The Shopping Robot

Group 5

Rahil Shah(09005011)

Pallav Dhobley(09005012)

Namit Rawal(09005014)

Aditya Gupta(09005017)

Description

- This project aims to automate the generic problem of sorting and delivering objects.
- Sorting is done by a gripper bot, using RFiD tags to identify an object, communicating with a coordinator using zigbee to find a delivery bot.
- The delivery bot then delivers the object to the appropriate destination.
- All the bots are moving in the same arena, and hence path planning and collision avoidance is also an integral part of the project.

Task Specifications

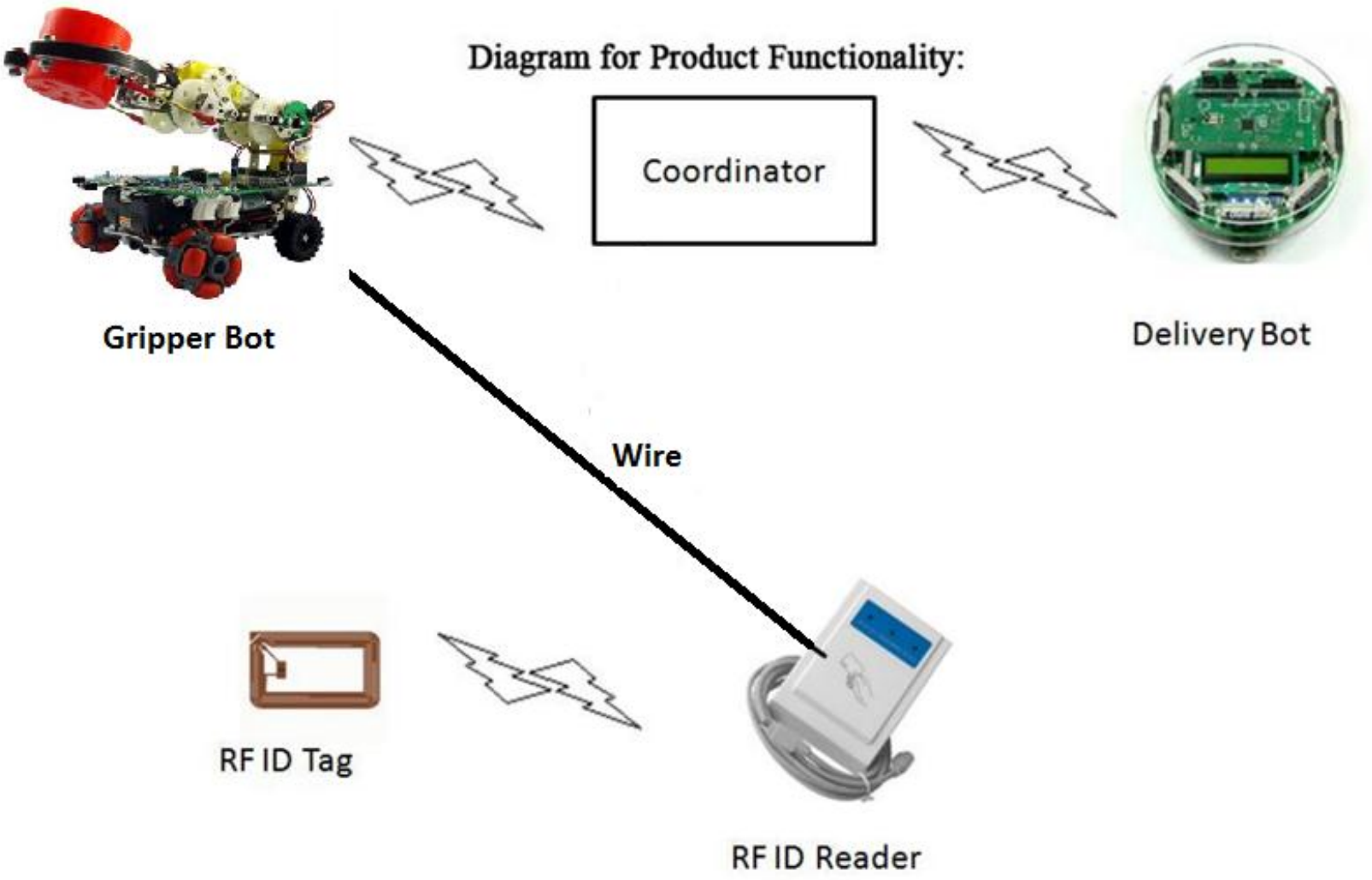
The following are the important tasks of the project

- Rfid based identification of the object
  - A Rfid scanner placed on gripper bot to identify the object which is collected
- Communication with the coordinator wirelessly using zigbee
  - All the bots behave like slave bots and get instructions from the coordinator at every step
- Path Planning for all bots and collision avoidance.
  - Since there are multiple bots on the arena, path planning and collision avoidance is done by the coordinator(and not depending on the front sharp sensors of the bots, thus different from adaptive cruise control).

