Ad-Hoc Communication Network for Disaster Relief

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SIGHT
Your autonomy partner

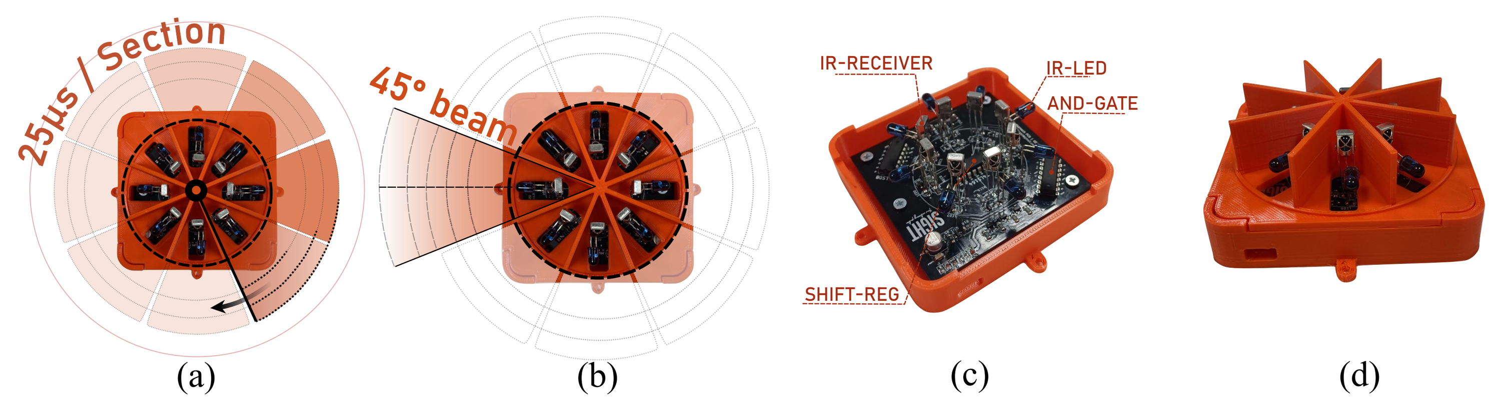


Figure 1: Communication Unit: (a) Search Methodology, (b) Transmission Methodology, (c) Component Names, and (d) Front View of Overall Hardware

