Project Title: Farmer Assistant Robots

Project Team number: 3

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1. Introduction

1.1 Problem statement :

The objective of this project is to build a system that will help the farmers in their day to day activities of maintaining their farms. To carry out this objective there should be a fully automated system capable of scouting through the farm and perform the required operations.

1.2 Requirements Specification

To achieve this we have prototyped a system which has three components scout robot, worker robot and central server.

1. **Centralized Server Requirements:**
    a. It should be able to receive information from Scout Robots through wireless.
    b. It should be able to perform Digital Image Processing and identify the required objects (like whether fruit ripening has occurred).
    c. It should be able to issue commands to take appropriate actions.
2. **Scout Robot's Requirements:**
    a. It should be able to move through the field.
    b. It should be able to locate it's position.
    c. It should be able to capture require field images and upload them along with position information to Centralized Server.
3. **Worker Robots' Requirements:**
    a. Receive commands from centralized Server.
    b. Move to the required location.
    c. Perform necessary operation.
    d. Worker Robot should be able to collect objects using the arm assembly.

1.3 System Design

Our system has three components, scout robot, worker robot and central server. The scout robot scouts the farm checking whether fruits are ripened. Then it sends this information along with the co-ordinates to the central server, which after analyzing this data, informs the worker robot to take action.

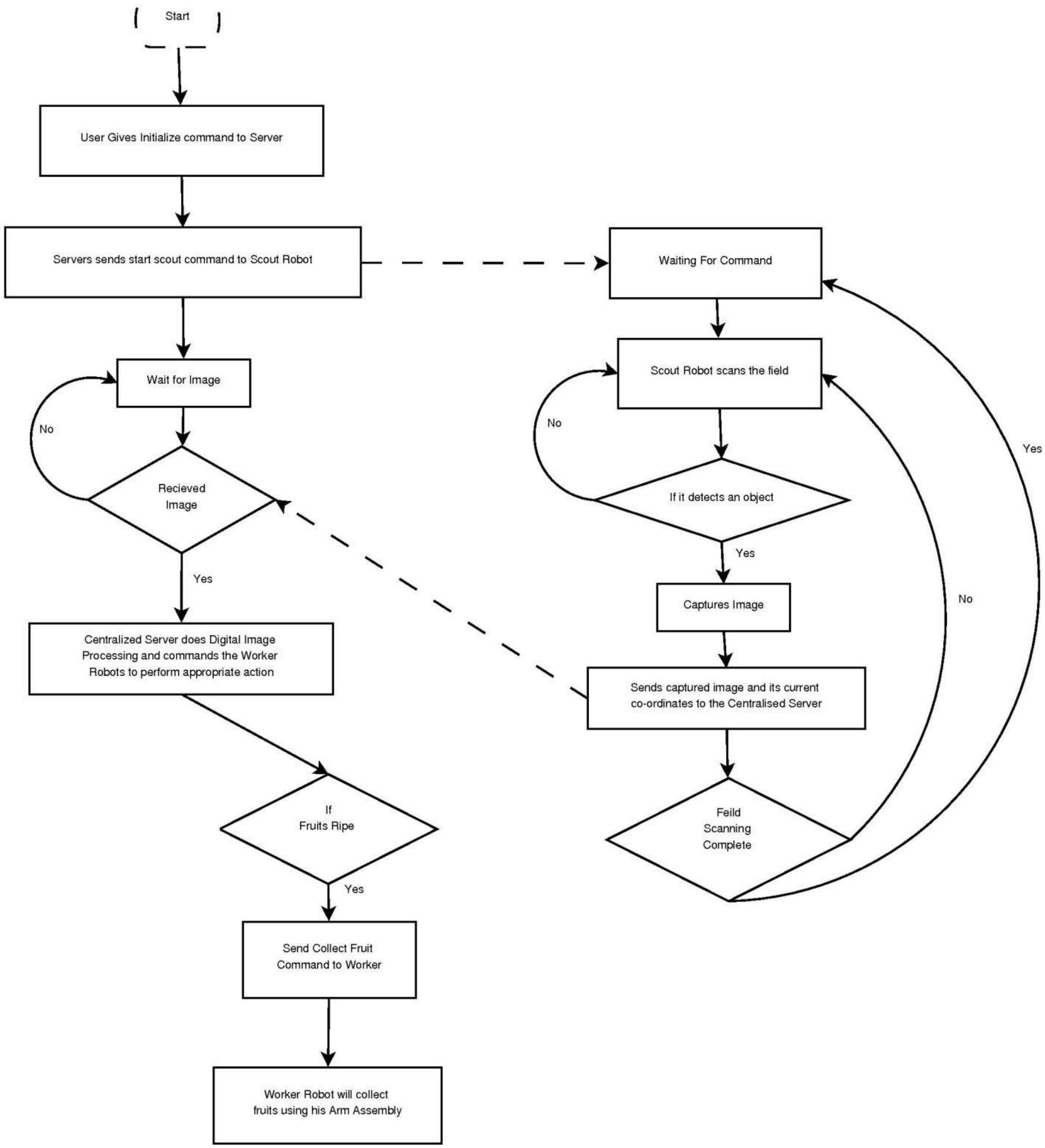

Figure 1: System Flow Chart

1.4 Assumptions and limitations

For prototyping our system, we are assuming:

1. That a straight white line path in the field. This path is marked with black strips, for location identification.
2. Those objects (fruits) are in red color and have height range within the bounds of the arm movement.
3. Those objects (fruits) are at locations identified by black strip markers on the path.

