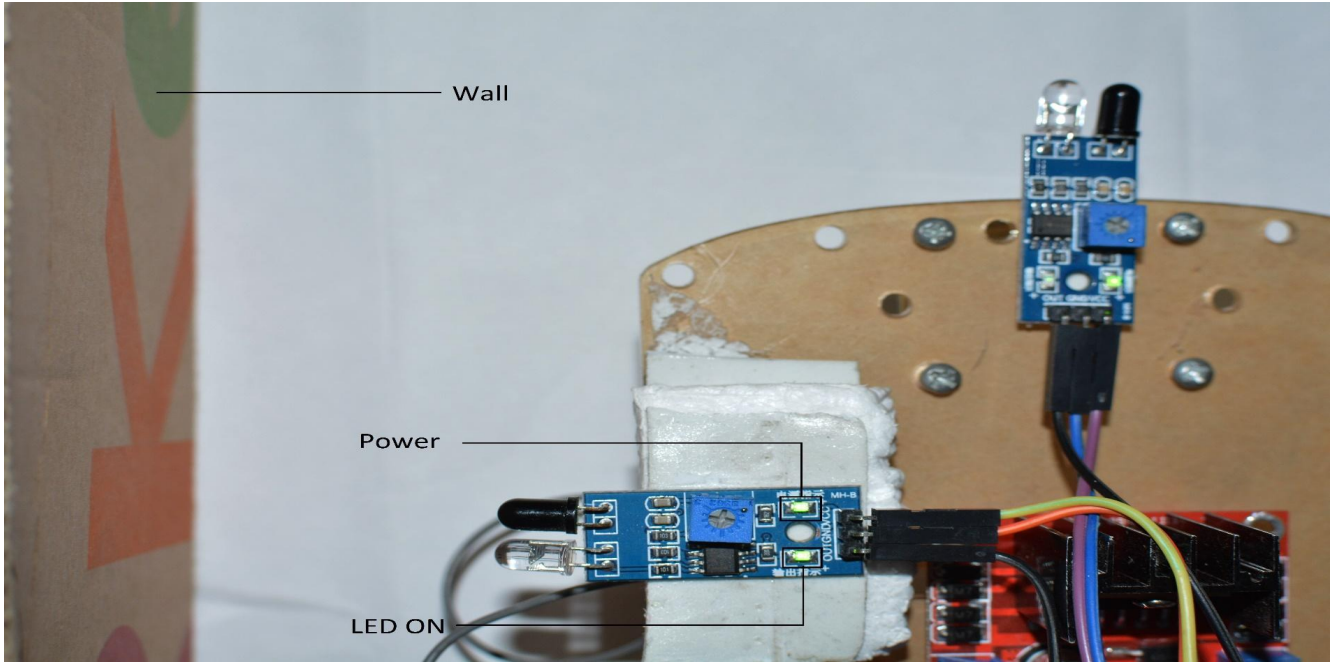
Height of the Wall: 8 inches

METHODOLOGY (Obstacle Detection)

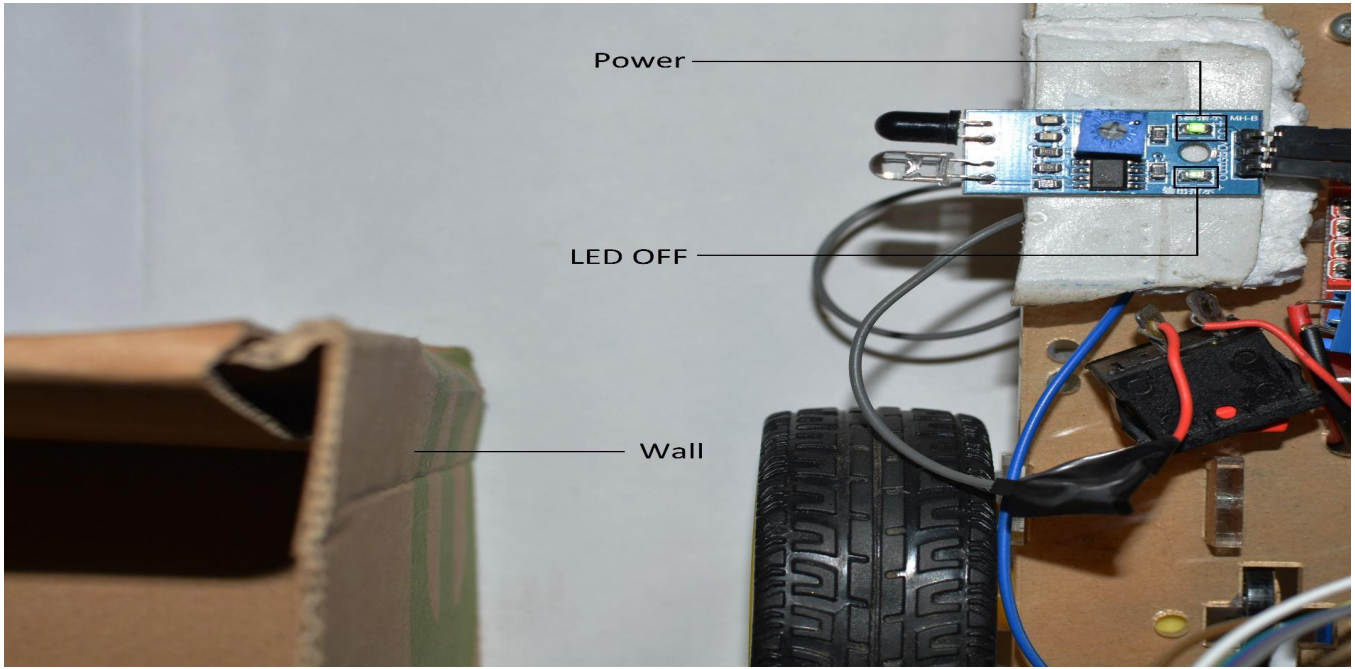
- Detection Carried Out Through IR Sensors **FC-51**
  - IR Transmitter
  - IR Receiver