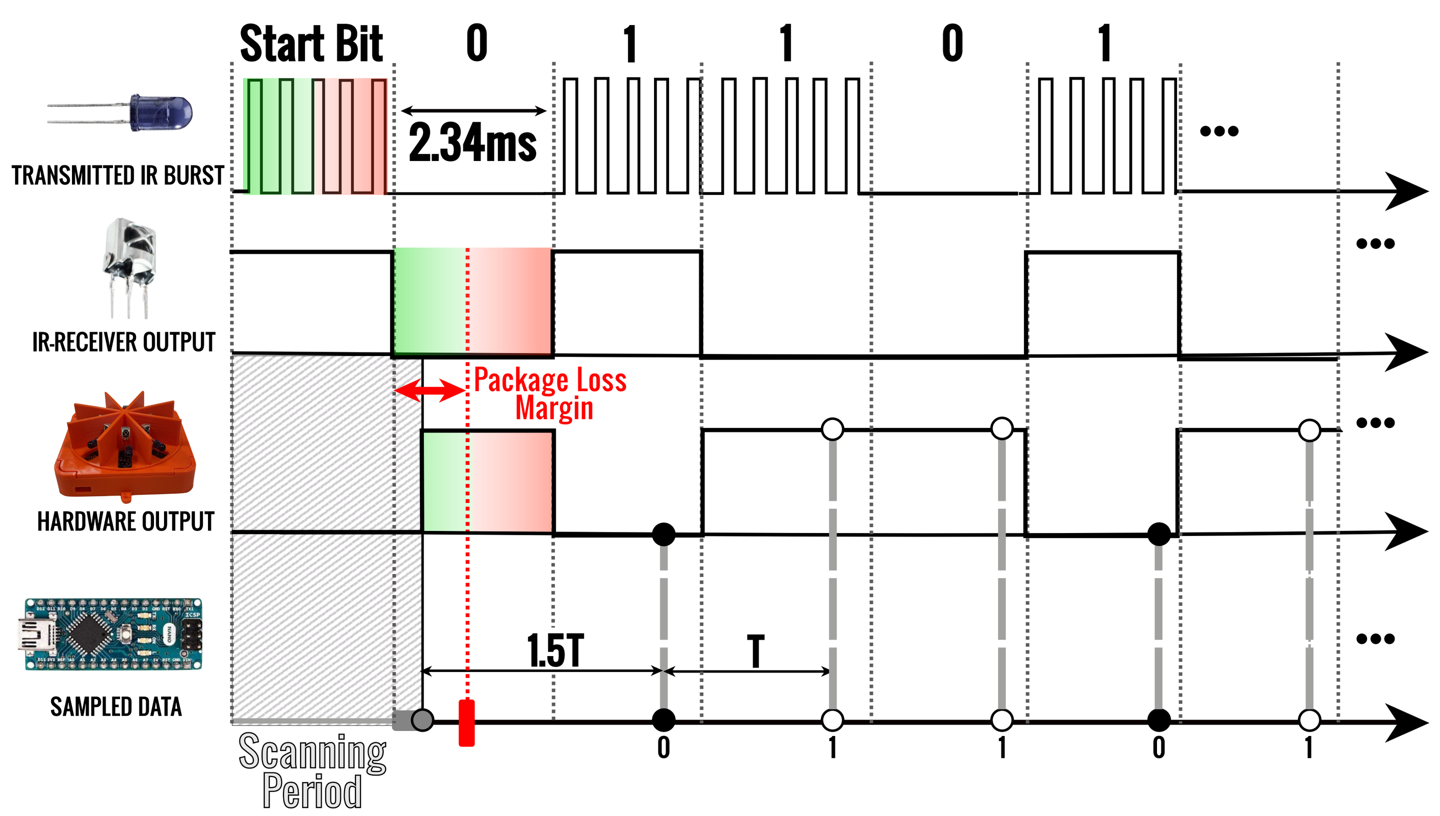


Figure 2: Timing Diagram of IR Communication: Showing Transmitted IR Burst, IR Receiver Output, Hardware Output, and Sampled Data When only one of the receivers is triggered

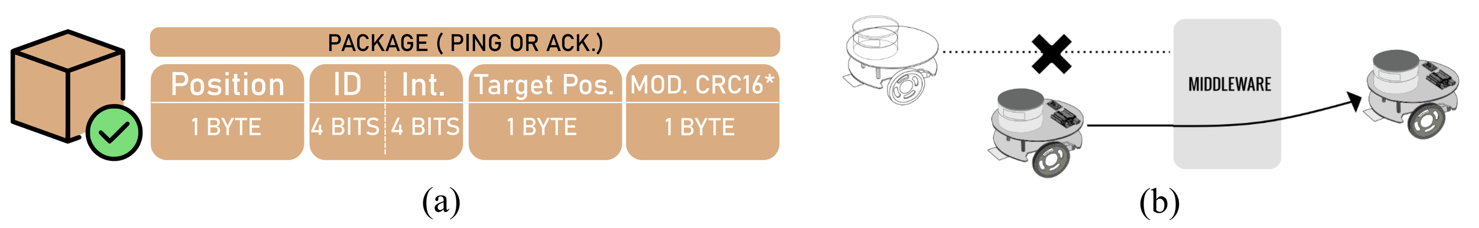


Figure 3: (a) Packet Structure and (b) Middleware Interaction in Communication System

Communcation Hardware

The controller circuit manages eight receivers and eight transmitters, totaling sixteen devices, using an 8-Bit Serial-In-Parallel-Out Shift Register (74LS164). By setting only one register output high, a single receiver-transmitter pair is activated. When a transmit signal is applied, the activated LED transmits, while the receive signal is controlled by the selected receiver. The circuit's electrical implementation, rather than a mechanical one, allows for rapid receiver selection, enabling the system to check each receiver up to 5000 times per second. This high-speed operation ensures reliable detection of incoming signals from any direction, maintaining a safe package loss margin.