Plan of Action

- Stage 1
  - Configured zigbee modules on the bots and successfully managed wireless communication
  - Wrote the basic code for path planning and collision avoidance.
- Stage 2
  - Learned how to use Rfid Scanners and interface them with AtMega 2560.
  - Completed the code for path planning.
  - Gripping mechanism to collect objects.
- The critical tasks were
  - Interfacing the Rfid Module with the microcontroller
  - Zigbee Communication
  - Gripping Mechanism
- All team members were always present and work was divided according to the need at that time.

Block Diagram



Work Flow Description

- Gripper
  - The gripper is directed by the coordinator to the nearest object.
  - The object is picked up
  - The Rfid tag is read by the gripper and communicated back to the coordinator.
  - Based on the Rfid tag, the coordinator directs the gripper to the correct delivery bot.
  - After dropping the item on the delivery bot, the gripper moves on to the next object
- Delivery Robot
  - Waits indefinitely until the coordinator gives it a signal to start the delivery process
  - On reaching an interesection, it communicates the same to the coordinator and waits for the next instruction, which could be F,B,L,R or wait.
- Coordinator
  - This entire process is coordinated by a laptop(coordinator).
  - Zigbee communication protocols were defined by us to prevent miscommunication

Innovation & Challenges

- We have successfully managed to interface the RFid scanner with the firebird.
  - It has very simple connections.
  - UART based communication.
  - Small and easy to mount on the Firebird.
- We are doing wireless communication between a coordinator and multiple bots(3 were used during the demo).
- Picking up objects using the gripper was another major challenge.

Tasks Completed

- RFid Communication
  - We spent a lot of time to interface the scanner with the Atmega 2560 on the firebird. This is because we did not have any documentation regarding RFid scanners
  - We have successfully completed this task.
  - The scanner uses UART communication (UART3 is used) to send the id of the scanned tag to the microcontroller.
- Path Planning and Collision Avoidance
  - The coordinator plans the path for every bot.
  - It also ensures that two bots do not collide into each other by maintaining the position of every bot.
  - If two bots are moving towards a same intersection, then one of the waits for the other to pass and then moves.

Tasks Completed(Contd…)

- Zigbee Communication
  - We learned how to configure zigbee using X-CTU.
  - 4 Zigbees have been used(1 connected to coordinator and 1 on each bot).
  - The coordinator instructs all the bots about various movements using zigbee.
  - The gripper bot sends the scanned RFid value to the coordinator using Zigbee.
  - Faced a problem in communicating simultaneously with all bots.
  - Hence, defined a protocol to communicate with only a particular bot.
- Gripping Mechanism
  - Gripping and lifting of objects was done using one arm assembly with two motors.
  - This arm was mounted on the firebird.

Review

- Test Criteria
  - Detection of RFid tag by the scanner interfaced with Atmega 2560.
  - Communication of the RFid tag to the coordinator.
  - Simultaneous wireless communication of instructions for movement of the 3 bots.
  - Path Planning and Collision Avoidance.
  - Hardware: Line Following, Intersection detecting and gripping action.
- Test Description
  - One gripper bot(firebird)
  - Two delivery bots(spark)
  - 6x4 grid.
  - Laptop as the coordinator.

Review(Contd…)

- Test Results
  - RFid tag was successfully detected and read by the scanner.
  - Communication of the RFid tag to the coordinator was successful
  - The coordinator successfully communicated the path to all the bots.
  - There was no interference or miscommunication.
  - The delay in communication due to zigbee did not affect the performance of the system
  - No collisions occurred and optimal path was chosen.
  - Line Following, Intersection detection happened successfully
  - The mechanics of the gripper arm failed. This was purely a mechanical problem due to slipping of gears. We have replaced the gripper with another one.

Review(Contd…)

- Assumptions
  - Since it is a simulation of sorting and delivery, we assumed the laptop knew the arena and the position of the bots and objects before hand.
- Performance metrics
  - Speed of delivery v/s accurate line following and intersection detection
    - We observed that as we increased the speed of the bots, the line following and intersection detection failed sometimes.
    - Thus, it was important to maintain a balance.
  - Despite simultaneous communication with 3 bots, there was no miscommunication or delays, and hence we believe it can be scaled up to many bots.
    - **Protocol stack size:** 28 kbyte
    - **Maximum network speed:** 250 kbit/s
    - **Network range:** Up to 70m
- There is a single point of failure – the coordinator
    - This is because all bots behave like slave bots and get instructions at every point from the coordinator.

Re-usability Features

- The code for the bots as well as the coordinator is completely modular.
  - Different header files for various tasks done by the bot
    - Rfid scanning
    - Zigbee communication
    - Line following
    - Gripper movements
- Rfid can be used for future projects.
  - The functions for initialization and receiving rfid tag are available in the microcontroller code.
  - The hardware connections will be mentioned in the final documentation.

Future Enhancements

- Android apps can be developed using which users can specify the objects they want to try. The delivery bots can get all the objects for the user.
- A Robotic Arm can be used instead of the gripper to pick up objects with better precision.
- Cameras can be installed on the delivery bots so that they do not require a coordinator for the movements avoiding the problem of single point failure.
- Bots to unload objects from the delivery bot and stack them up.

Thank You