METHODOLOGY (Obstacle Detection-Left Wall)



METHODOLOGY (Obstacle Detection-Left Wall)



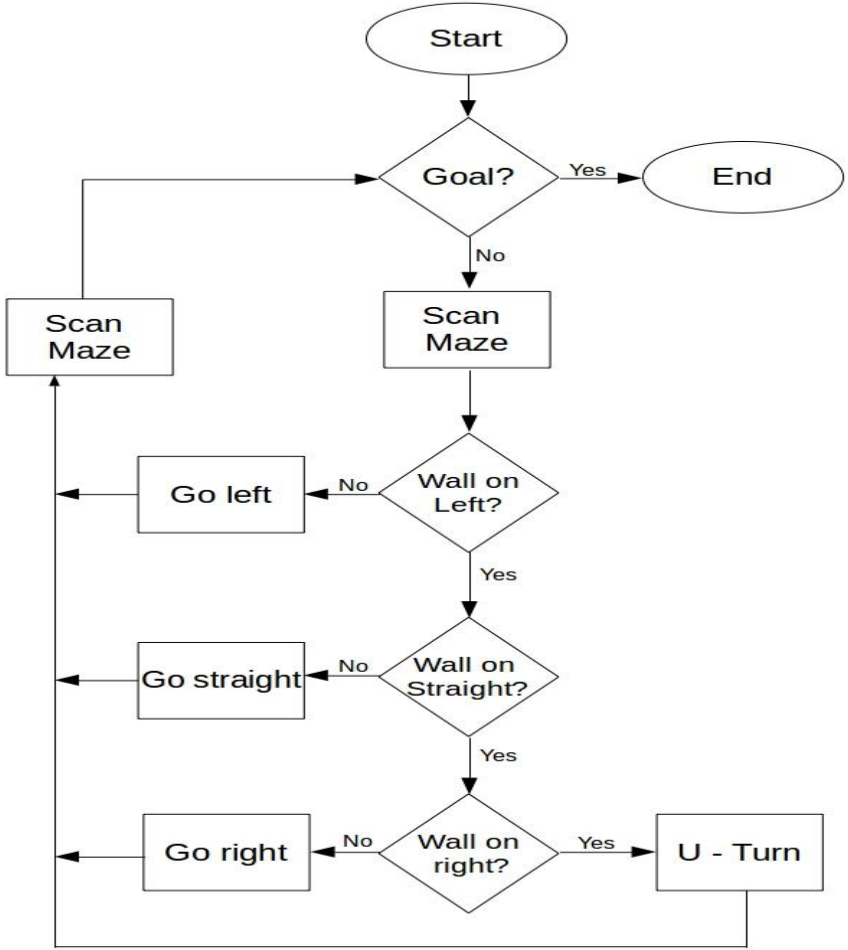
METHODOLOGY (Maze Traversal-First Robot)

- **Left Wall Following Algorithm**
  - Robot will reach the target by keeping track of the left wall