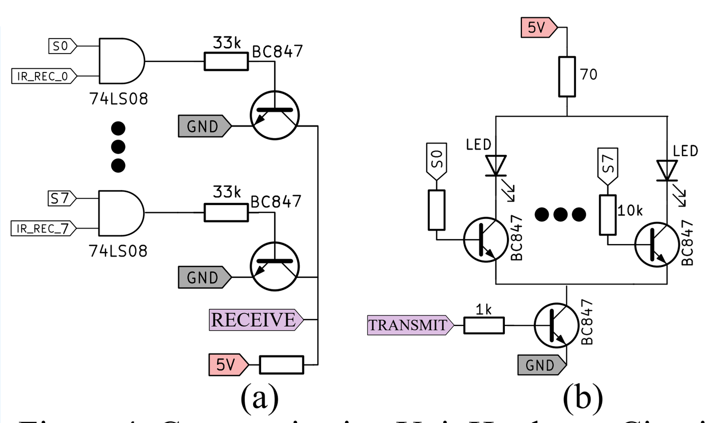
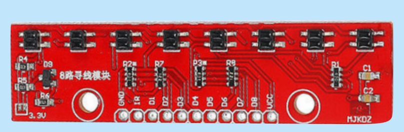


Figure 4: Communication Unit Hardware Circuit Diagram for (a) Receiver Selection and (b) Transmitter Control Using Shift Register Outputs

Line Sensor

The working principle of a line follower sensor depends on the detection of the reflected light.Dark surfaces reflect less infrared light than light surfaces, allowing the sensor to distinguish between lines and the background based on the varying reflectivity. The feedback taken from this reflectance data is utilized to orientate the robots to the direction of that is desired.

