SWARM INTELLIGENCE BASED MAZE SOLVER

Project Members

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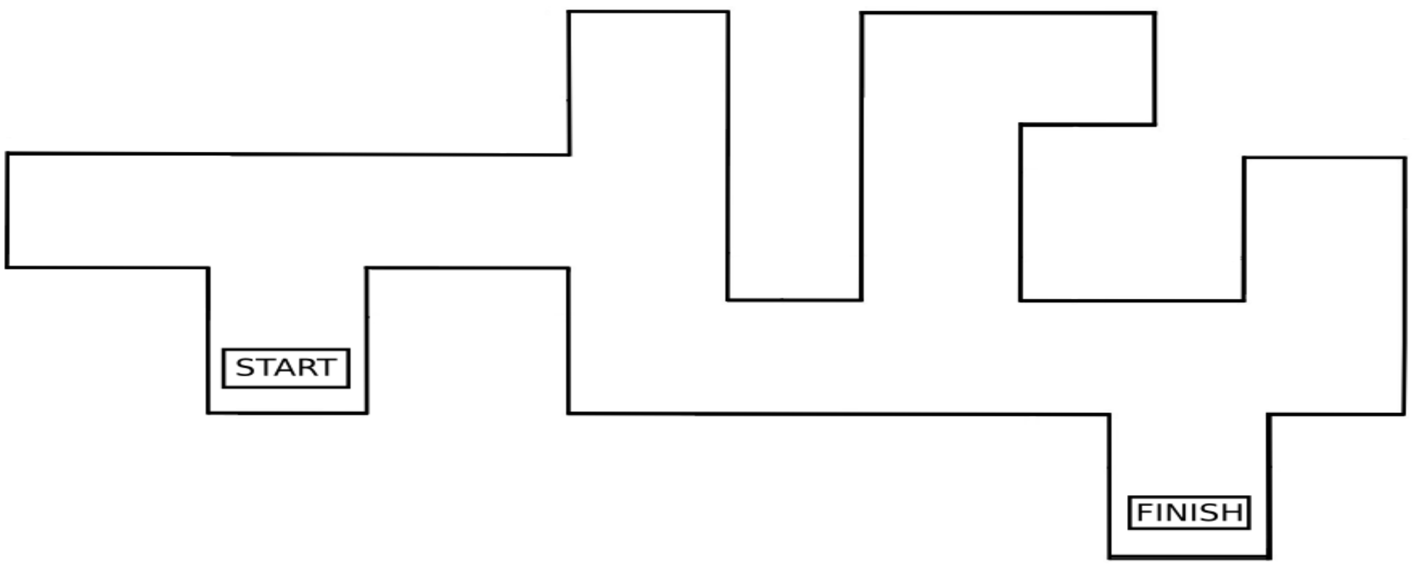
OUTLINE

- **Motivation**
- **Introduction**
- **Methodology**
- **Result**
- **Conclusion**

MOTIVATION
How can a robot find the shortest path?



PROBLEM STATEMENT

- To demonstrate the concept of Swarm Intelligence
- To solve a maze using swarm robotics
- To establish an effective communication between two robots

INTRODUCTION

- Group of robots operate without any form of centralized control
- Using 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