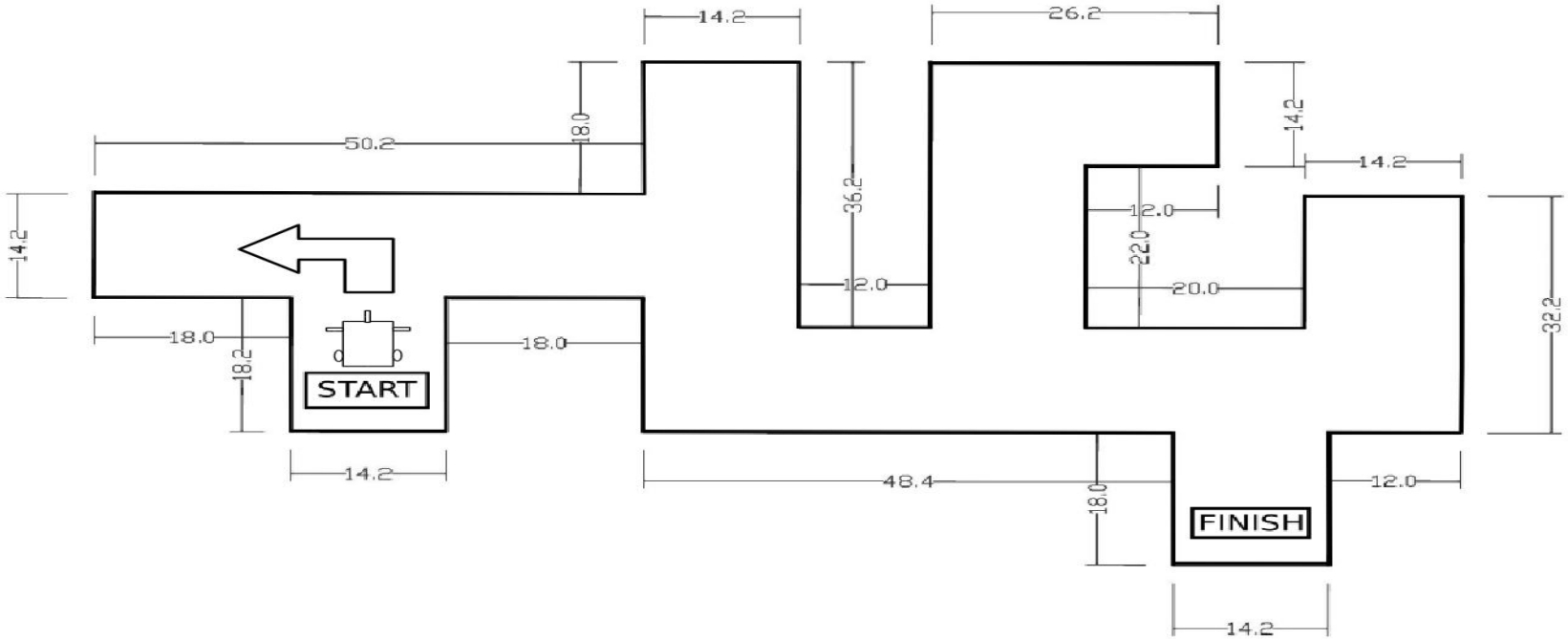
Priorities	Direction
1	Left
2	Straight
3	Right
4	U-Turn

METHODOLOGY

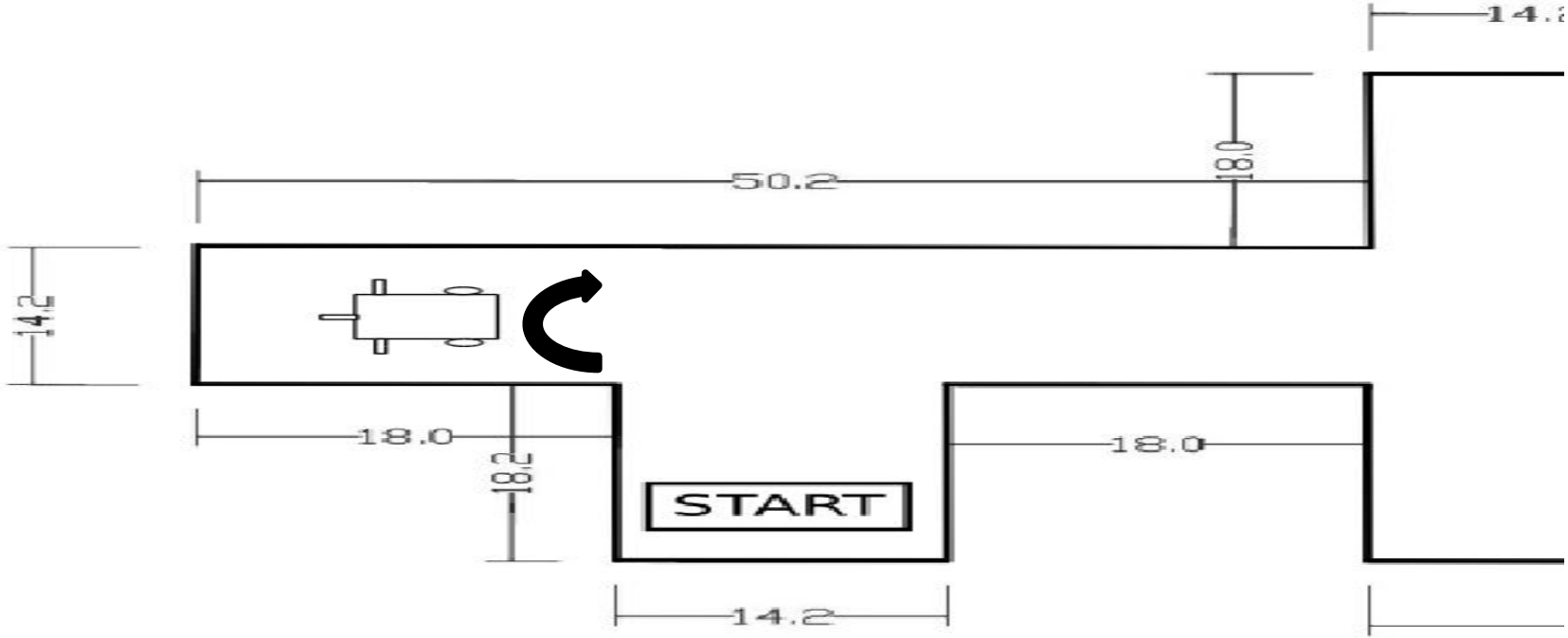
- Algorithm - maze traversal -first robot