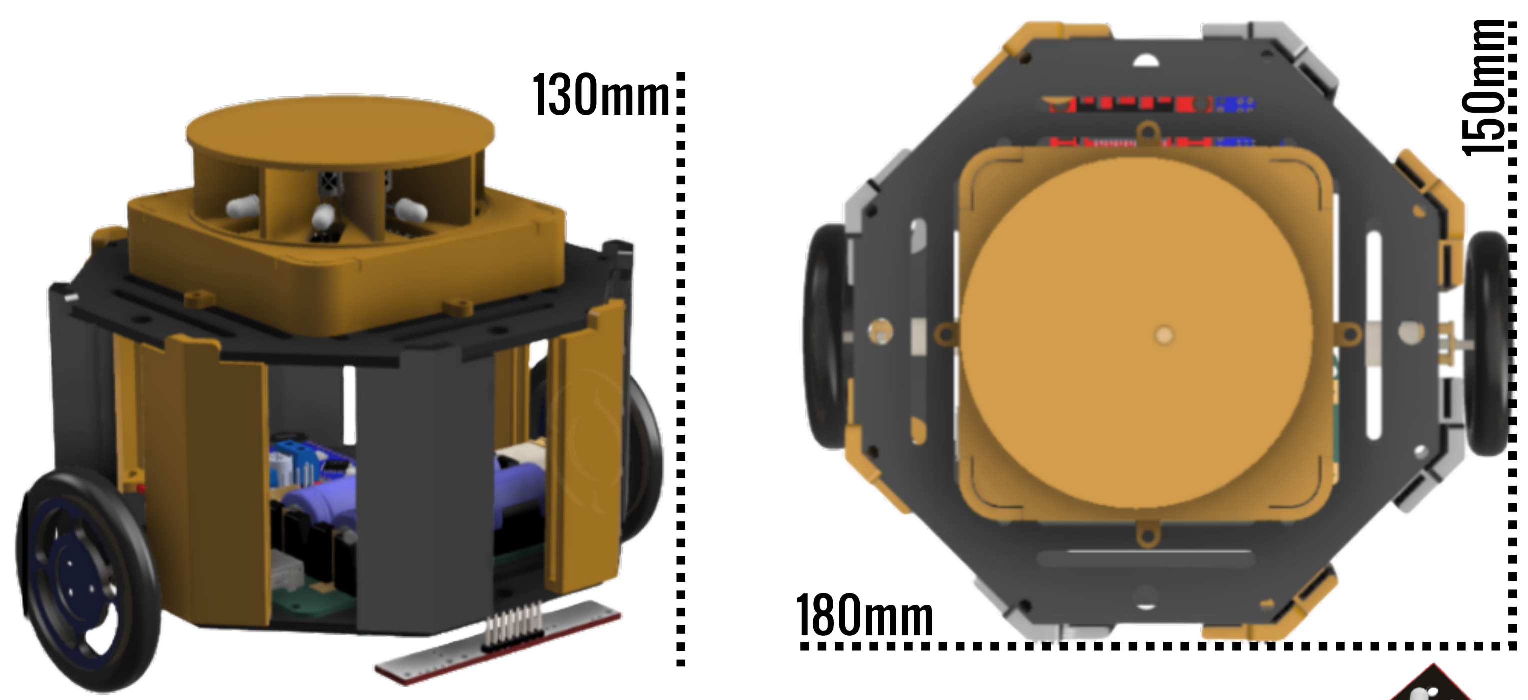


RFID Reader

Each RFID tag incorporates an integrated circuit, storing data and a unique identification number (UID). This facilitates the ability to write the location and presence of the target information of each tile while a single RFID tag is placed in the center of each tile.

Project Description

The Ad-Hoc project is about designing a communication system for disaster scenarios. The system contains a base unit, 3 mobile units, a target, and a grid to conduct the search on. The main objective is to find the target and effectively communicate its location to the base unit. Eventually, all mobile units should be gathered around the target



Functional Requirements:

- Identifying Location and Target Presence
- Finding and Gathering Around the Target
- Route Planning
- Recognizing & Avoiding Obstacles
- Communicating with Other MUs and BU in IR frequency
- Reporting Target Location to the BU
- Collision Avoidance

Performance Requirements:

- Finding and Gathering Around the Target in 4 minutes.
- Having 80 cm Range of Communication
- Correct Corruption Analysis of the Communicated Data
- Operating for 1 hour on a Single Charge

Physical Requirements:

- 200cmx200cm Platform Size
- Grid with 9 x 9 square tiles
- Size of the Robot within a tile