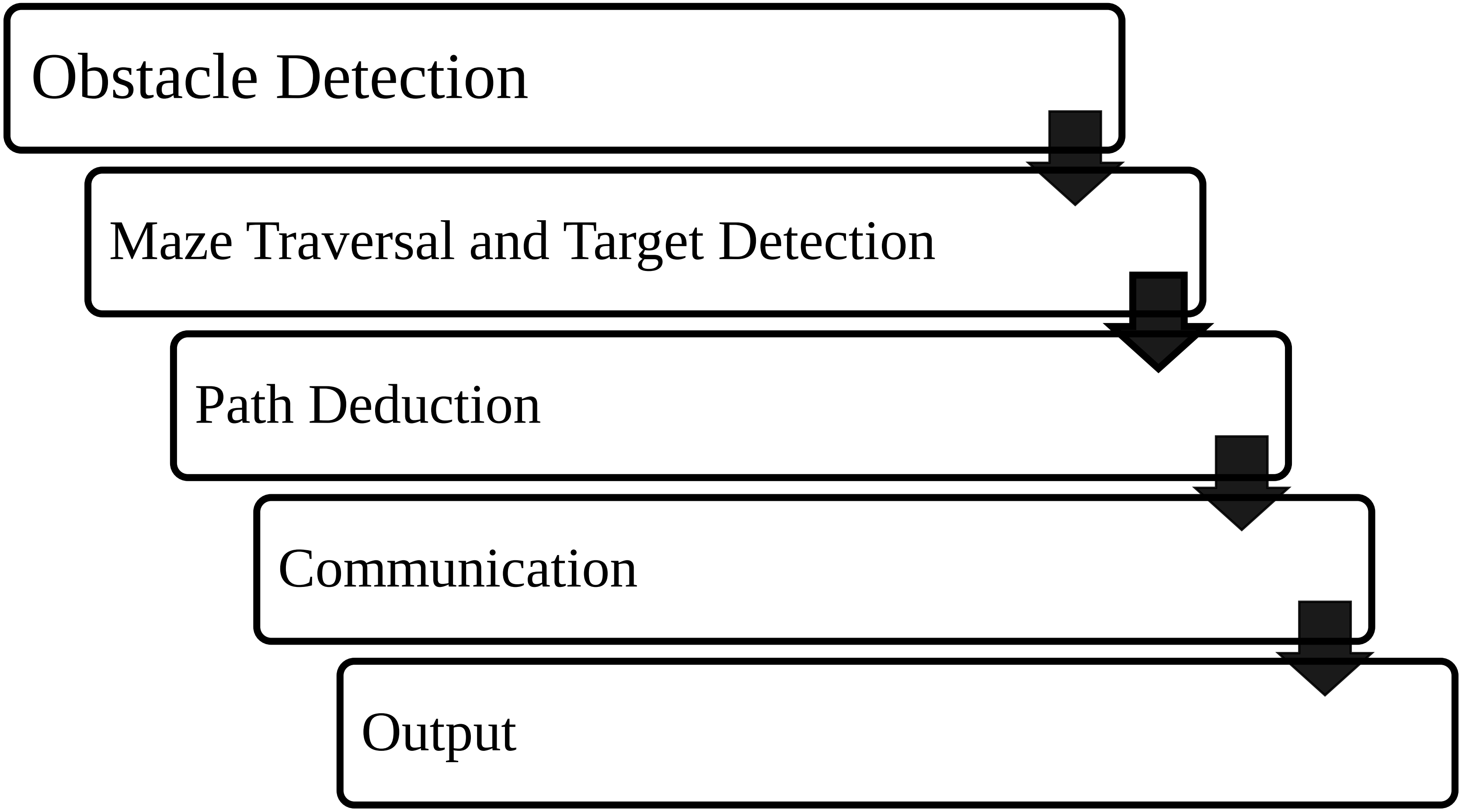
- Disaster Relief

- Landmine Detection and Further Operations

PURPOSE OF SWARM INTELLIGENCE

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

METHODOLOGY



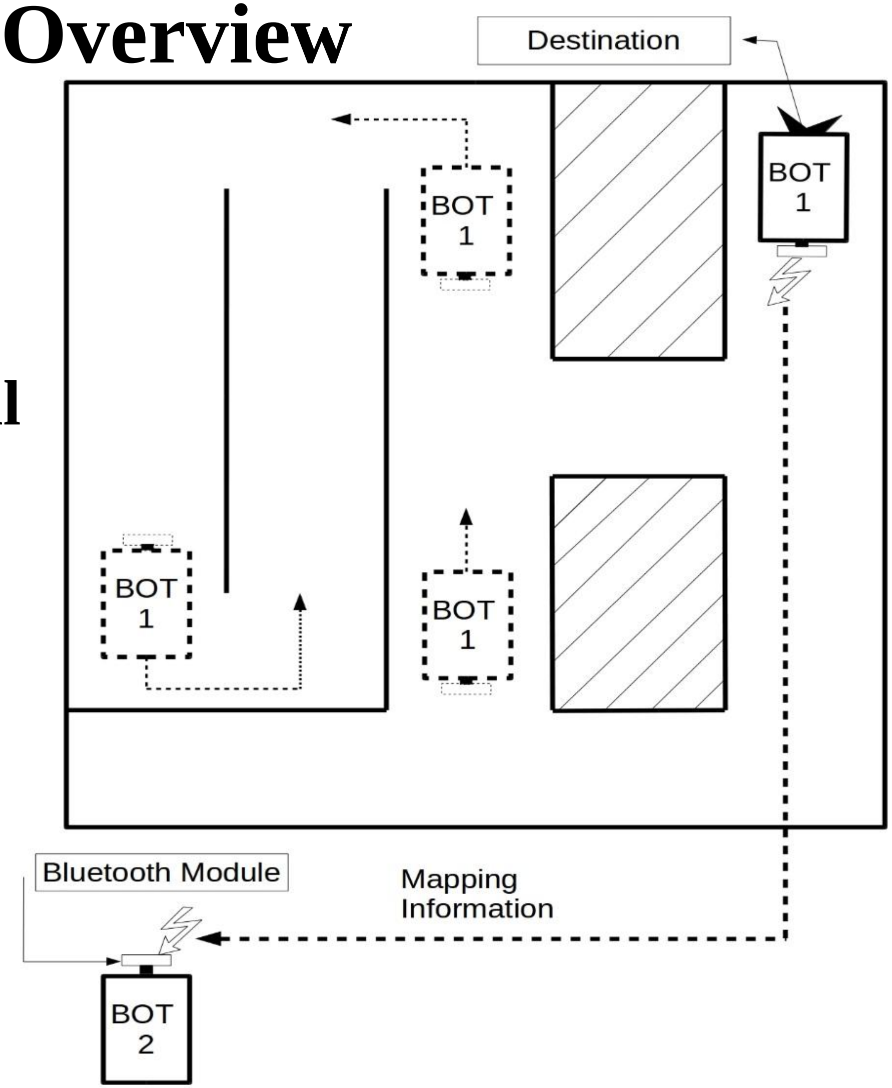
METHODOLOGY
System Overview

<u>First Robot</u>

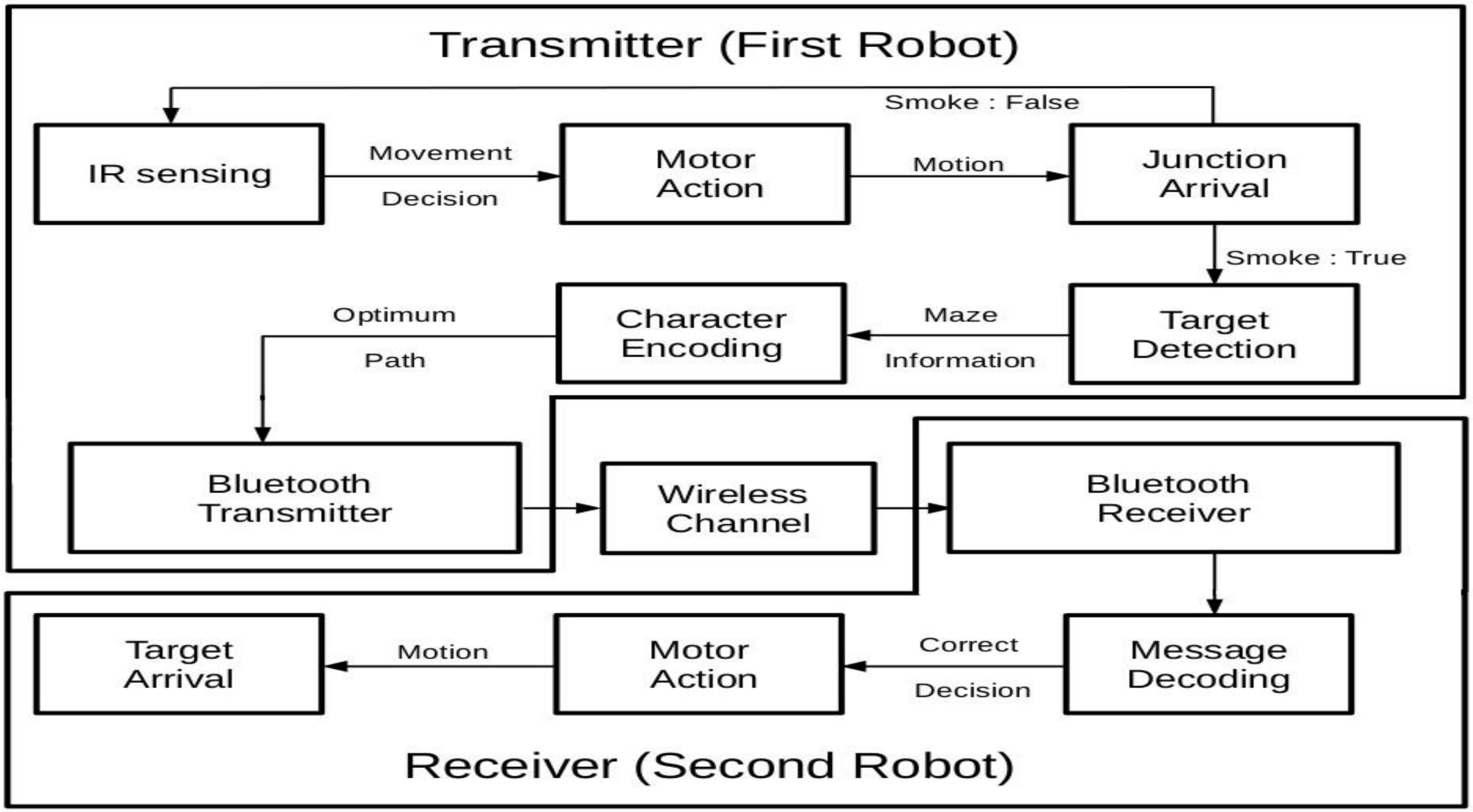
- Traverses the whole maze from start to finish implementing the **Left Wall Following Algorithm**
- Relays maze mapping information

<u>Second Robot</u>

- Traverse in shortest possible path



METHODOLOGY
Functional Block Diagram



METHODOLOGY
Functional Overview-First Robot

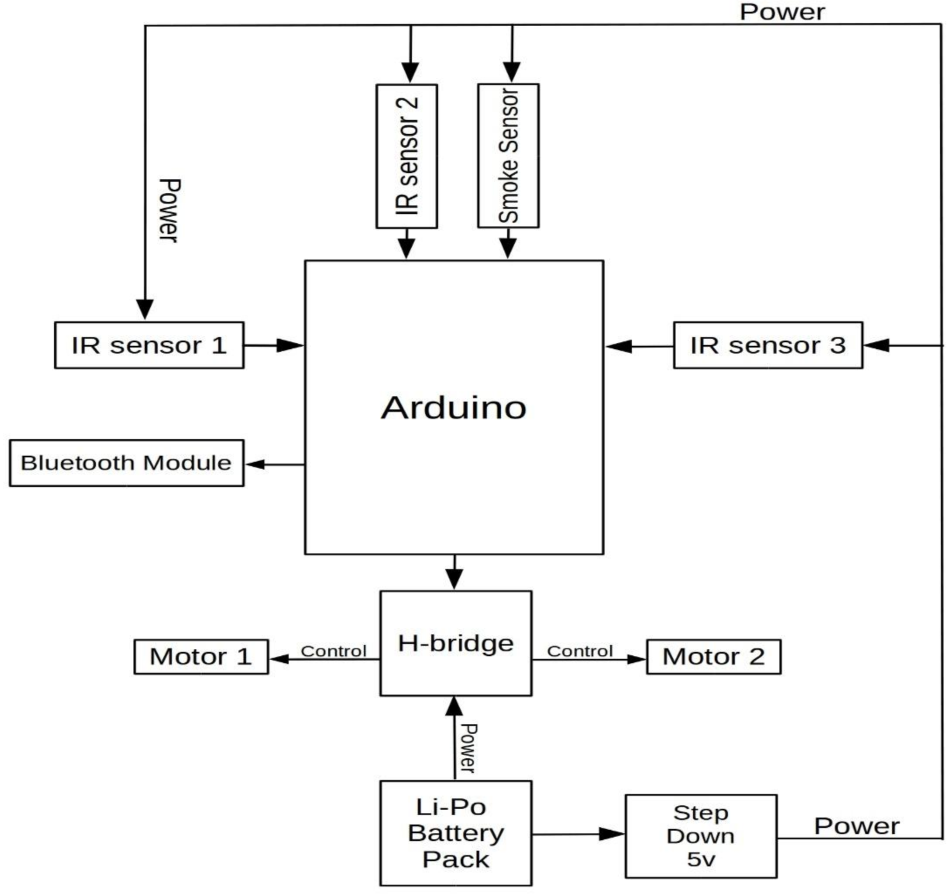
- The **first robot** traverses the entire maze. (non-optimal path)
  - Implementing left wall following algorithm.
- Detects the target.
- Sends the optimized path to the second robot.

METHODOLOGY
Functional Overview-Second Robot

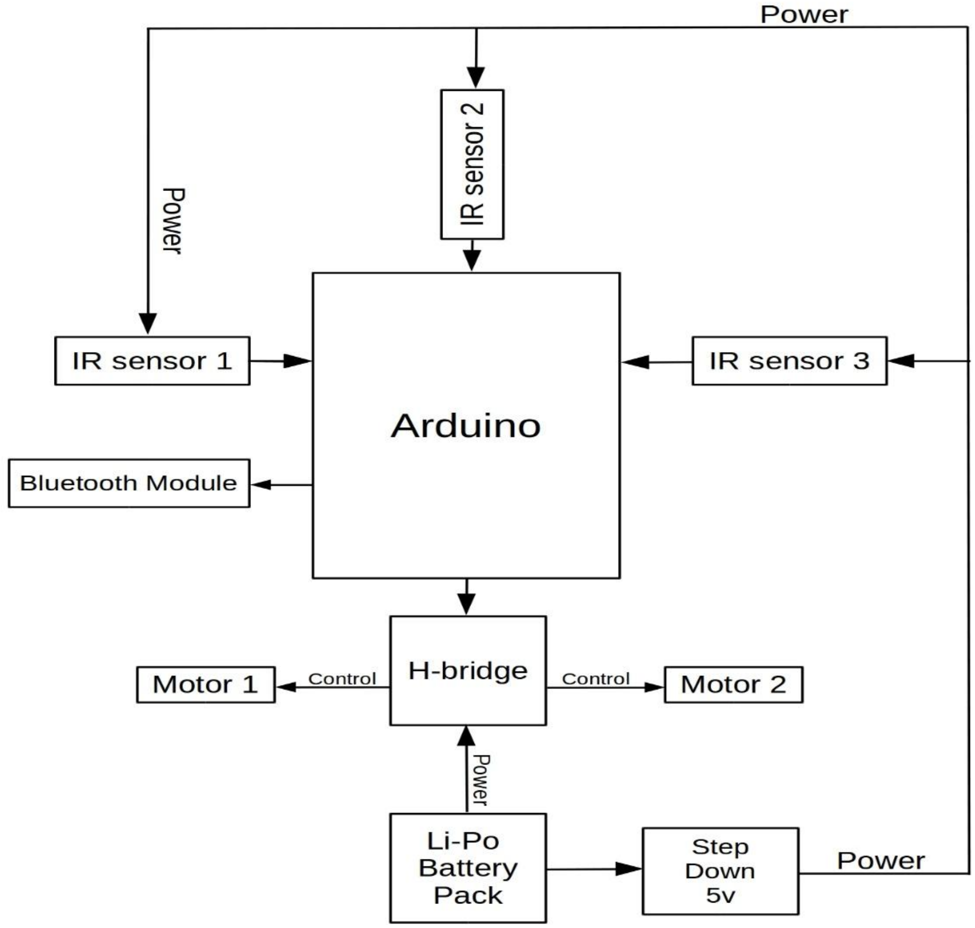
- The second robot receives the optimized path from the first robot.

- Traverses the maze in the shortest path possible.