METHODOLOGY (Maze Traversal-First Robot)



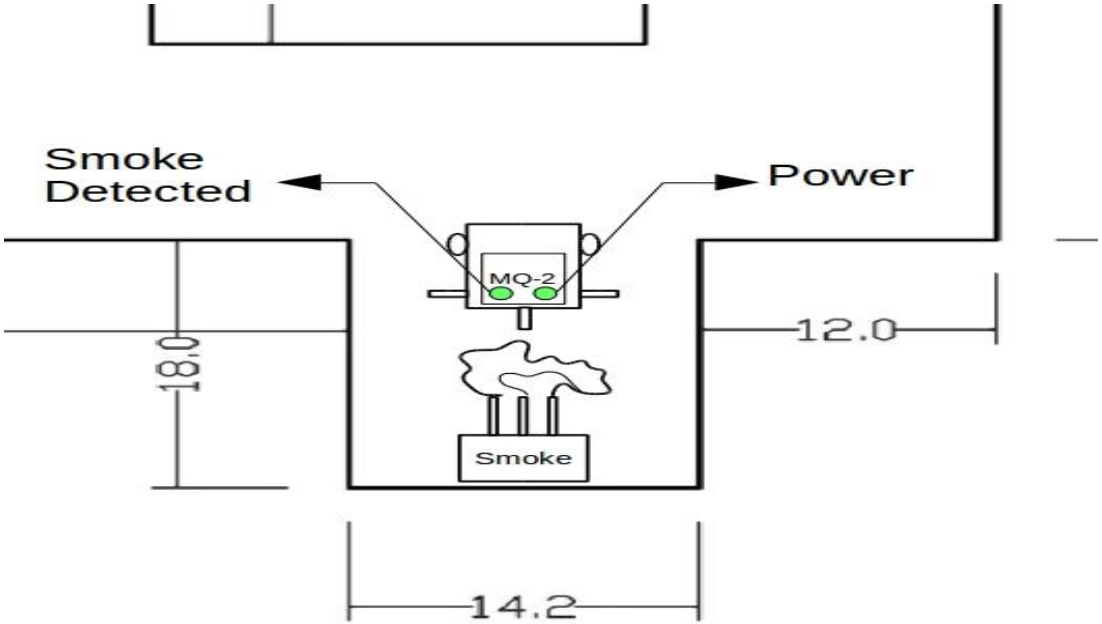
METHODOLOGY (Maze Traversal-First Robot)



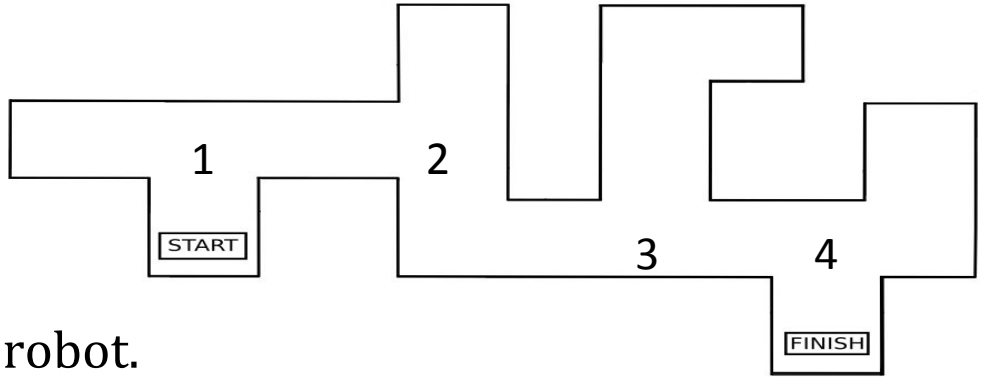
METHODOLOGY (Target Detection)

- Target : **Smoke**
- Target detected using MQ-2 Smoke Sensor
- Smoke generated using incense
- Spreading contained with enclosure

METHODOLOGY (Target Detection)



METHODOLOGY (Path Deduction)