Constraint

- $300 Budget Limitation

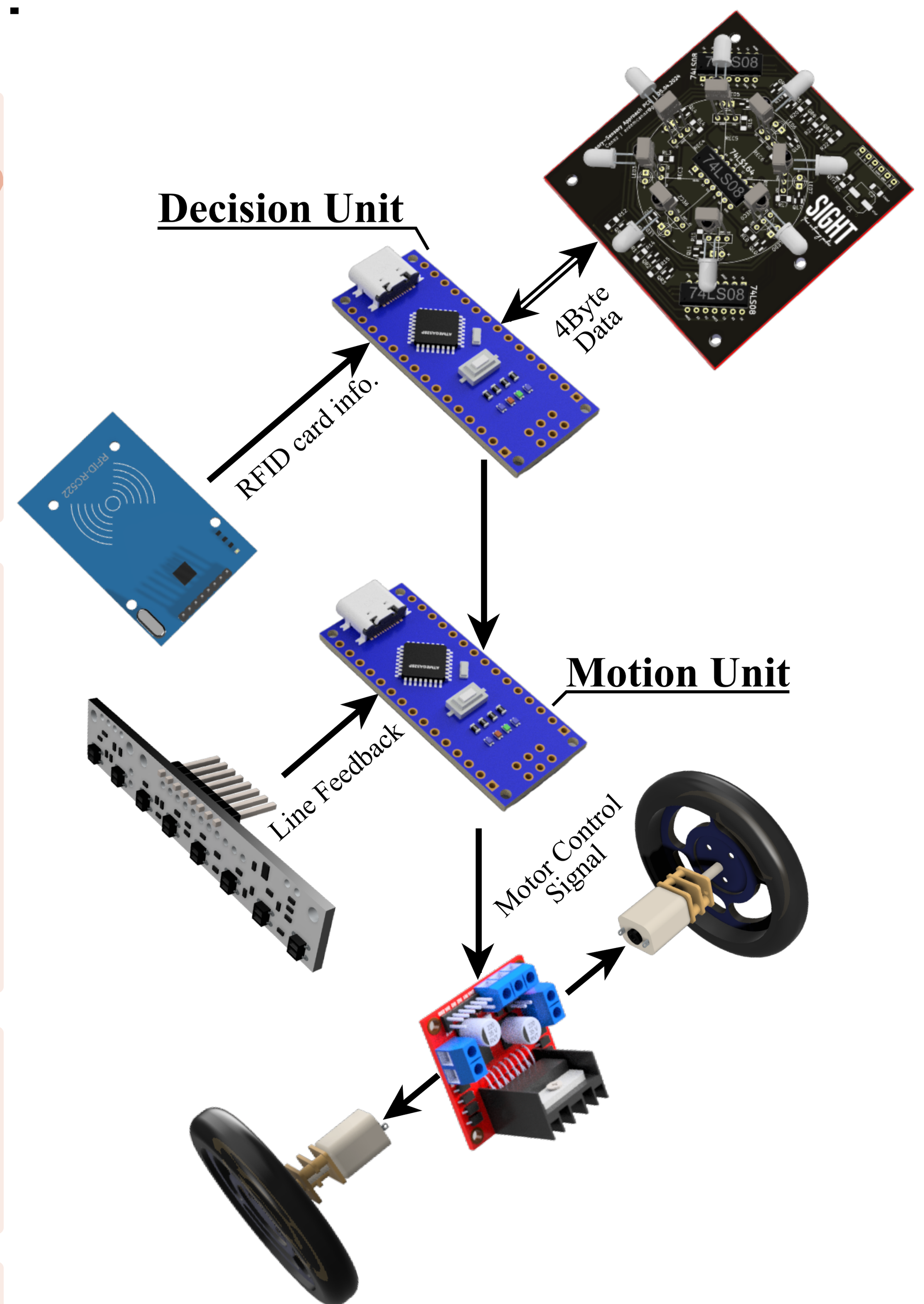
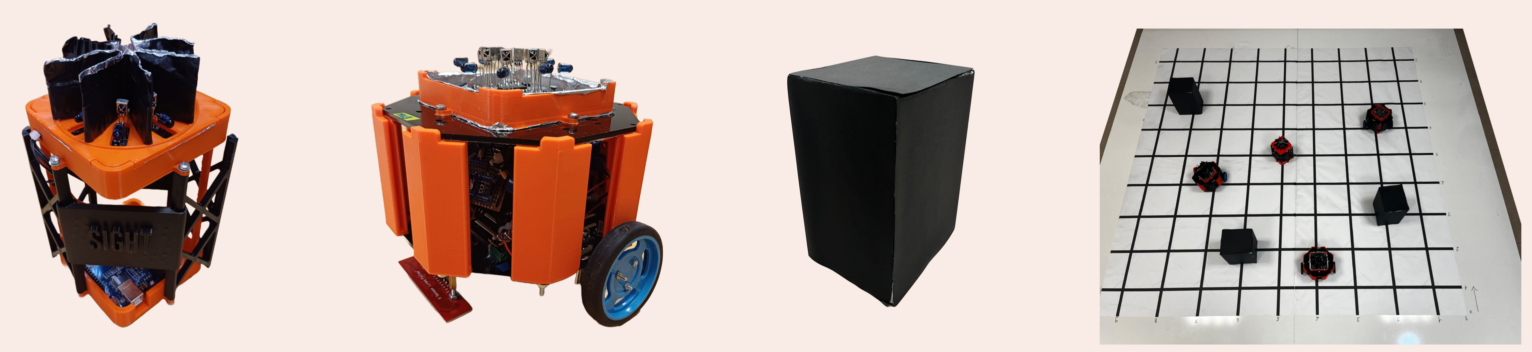


Figure 5: Subsystems Diagram of the Robot

Deliverables



Base Unit (x1) | Mobile Unit (x3) | Obstacles (x3) | 9x9 Grid (x1)

Decision Unit

The decision unit determines the MUs' next moves using search status data from the communication unit and its own gathered information, via a search algorithm. It also decides which information to pass to the communication unit for relay to other MUs. Each MU has its own decision unit, which evaluates the unit's location, other units' positions, scanned tiles, and surrounding obstacles to decide its next move (forward, backward, right, left, or stay). This move is sent to the motion unit for execution. This process repeats until the search is complete. The BU's decision unit, being stationary, only determines data to share with other units. The decision unit algorithm runs on Arduino Nano.