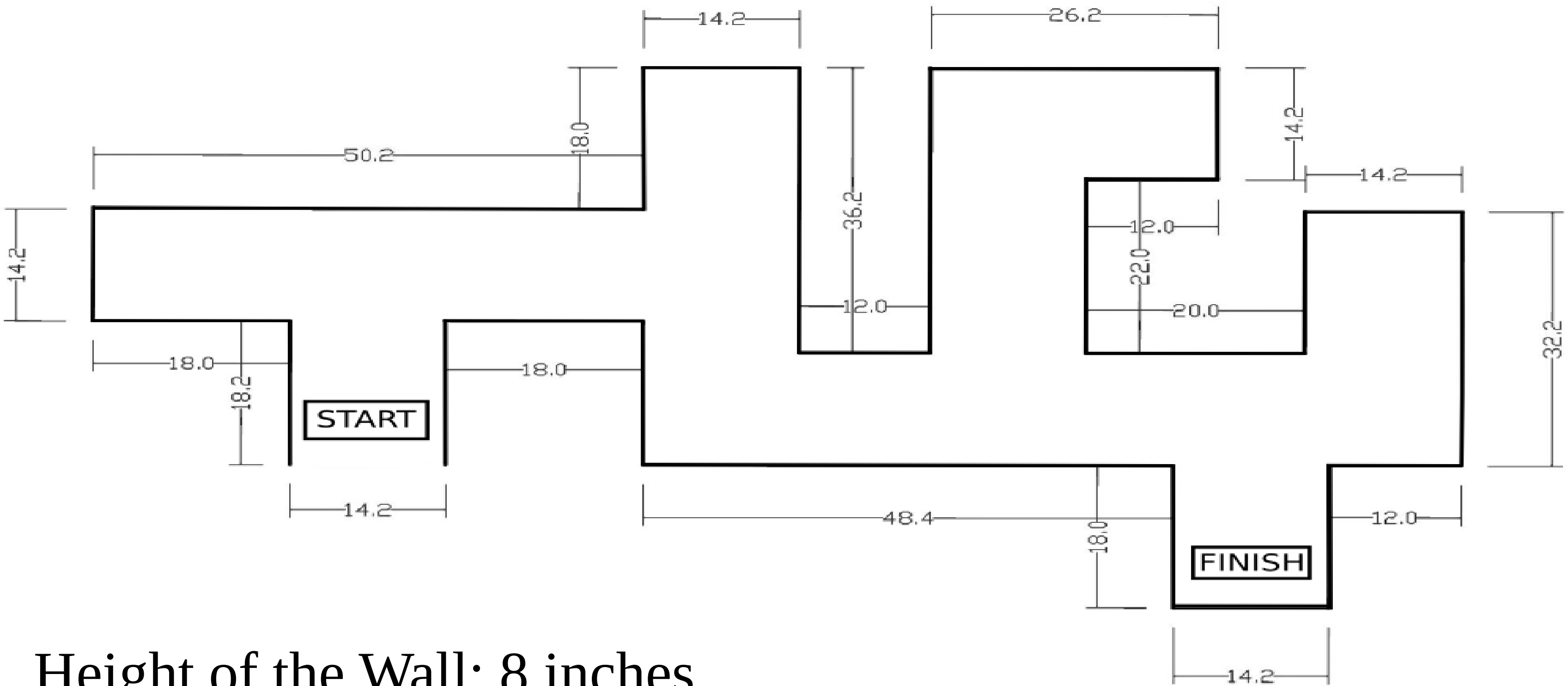
METHODOLOGY
First Robot Schematic



METHODOLOGY
Second Robot Schematic



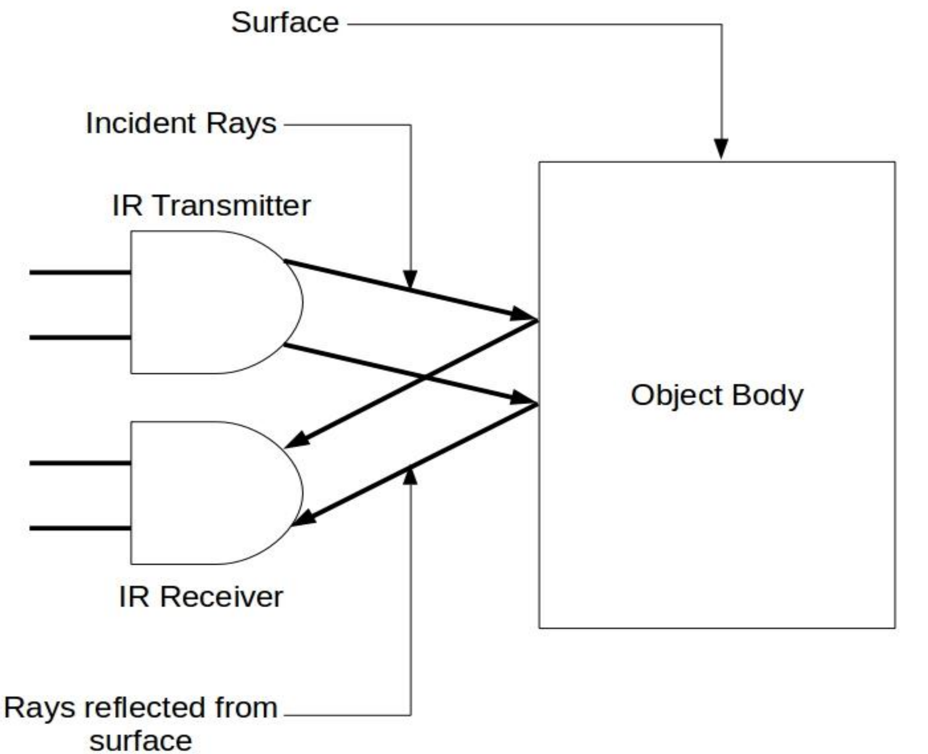
METHODOLOGY
Structure of The Maze



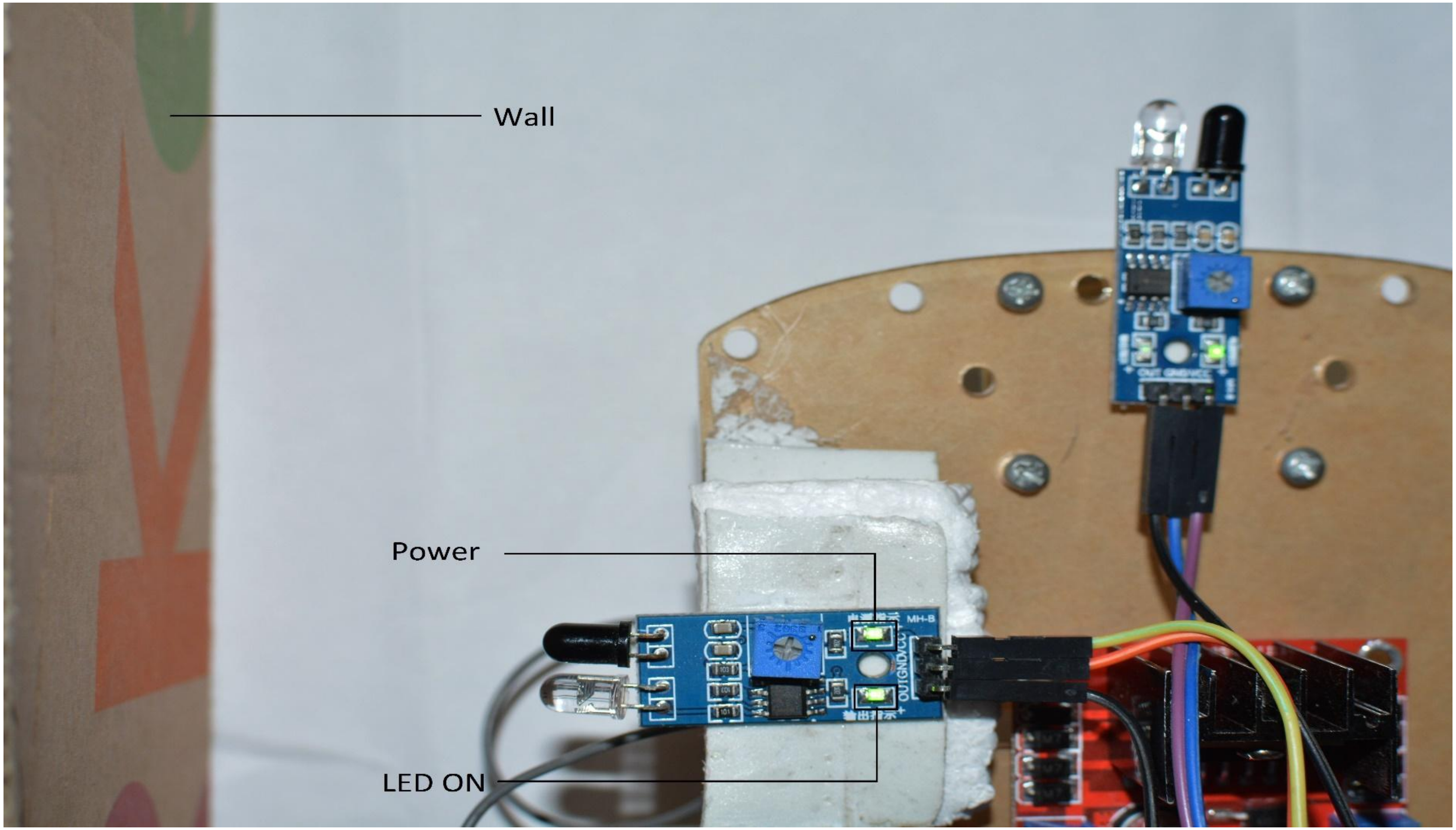
Height of the Wall: 8 inches

METHODOLOGY
Obstacle Detection

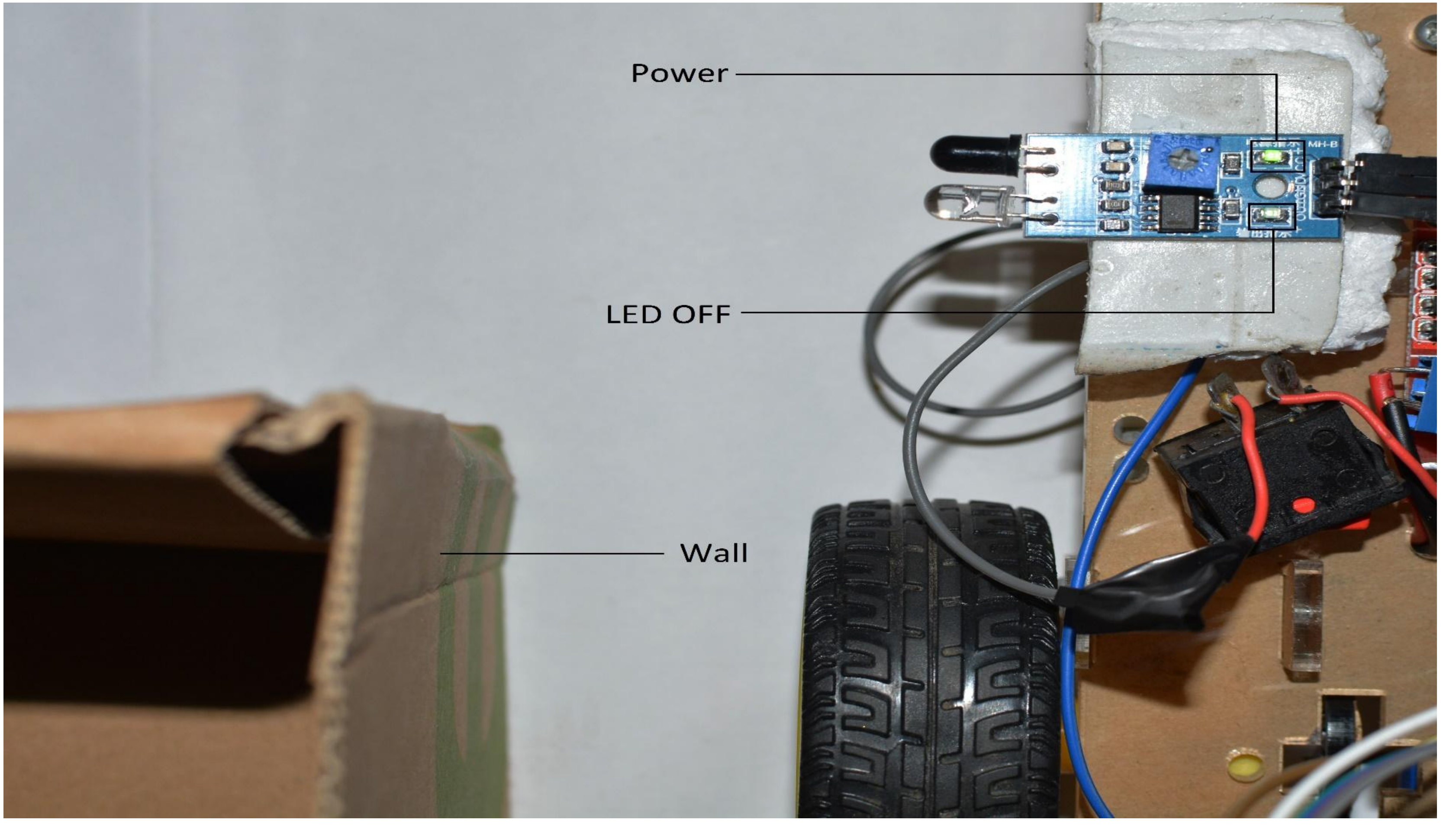
- Detection Carried Out Through IR Sensors **FC-51**
  - IR Transmitter
  - IR Receiver