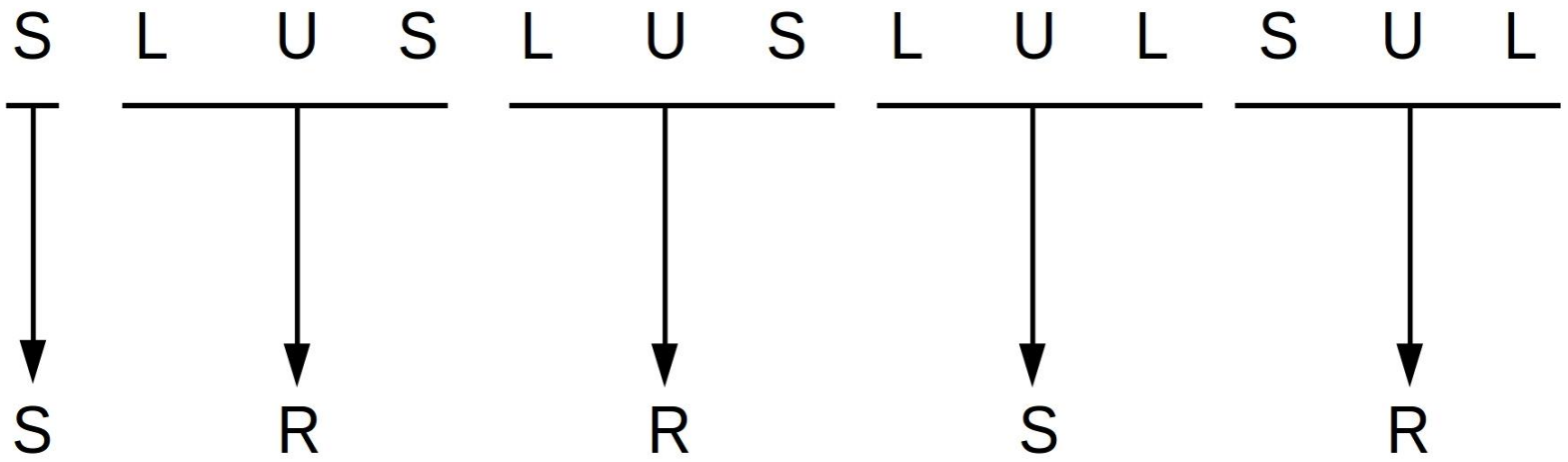


The path followed by the first robot.

S	L	U	S	L	U	S	L	U	L	S	U	L

METHODOLOGY (Path Deduction)

- The optimal decisions for shortest path.



METHODOLOGY (Path Deduction)

- Deduced path stored in an array.

S	R	R	S	R	U

- This array is sent to the second robot.

METHODOLOGY (Bluetooth Communication)

- The deduced path sent to the robot via Bluetooth.

- Two **HC-05** used for interfacing the Arduinos'.
  - HC-05 used as **master** in the first robot
  - Used as **slave** in the second robot

- Serial Communication is established.

- Data transfer only from the first to the second robot

METHODOLOGY (Bluetooth Communication)

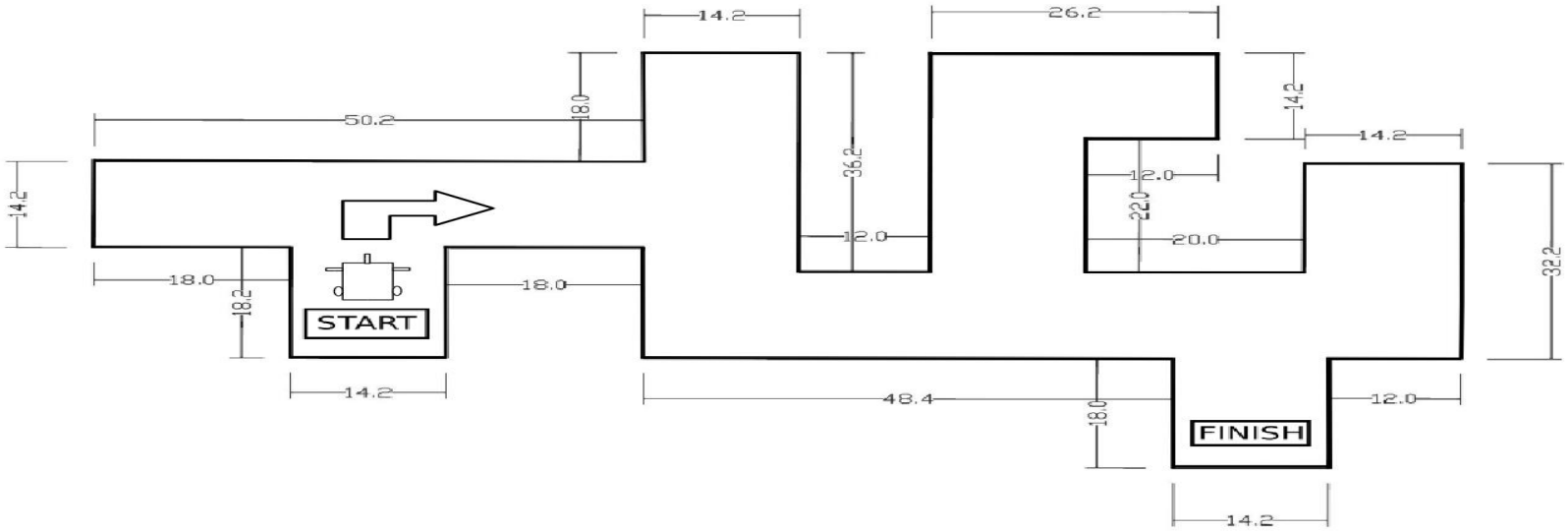
- Asynchronous Connectionless Packet's Payload i.e. only data is sent to the second robot.

- The decoded array used as the payload for the wireless transfer.