Search Algorithm	Average Number of Iterations (10k cases)
Predetermined Area Assignment	28
Dynamic Area Assignment	31
Randomized Search	40

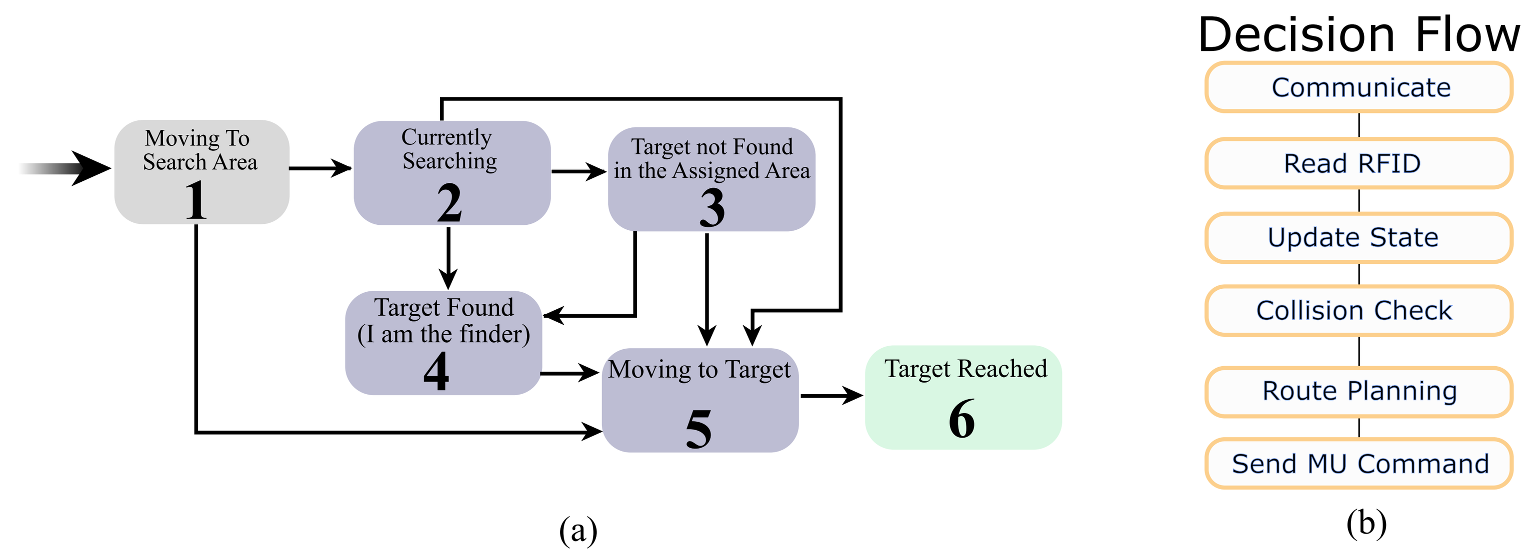


Figure 6: (a) State-diagram of Search and Target Acquisition Process and (b) Decision Flow