METHODOLOGY
Obstacle Detection-Left Wall



METHODOLOGY
Obstacle Detection-Left Wall



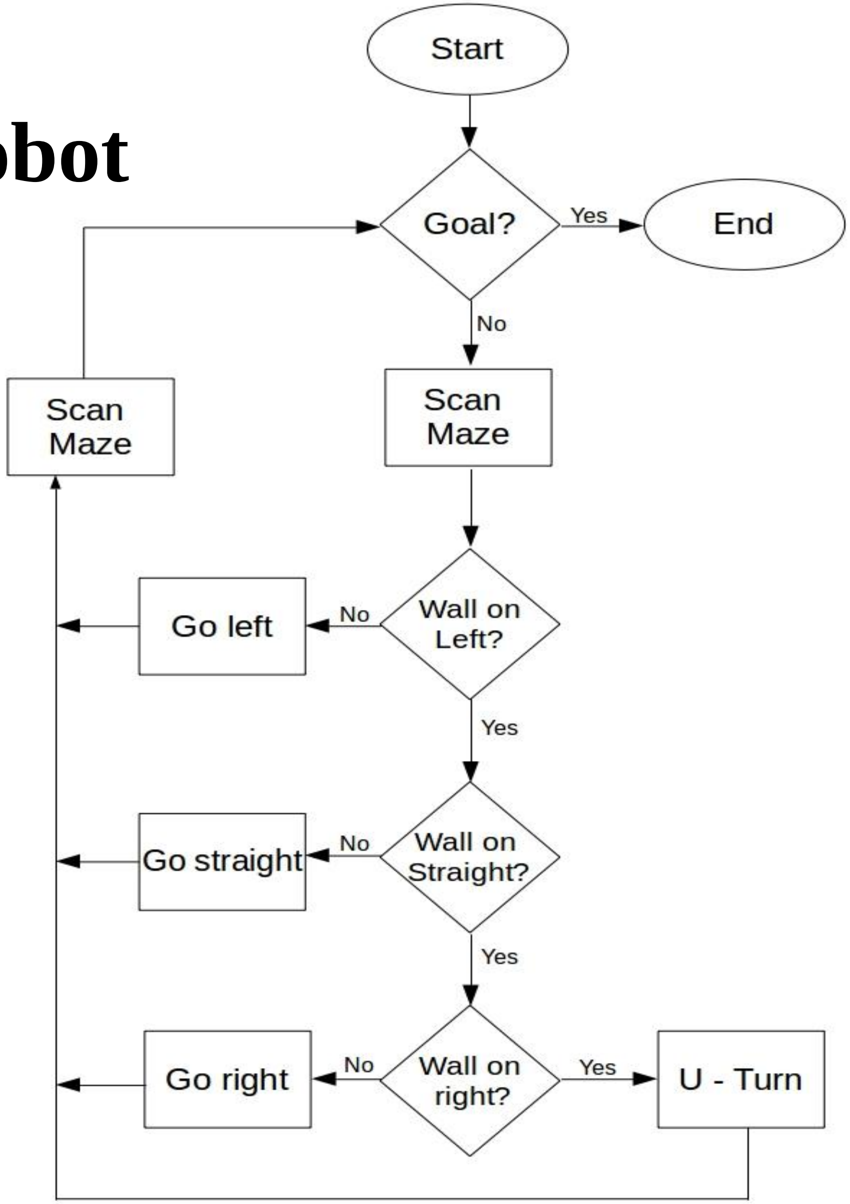
METHODOLOGY
Maze Traversal-First Robot

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

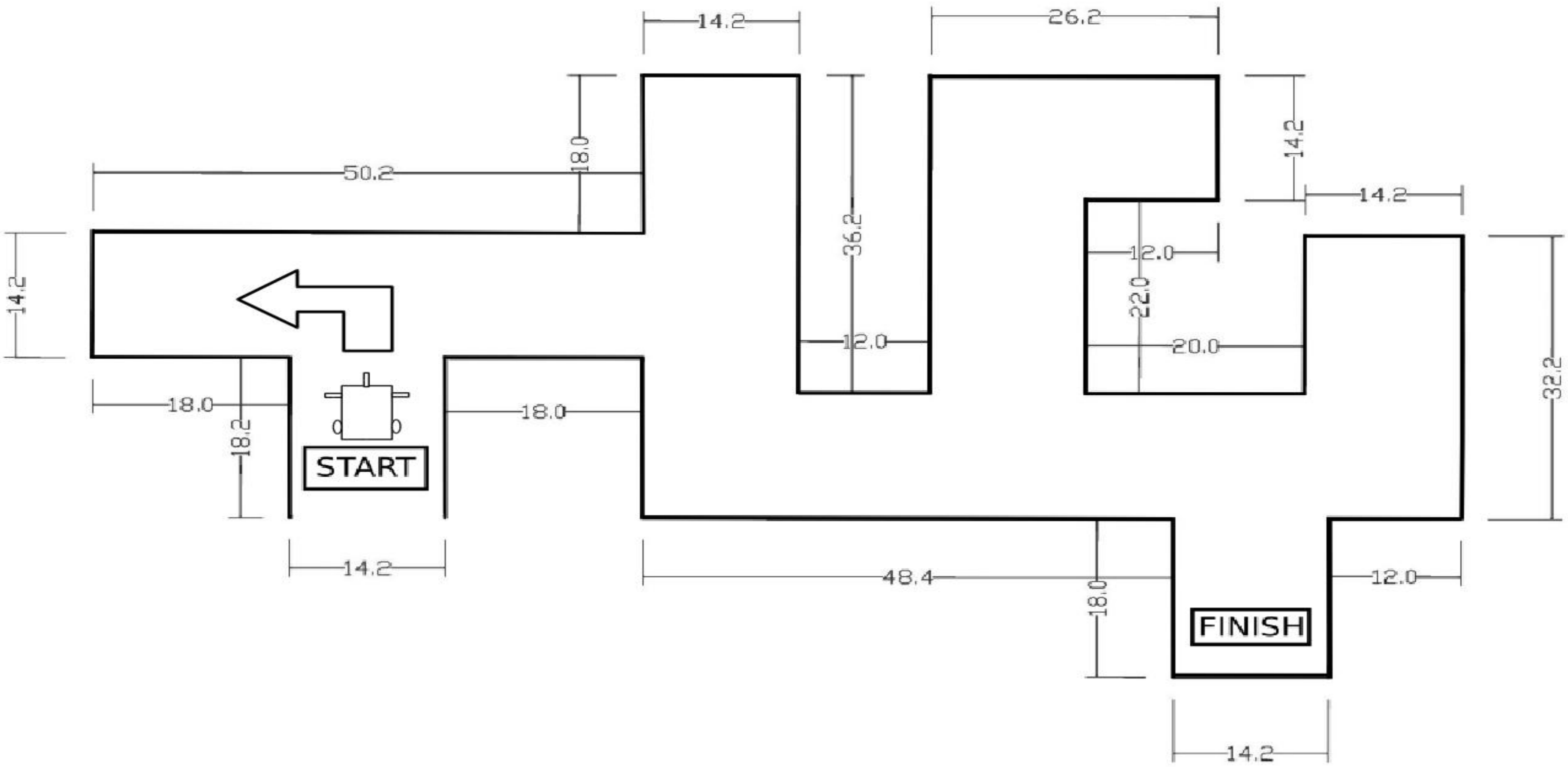
Priorities	Direction
1	Left
2	Straight
3	Right
4	U-Turn