S	**R**	**R**	**S**	**R**	**U**

METHODOLOGY (Optimal Path Information)

- Upon receiving the optimal path, the second robot traverses the maze avoiding wrong turns



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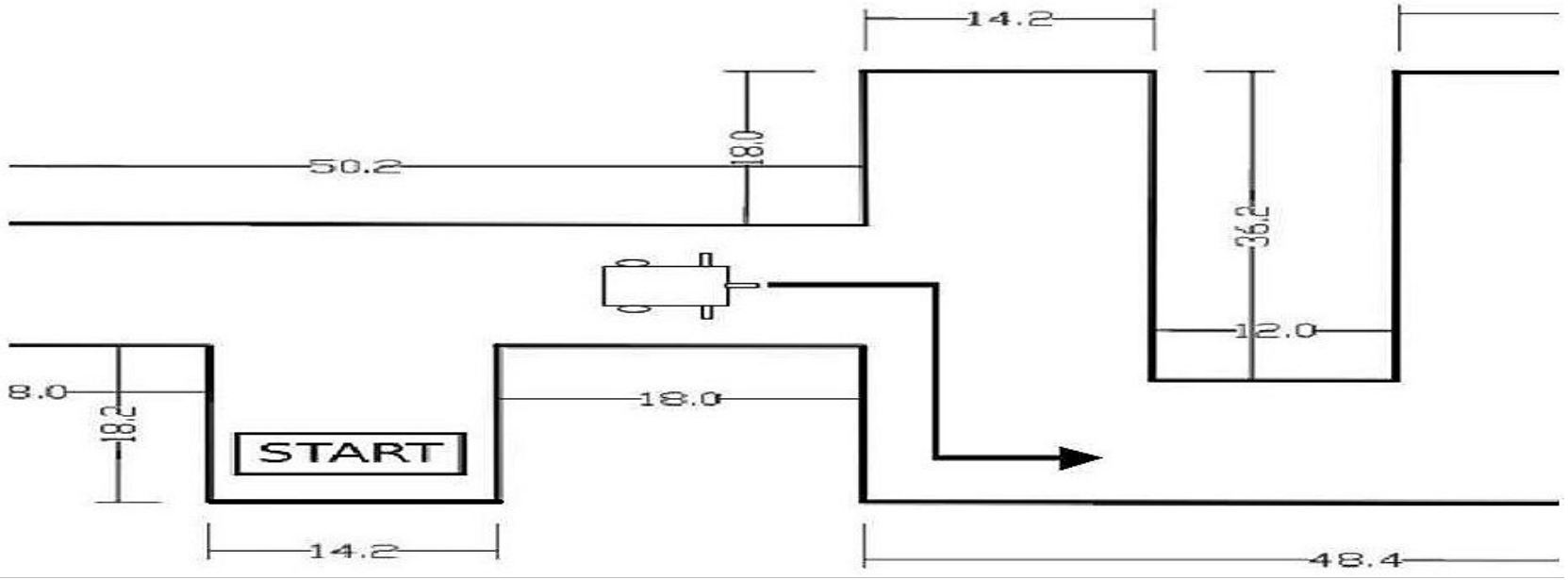
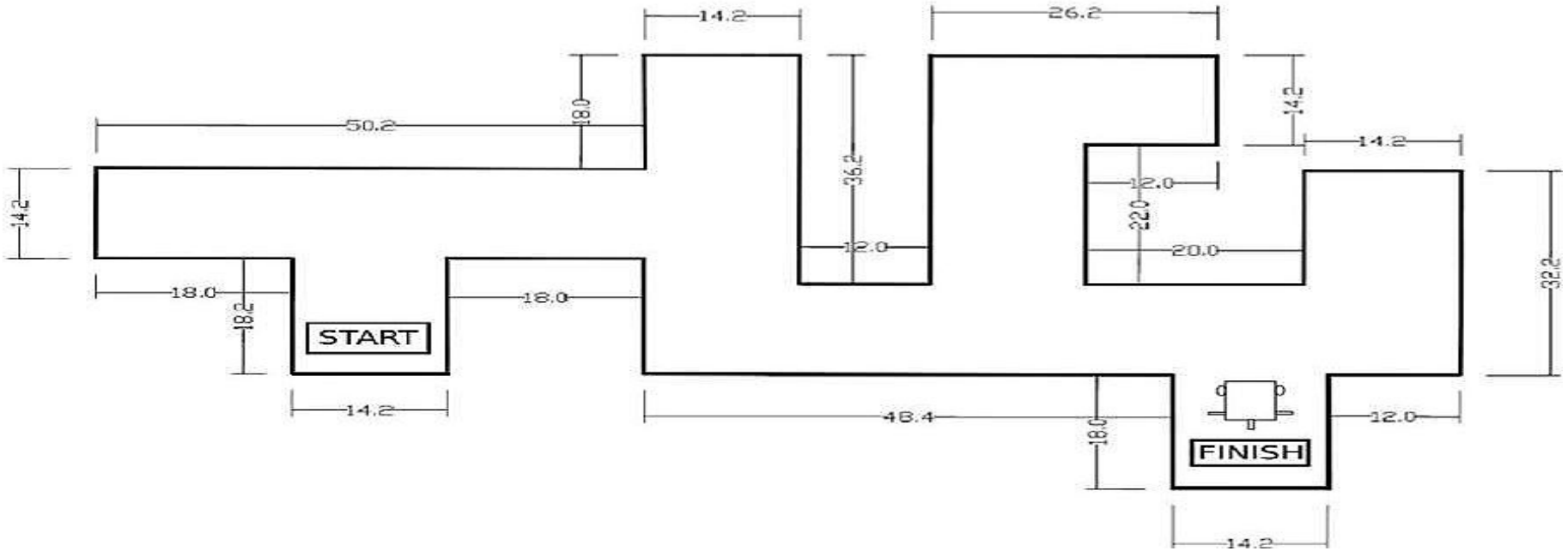
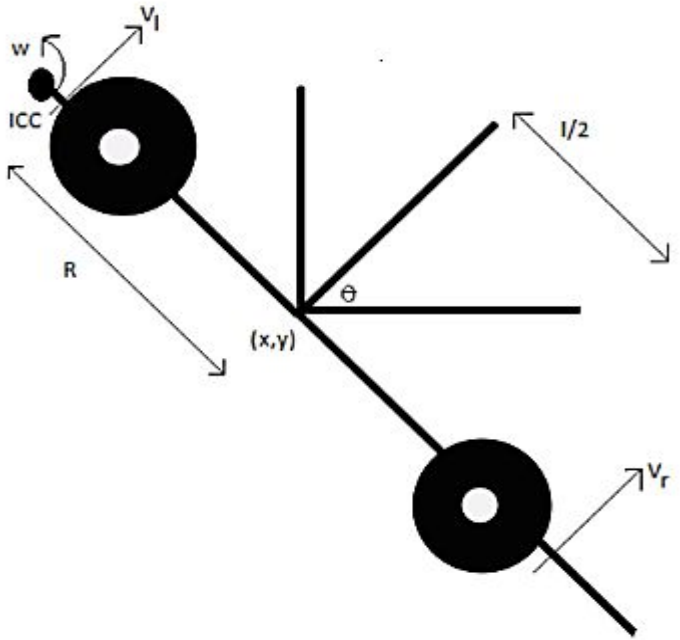