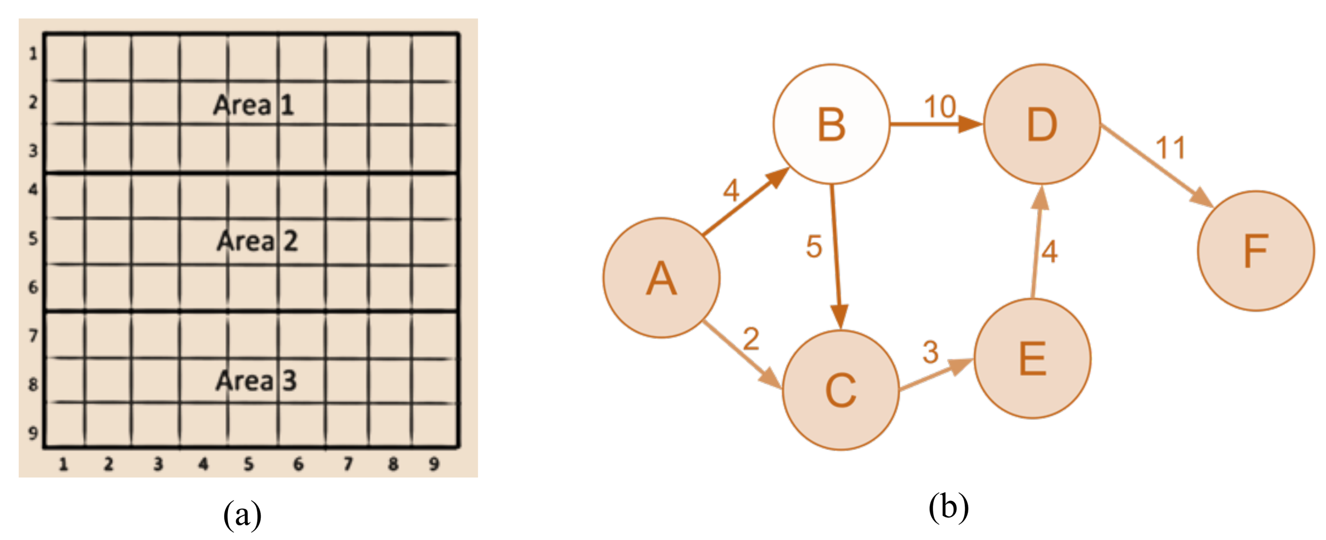


Figure 7: Decision Unit (a) Search Algorithm and (b) Route Planning

Cost Breakdown

$251

Microcontrollers	$40	IR transmitters, receivers and PCB	$36
Motor drivers, motors and wheels	$36	Chassis	$10
Batteries	$26.5	Grid	$66
Line follower and RFID reader sensors	$12	Passive circuit components	$10
RFID Tags	$14.51	**Total Cost**	**$251**

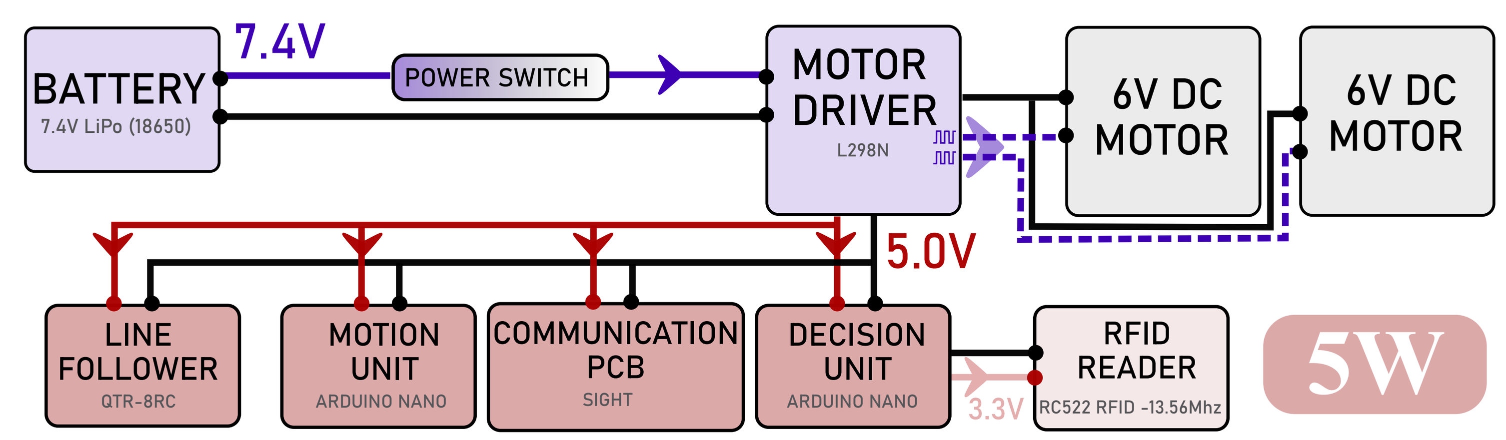


Figure 8: Power delivery system of the robot