METHODOLOGY
Maze Traversal-First Robot

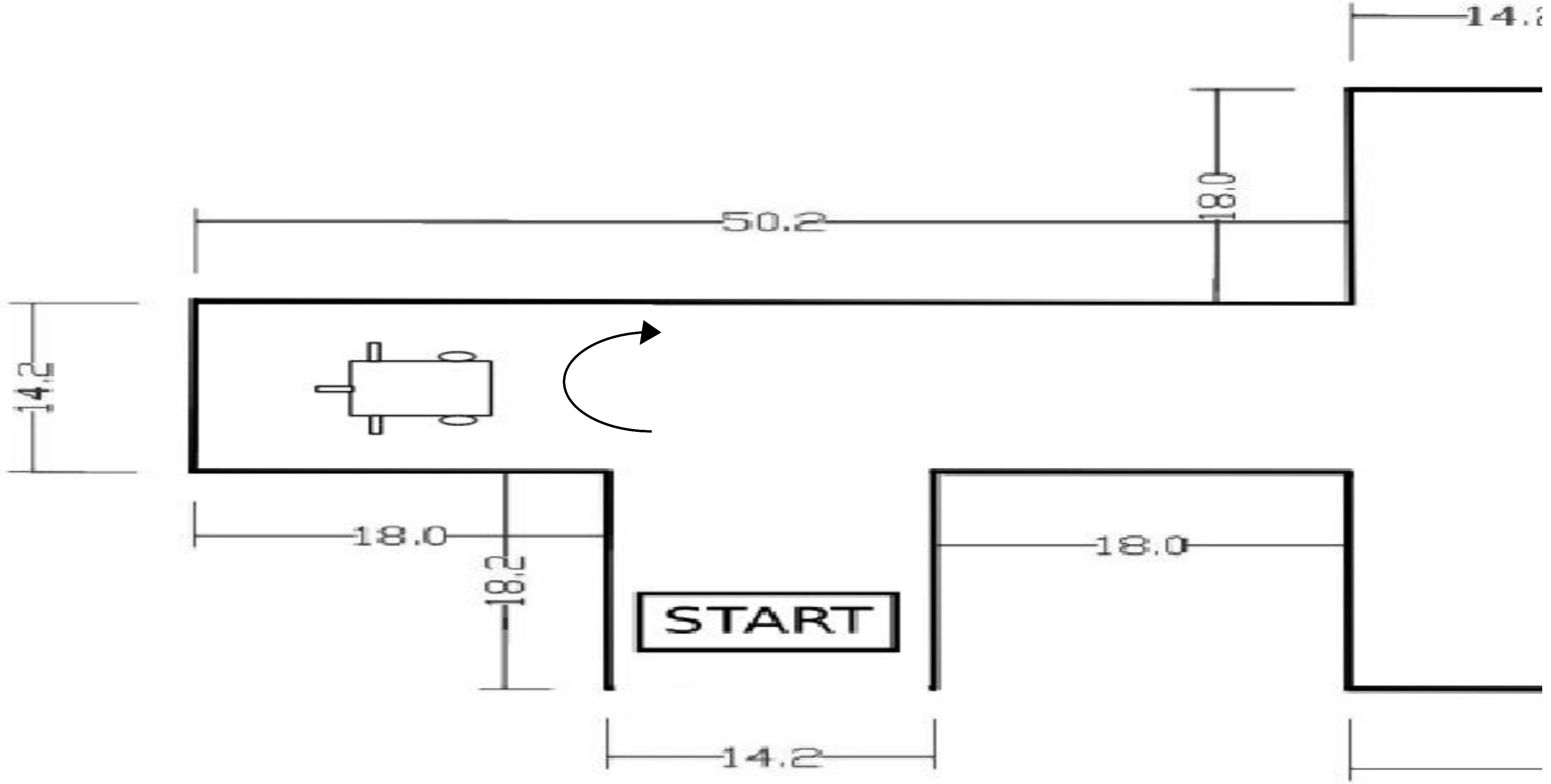
Algorithm



METHODOLOGY
Maze Traversal-First Robot



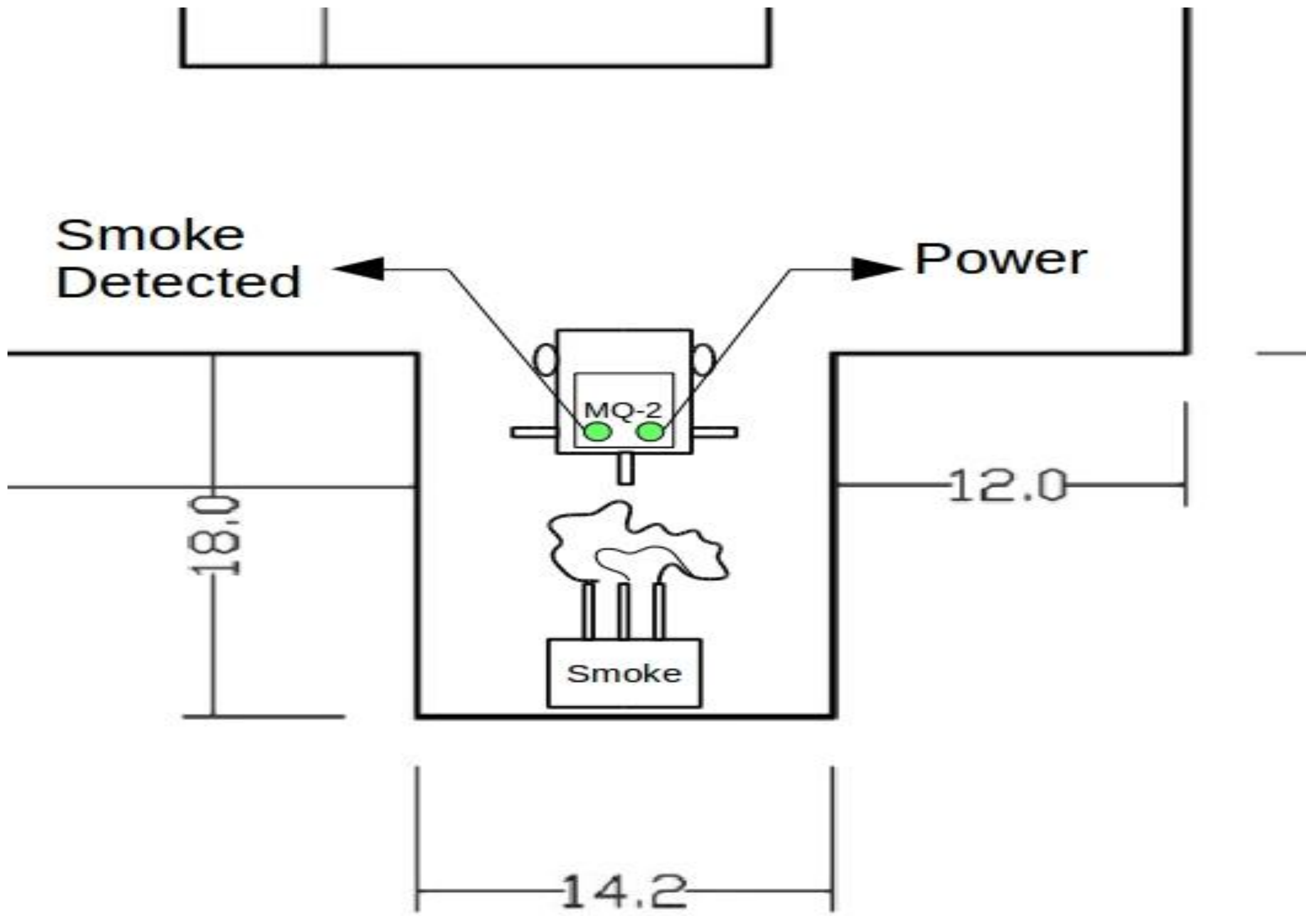
METHODOLOGY
Maze Traversal-First Robot



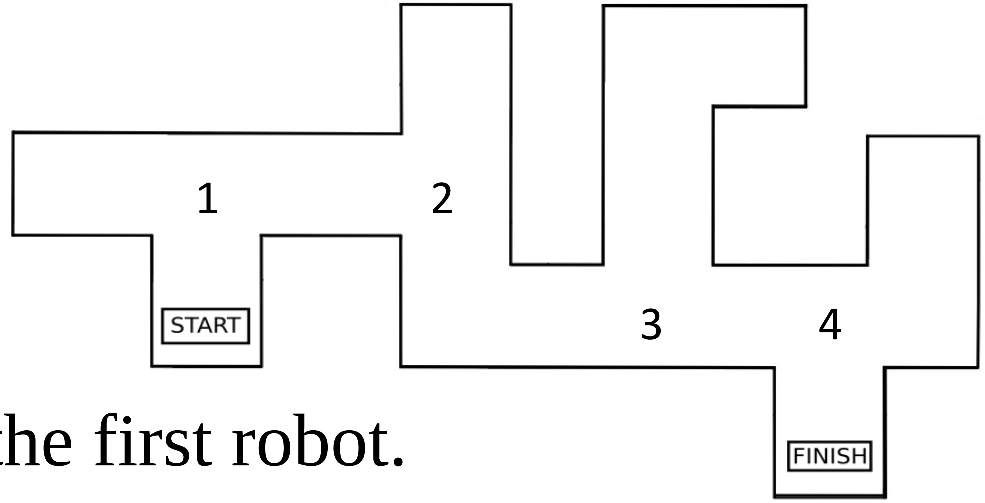
METHODOLOGY
Target Detection

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

METHODOLOGY
Target Detection



METHODOLOGY
Path Deduction

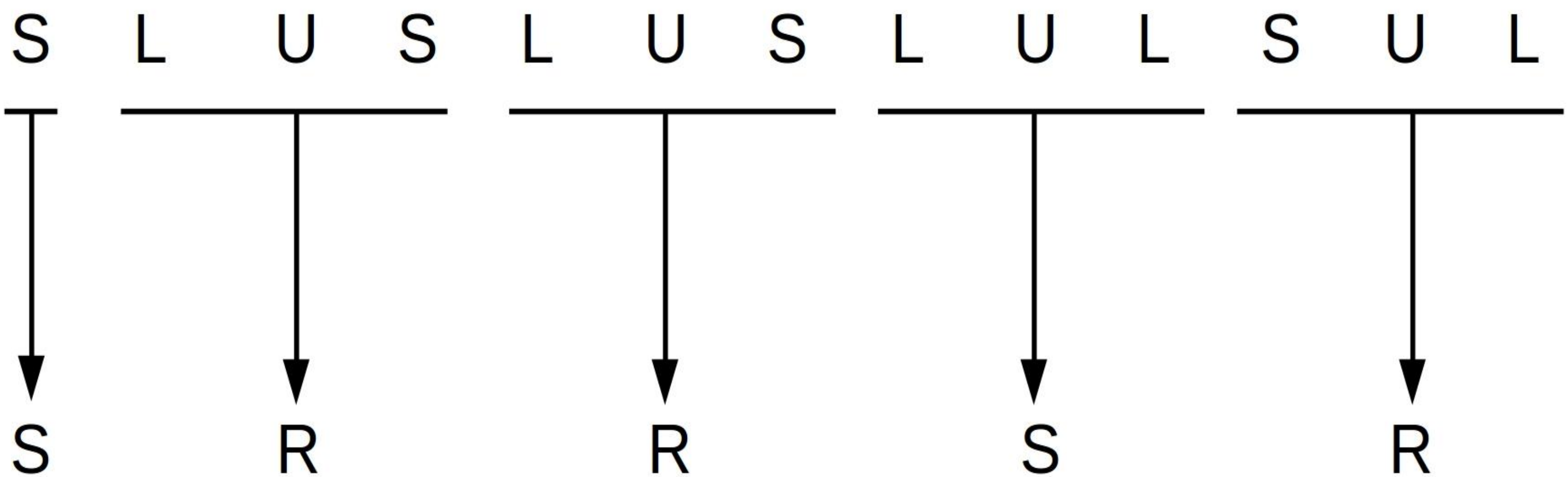


The path followed by the first robot.

S	**L**	**U**	**S**	**L**	**U**	**S**	**L**	**U**	**L**	**S**	**U**	**L**

METHODOLOGY
Path Deduction

- The optimal decisions required for shortest path.



METHODOLOGY
Path Deduction

- The 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

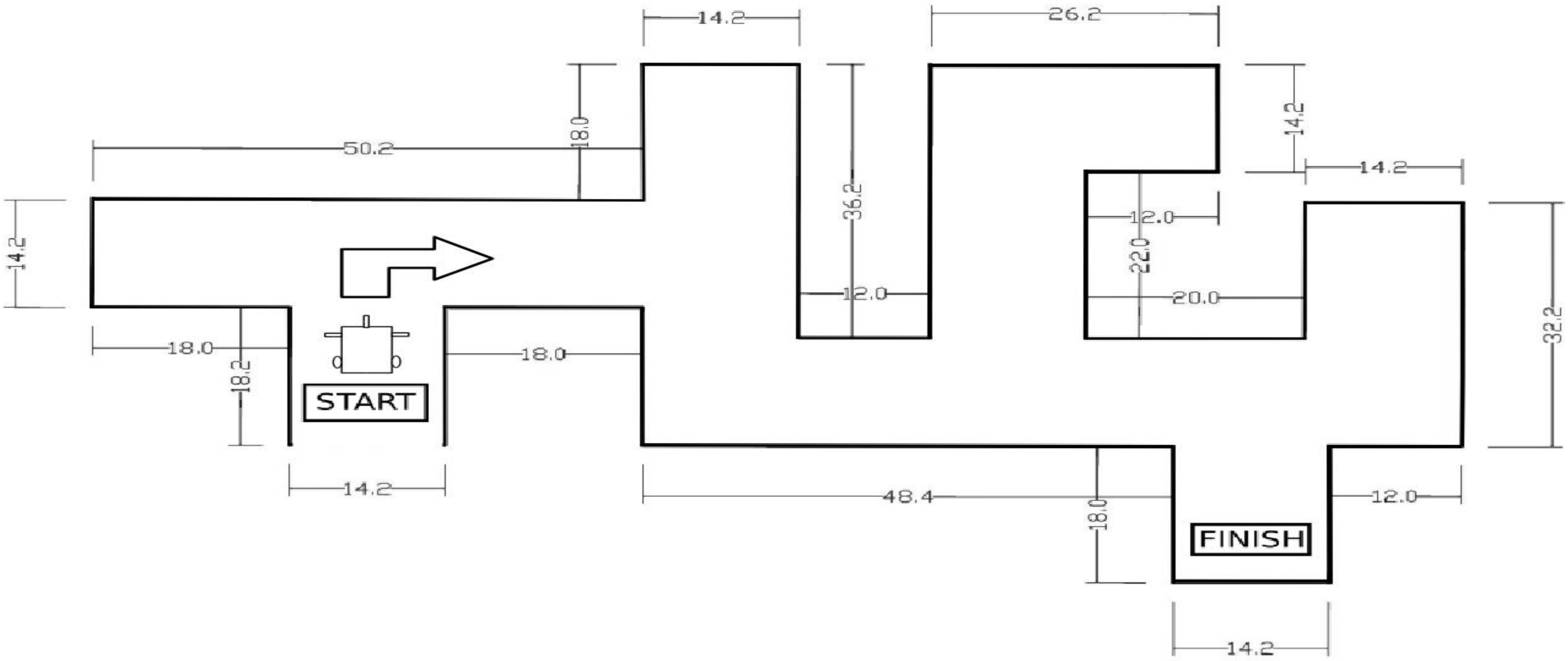
- Asynchronous Connectionless Packet's Payload i.e. only data is sent to the second robot.