METHODOLOGY (Optimal Path Information)



METHODOLOGY (Differential Kinematics)

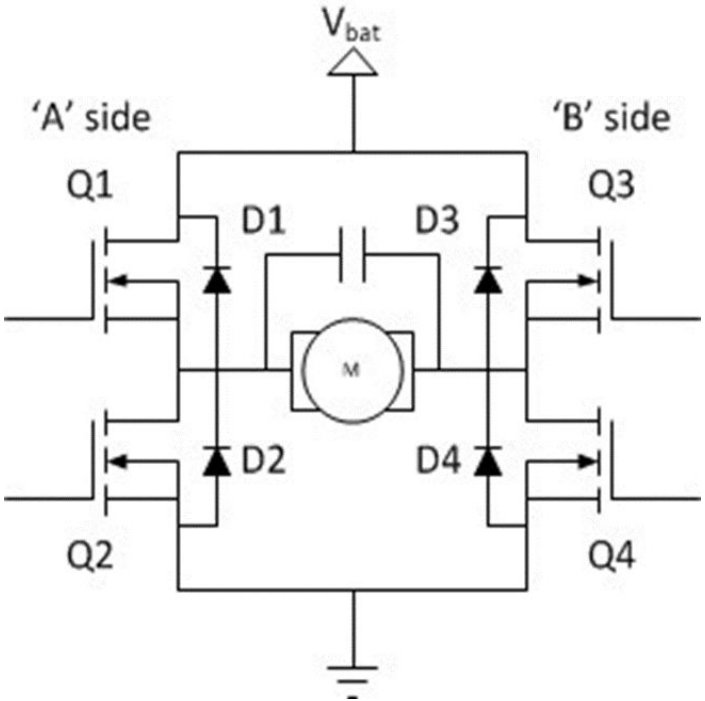
- Consists of 2 drive wheels
- Has high degree of freedom i.e. 3



METHODOLOGY (H-Bridge L298N)

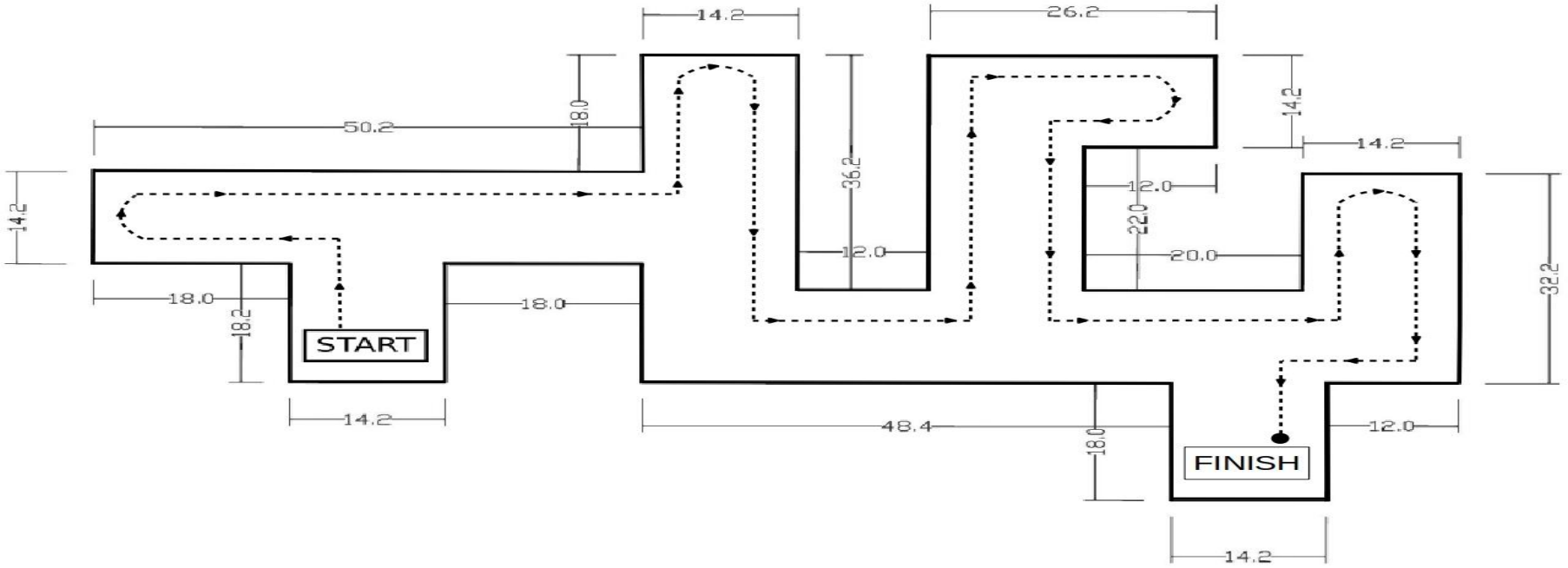
- Interface between motor and Arduino
- Contains four switching element.
- Load at center.