Limitations:

1. Arm movement precession:
    a. The low resolution of arm assembly imposes a constraint on grabbing and positioning abilities.
    b. Arm assembly only has one degree of freedom, i.e. it can only move up and down. So this limits the flexibility of grabbing on the horizontal axis.
2. Using of white line for location Identification constraints the optimal path selection to the desired location (GPS would have been better).
3. Low Camera Resolution: limits the accuracy of object detection.
4. Unbalanced Wheel Rotation Speed: imposes a constraint on the accuracy of movement.

1.5 Additional hardware used

Arm Assembly:

Steps to mount the arm assembly on the FireBird robot.

1. Place the gripper in front part of the arm contraption of worker robot.
2. A string attaches the gripper to a servo motor fixed in the upper part of the contraption. This string runs over a pulley.
3. The servo motor with the pulley system fixed in the upper part of the contraption controls the height of the gripper.
4. Camera should be positioned in such a way that it should be able capture image when the gripper is at its default position.
5. With the help of a second servo motor camera should be able to rotate on its right as well as left.

Digital Wireless Camera:

1. Mount the camera with servo motor on the robot.
2. The camera should have a clear view in the front and right side.
3. Camera should be able to rotate.

2. Present Status

2.1 A timeline based picture of project

- 20 September:
  - Project Started
- 30 September:
  - Scout robot can scan field, identify location of objects.
  - Central server basic DIP for object recognition.
- 10 October
  - Basic Zigbee communication done.
  - Semantics for commands between scout robot and centralized server are defined
  - Scout robot works in sync with central server
  - Worker basic functionality implemented, such as moving to specified location
- 20 October
  - Basic Command semantics for commands between worker robot and centralized server are defined
  - First version of arm assembly mounted on worker robot and basic movement is verified
- 30 October:
  - New version of arm assembly built and mounted on the worker robot.
  - Necessary refinement in the basic movement of arm assembly done.
- 8 November:
  - All command semantics between central server and robots are defined tested and working.
  - Worker robot working in sync with central server. Including arm assembly movement.
  - All tree component of the system are integrated and their operation is coordinated.
  - And demo presented.

2.2 If there are any delays, why they occurred? How you have overcome issues?

- One of the delays we experienced was because we had to change the arm assembly mid way through the project.
  - **<u>Soln</u>**: We designed and built a new arm assembly.
- Zigbee interference in the lab
  - **Soln**: We were not able to eliminate it but we minimized its impact by defining our own packet structure and checking every received packet for it.
- We only had one robot, but we required two for our prototype.
  - **<u>Soln</u>**: So we had to work serially for both robots.

2.3 Critical steps in the projects:

- Synchronizing the actions of the robots with the central server.
- Identifying correct object position.
- Designing, building and working with the new arm assembly Hardware.

2.4 Individual roles and contributions

- Mehadi Seid, Rajesh Kaushik :
    - Robot Motion
    - Robot Positioning
    - Arm Movement
- Swanand Kulkarni :
    - Digital Image Processing(DIP)
    - Zigbee Communication (with Mehadi and Rajesh)

2.5 How much time devoted to project so far - man-days

On average each person in the group worked for about 10 to 12 hours per week since the start of the project in 20 September.

3. Innovation, Creativity and Reusability Index of your Project

3.1 Innovations in project

The overall idea of project is innovative and it solves a real world problem.

3.2 How you have enhanced reusability in project

Code is written in a modular fashion. Each module performs a specific operation. Clear interfaces are defined for communication between the various modules. Each module is an independent component which can be debugged, developed and used separately.

In addition to this the code is commented properly, standard naming conventions are followed and the complete doxygen documentation is also provided.

4. Help us in improving the process

7.1 What you think can be improved in terms of project activities

- There was a shortage of robots and accessory hardware's. So try to make enough hardware available before time.
- At times the hardware operation was unpredictable. May be quality improvement can help.

7.2 Any comments on the current schedule of events

- It was somewhat okay, but we feel some of the reports submitted were redundant. That is the same things are repeatedly asked for in the various documents.

7.3 Are you satisfied with the way the course activities have gone – specially the project?

- The project has a good learning process. But compared to the amount of effort required, the weightage of the project in the overall project evaluation is small

8. Bug Report

- Zigbee interference: specially for the worker robot.
  - Soln: define a more clear and proper semantic for the zigbee packet
  - Soln: Do necessary filtration on received packets
  - Soln: Use uncast instead of broadcast communication
  - Soln: Having Bluetooth hardware on the robot can really help.
- Unpredictable behavior of arm assembly: The arm doesn't lift to the proper height when picking up the second object in a row.
  - Soln: The fine tuning of delay between arm assembly commands can help. It is a trial and verify process.
- Unbalanced wheel motion: The angular rotation of the robot is sometimes unpredictable due to the unbalanced wheel motion and power supply issues.

9. Future Scope

This project has tremendous scope as it applies to the real world problems in developing countries. It can be extended to enable remote diagnosis of different plant diseases, water conservation efforts etc.

It can also be extended to a system that scouts a large area for security purpose.

10. Learnings

- The main thing we have learned is how difficult and unpredictable real time hardware systems are.
- Other technical knowledge acquired
    - Digital image processing
    - System Programming
    - Working with mechanical parts(arm assembly)