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

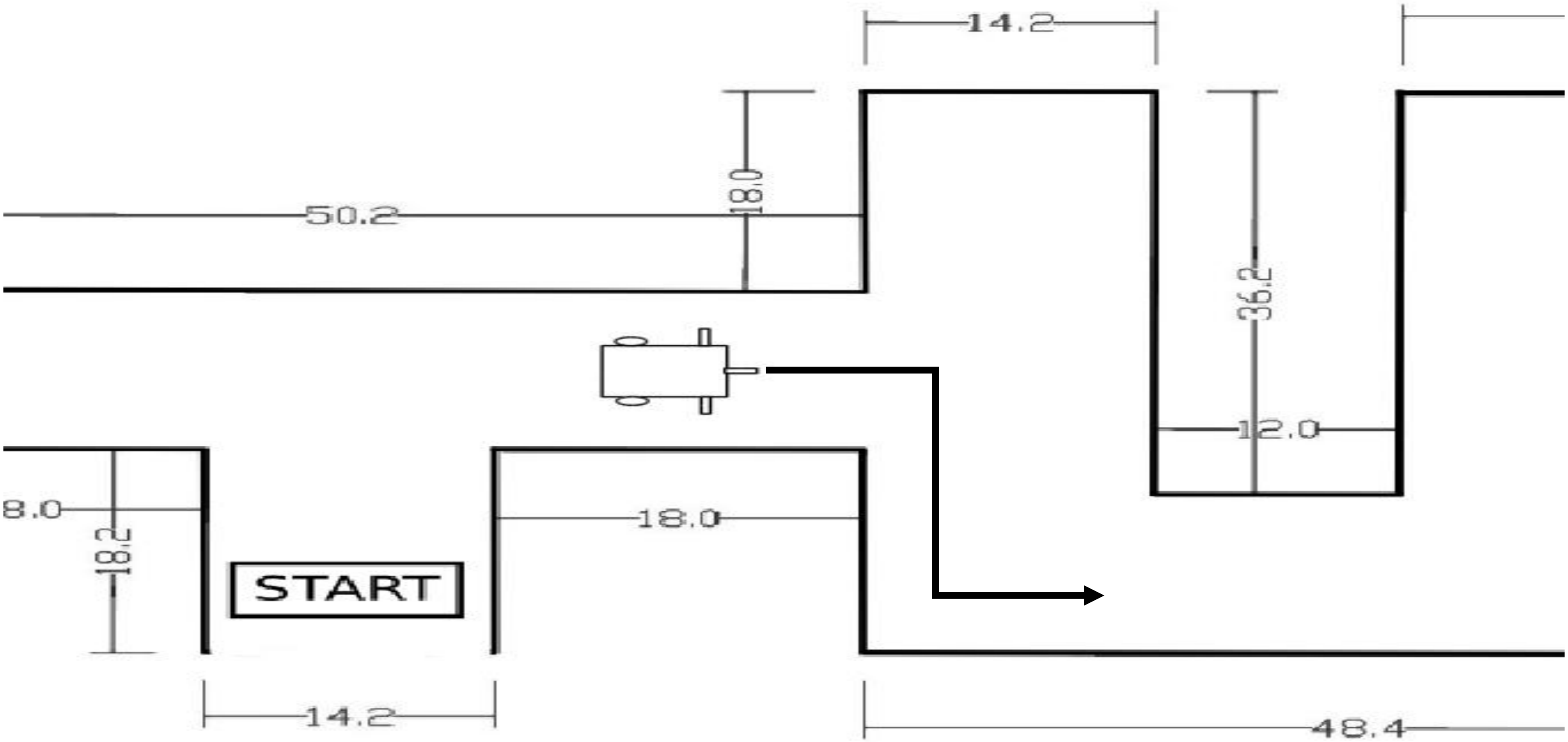
S	**R**	**R**	**S**	**R**	**U**

METHODOLOGY
Optimal Path Traversal

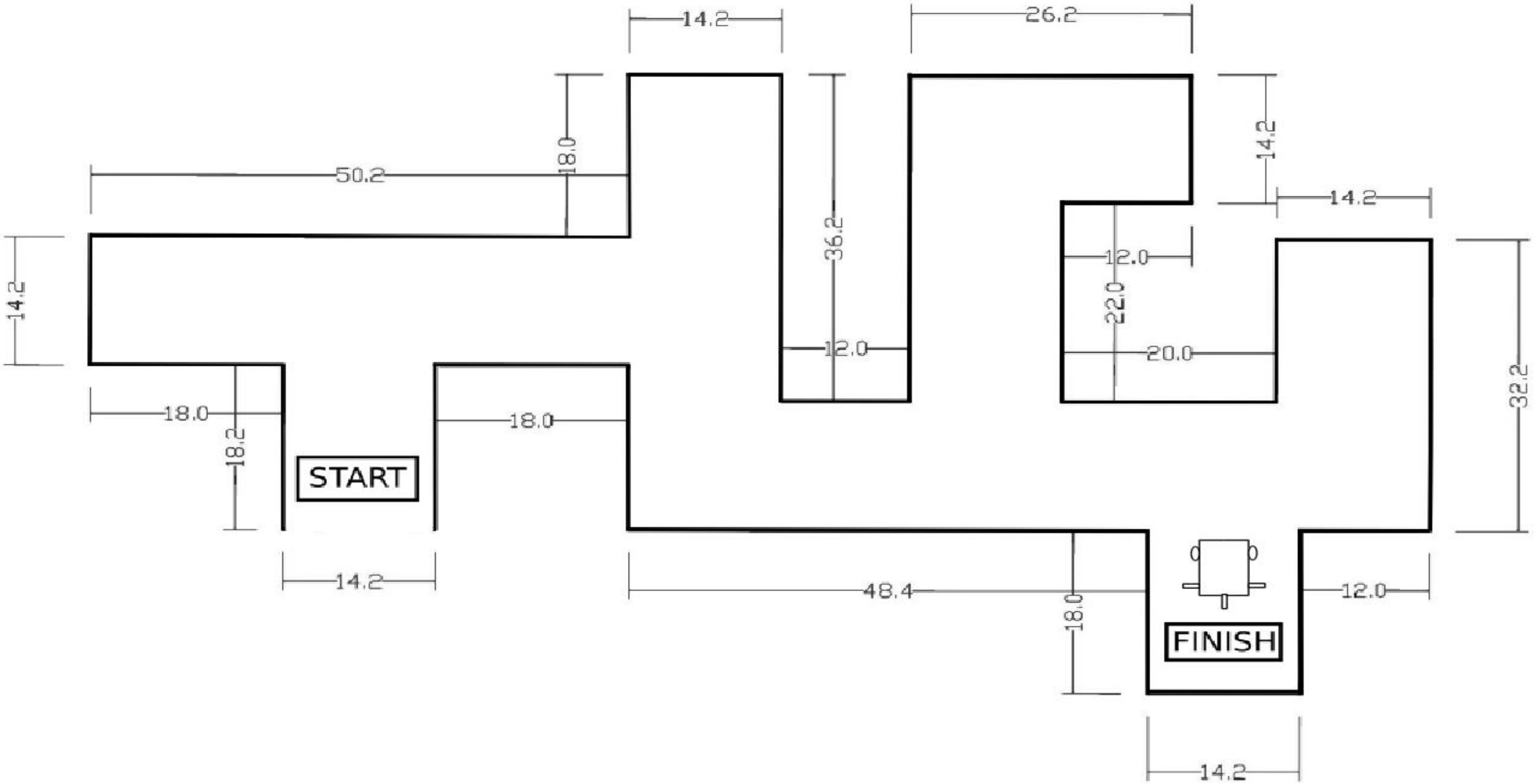
Upon receiving the optimal path, the second robot traverses the maze avoiding wrong turns



METHODOLOGY
Optimal Path Traversal

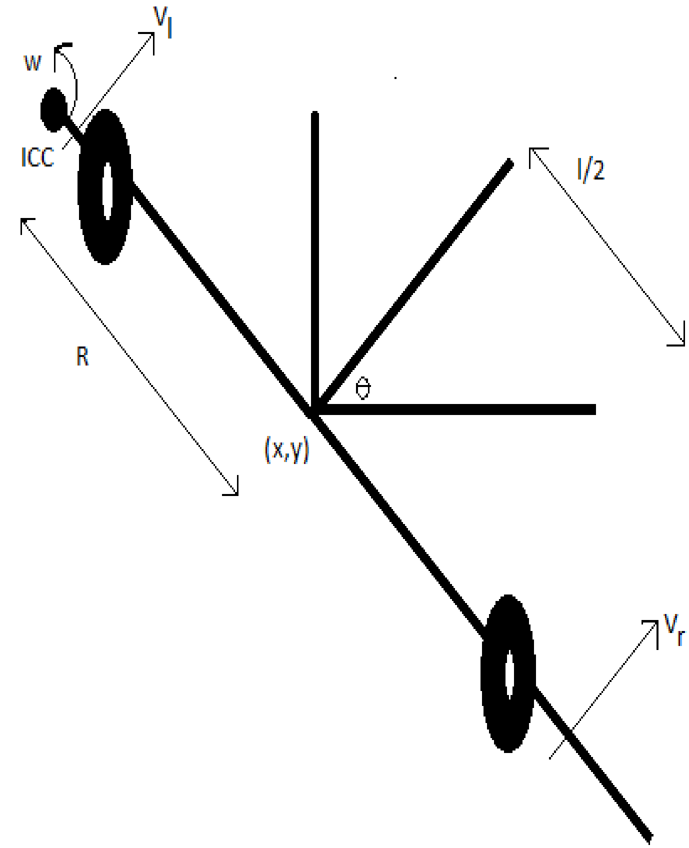


METHODOLOGY
Optimal Path Traversal



METHODOLOGY
Differential Kinematics

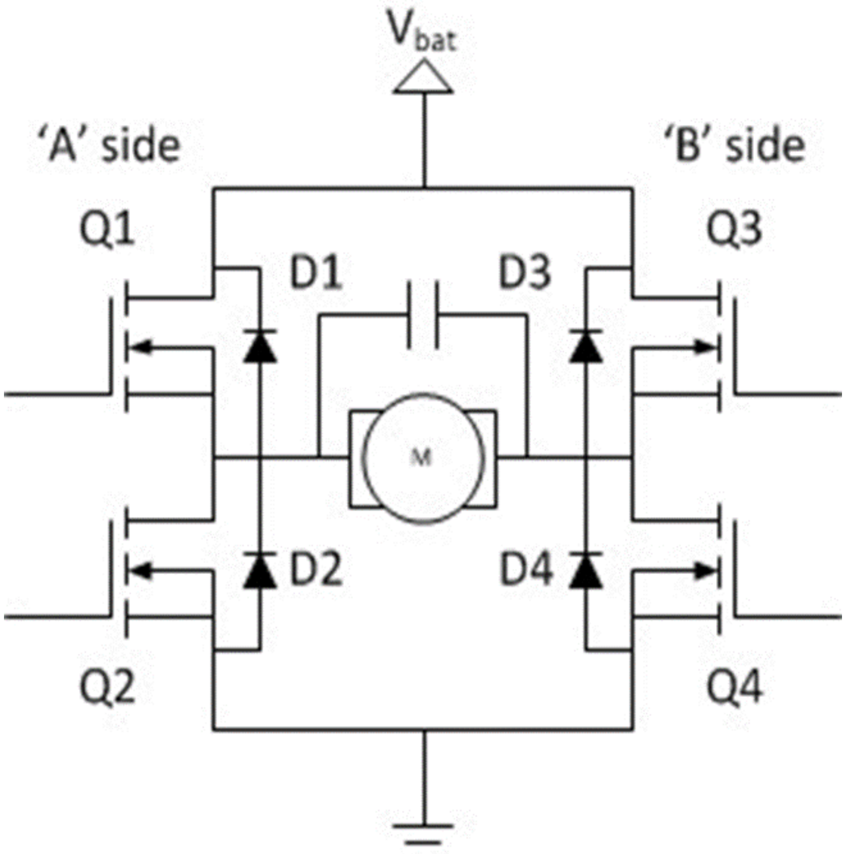
- Consists of 2 drive wheels
- Has high degree of freedom i.e. 3