METHODOLOGY (H-Bridge L298N)

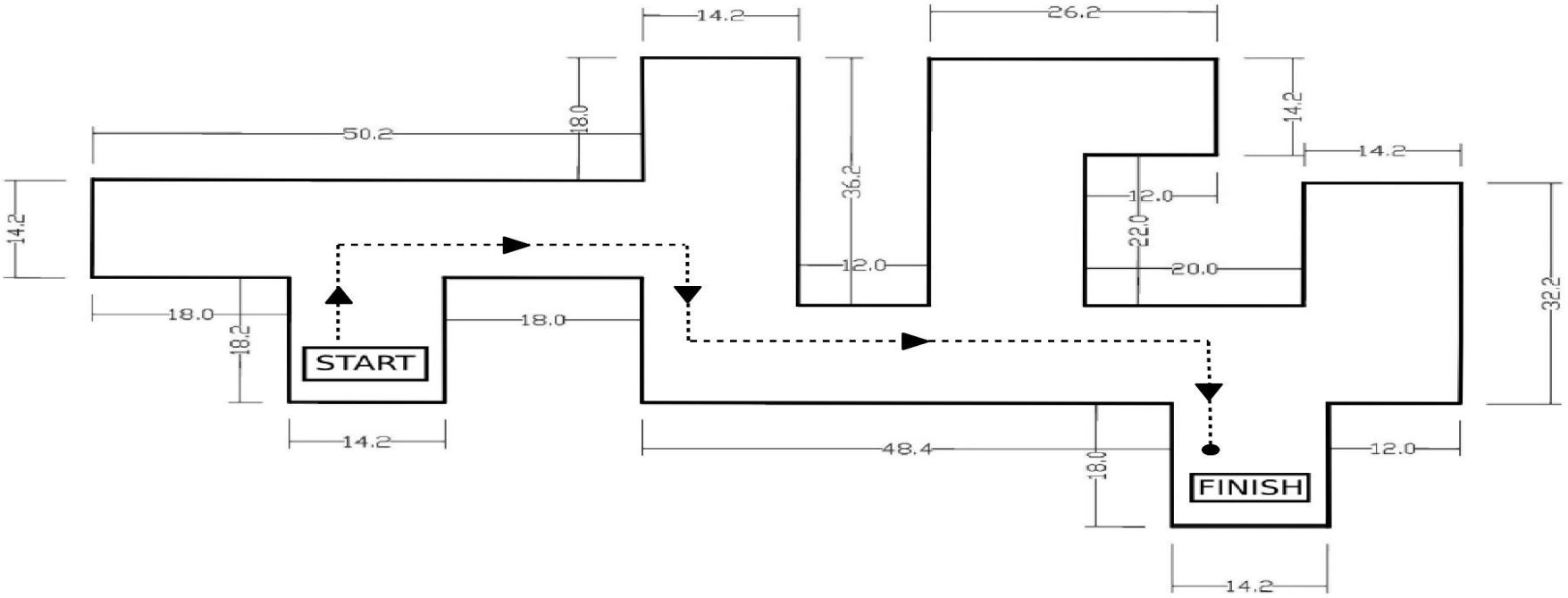


Q1	Q2	Q3	Q4	RESULT
1	0	0	1	Motor moves right
0	1	1	0	Motor moves left
0	0	0	0	Motor coasts
0	1	0	1	Motor brakes
1	0	1	0	Motor brakes
1	1	0	0	Short circuit
0	0	1	1	Short circuit
1	1	1	1	Short circuit

RESULTS (Path traversed by first robot)



RESULTS (Path traversed by second robot)



CONCLUSION

- Visualized the concept of Swarm Intelligence
- Not limited to Maze Solving
- Limitations of Bluetooth Communication
- A swarm of simple robots can be made intelligent

DEMO

THANK YOU

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