METHODOLOGY
H-Bridge L298N

- Used to interface motor with 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

METHODOLOGY
H-Bridge L298N

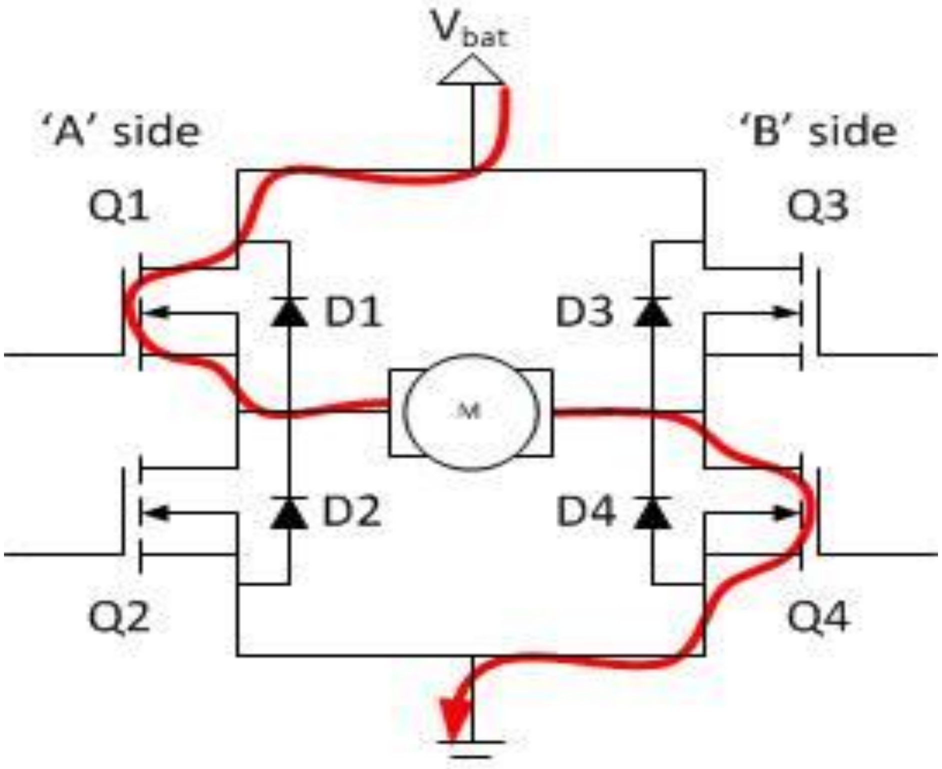


Figure : Motor moves in forward direction.

METHODOLOGY
H-Bridge L298N

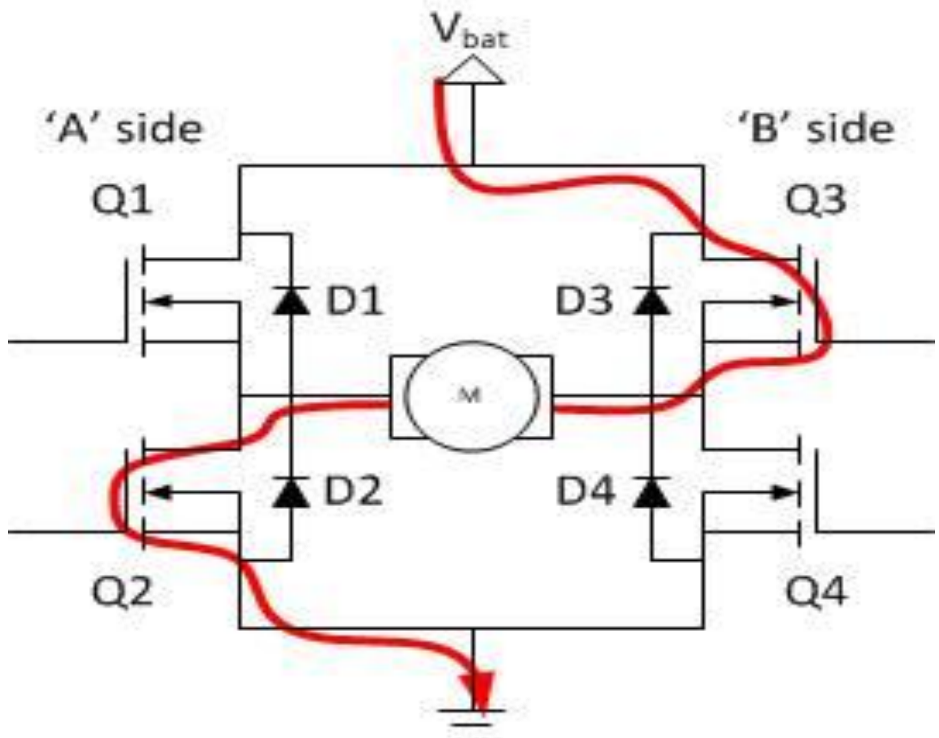


Figure : Motor moves in reverse direction.

METHODOLOGY
H-Bridge L298N

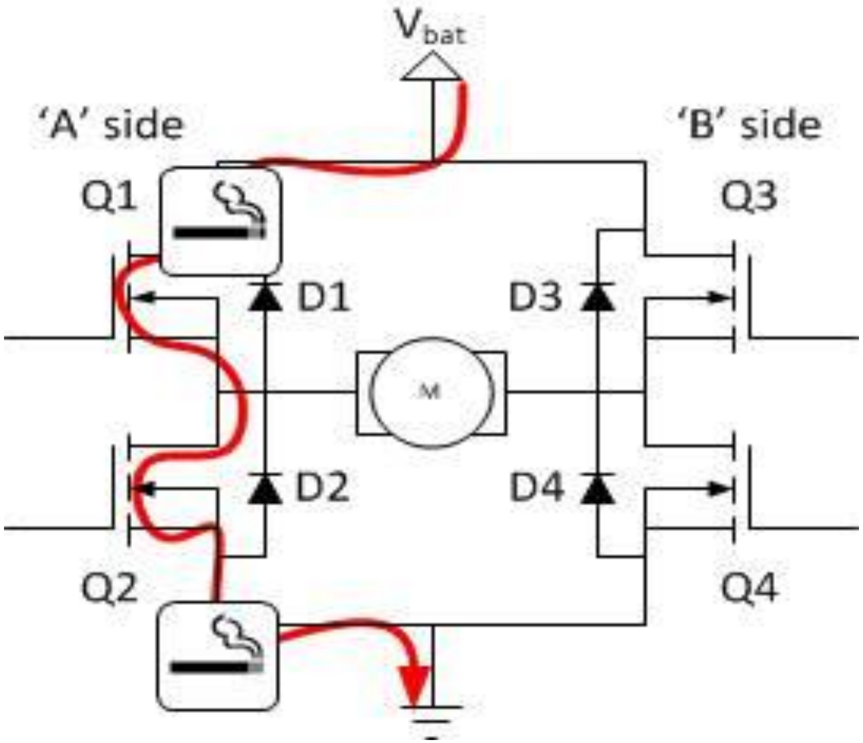
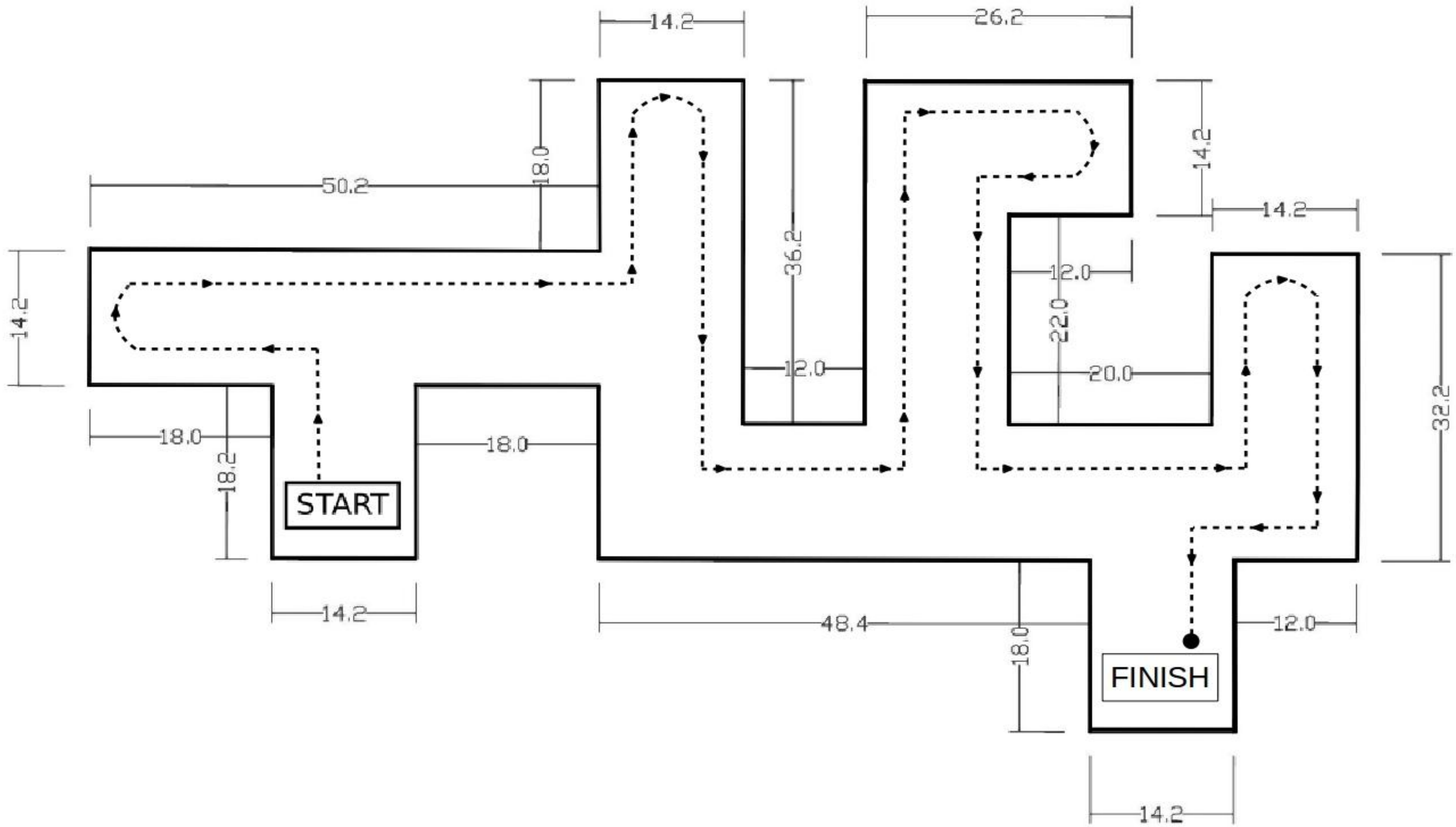
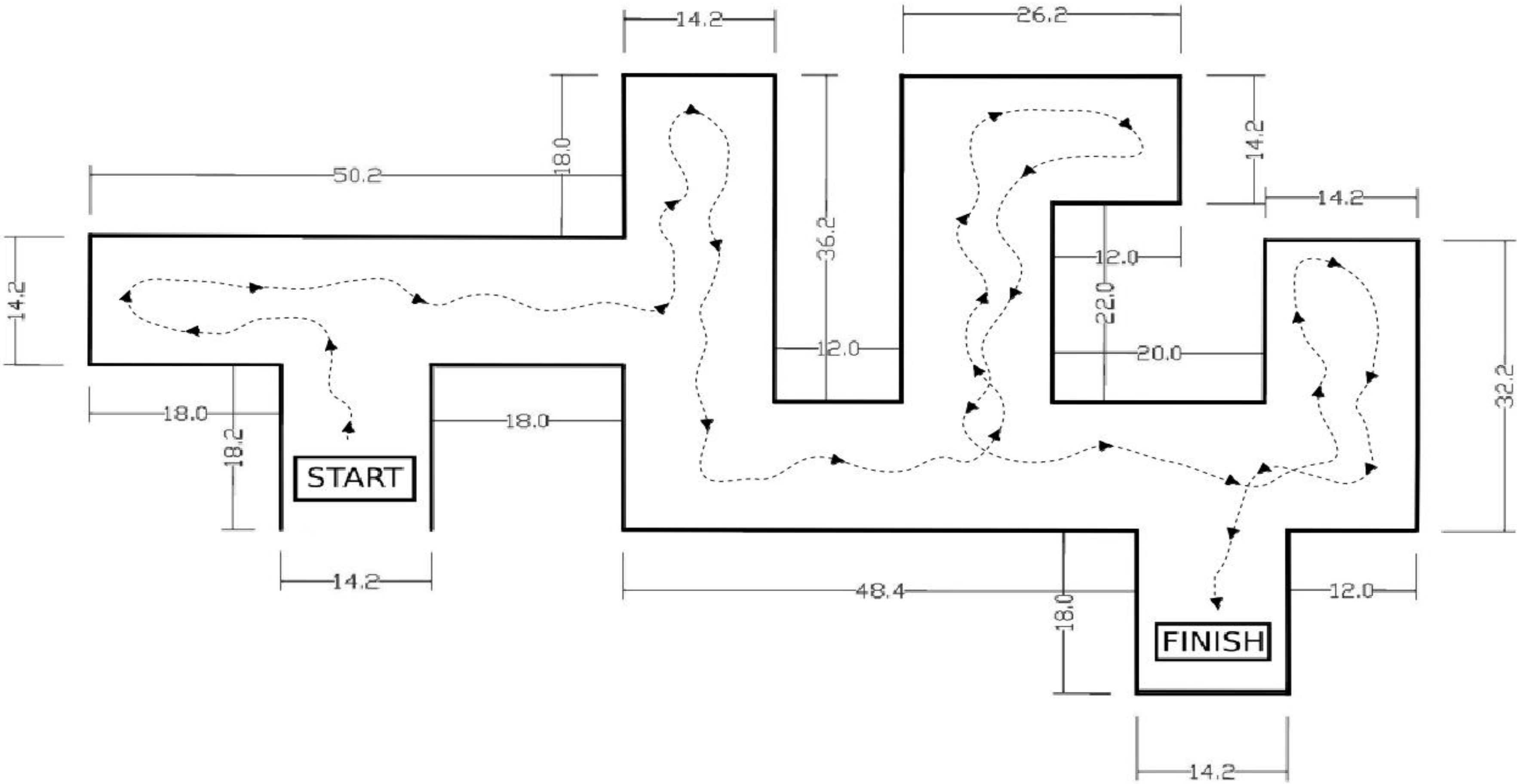


Figure : Motor stops due to Short Circuit

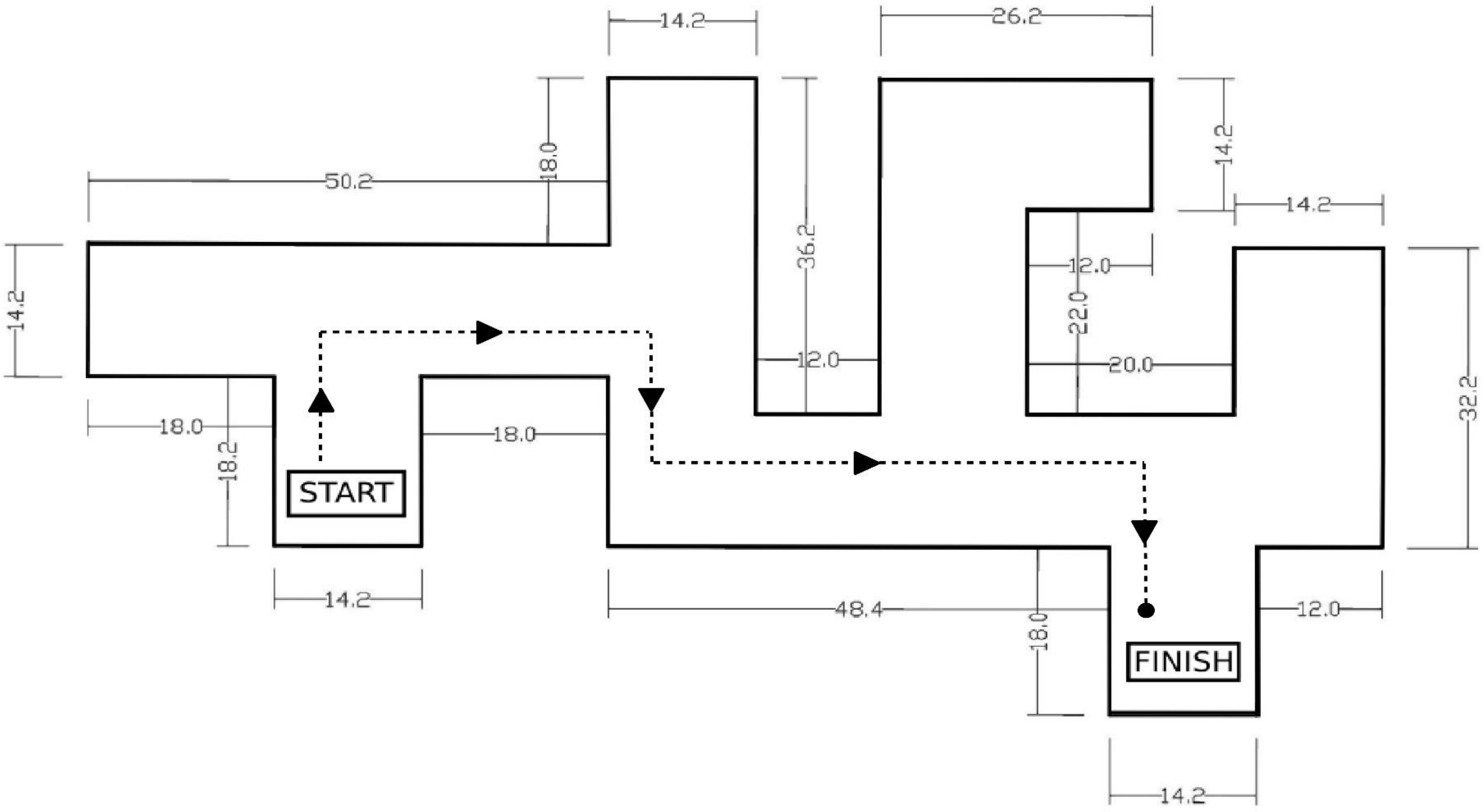
RESULTS
Path Traversed-First Robot(Expected)



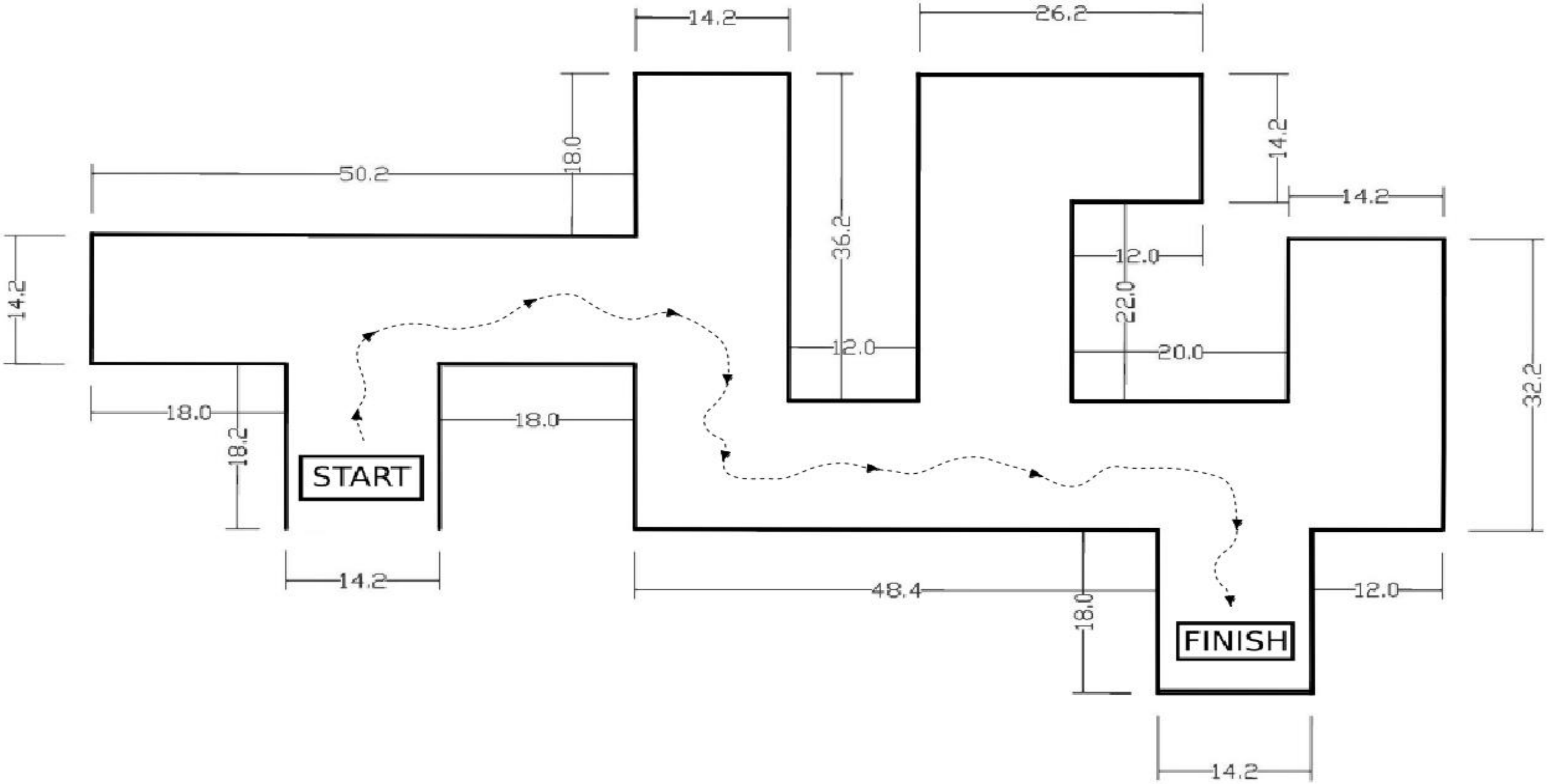
RESULTS
Path Traversed-First Robot(Obtained)



RESULTS
Path Traversed-Second Robot (Expected)



RESULTS
Path Traversed-Second Robot (Obtained)



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

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THANK YOU