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1 Introduction

Greenhouse is the building in which plants are grown. Building is covered with various covering materials like plastic sheets or glass. This allows solar or artificial light to enter the

building, but traps the heat inside the building. Weather conditions inside a greenhouse can be controlled. Our project aims to sowing seeds in such greenhouses completely autonomously. This report discusses design and implementation aspects of the project. It talks about design principles applied, engineering choices made and risks mitigated. It also enumerates difculties faced during the project development and further possible enhancements.

1.1 Definitions, Acronyms and Abbreviations

- FireBird: A robot indigenously designed at ERTS laboratory, IIT Bombay

2 Problem Statement

To build a robot, that automate the entire seed sowing operation in a green house using Firebird6. A greenhouse consists of greenhouse building with plants arranged in aisles and troughs formation, in which bot has to move in a pattern and sow the seeds in troughs accordingly.

Bot takes the input in the form of pattern which basically the distance between to seeds sow in the same line and second input is the distance between two lines of trough in which we have to sow seeds. Bot automatically detect the start and end of the trough and by maintaining a distance with trough it will sow the seeds in the pattern. Bot also ensure that it will dig the seed to proper deep and only one seed at a time.

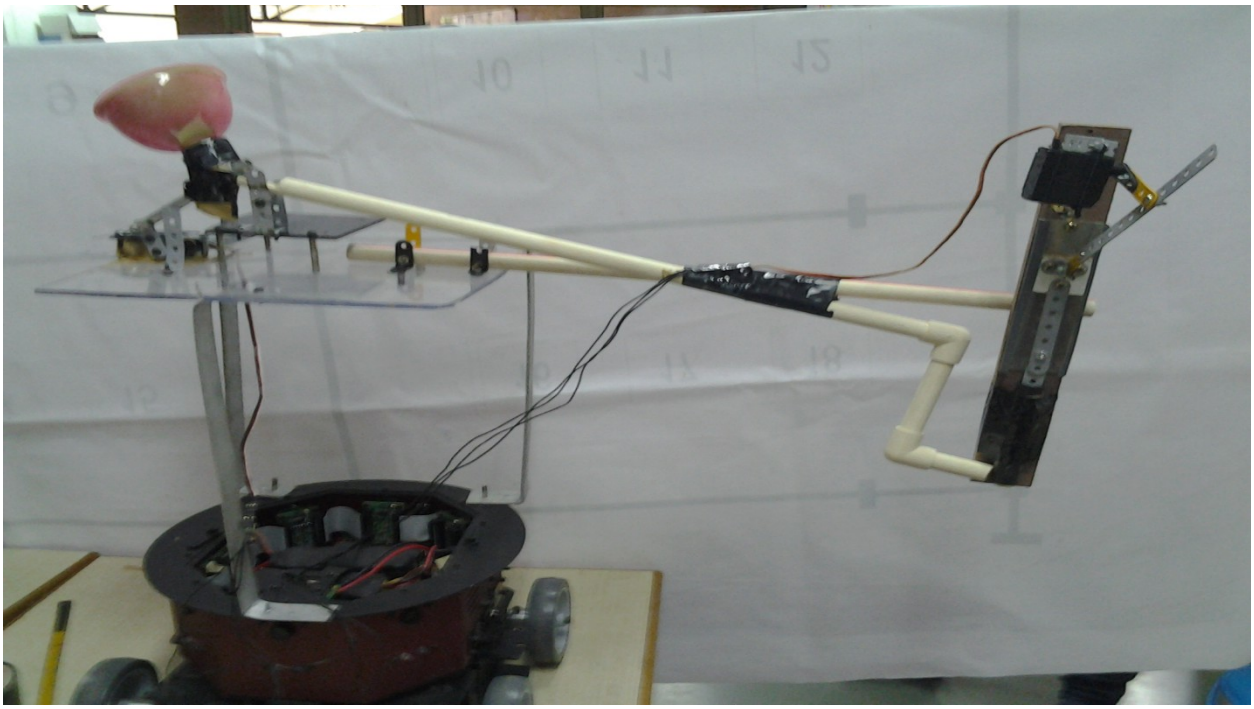

Figure 1: Seed Sowing robot

3 Requirements

3.1 Hardware Requirements

- FireBird VI robot
- Computer with Window OS
- Ultrasonic Sensors
- Servo Motors
- Boot Loader for Firebird VI

3.2 Functional Requirements

1. Takes the input in the form of pattern which basically the distance between to seeds sow in the same line and second input is the distance between two lines of trough in which we have to sow seeds.
2. Automatically detect the start and end of the trough.
3. Maintaining a distance with trough it will sow the seeds in the pattern.
4. Ensure that it will dig the seed to proper deep.
5. Ensure only one seed drop at a time.

3.3 Non Functional Requirements

- Accuracy in determining the distances between the holes.
- Robot should efficiently dig and drop seeds by the servo controlled container.
- Takes less time between to seed sowing.

3.4 Design Constraints

We use the Ultrasonic sensor to control the robot and move it in the pattern according to trough but since its precision is about 1 inch that's why it can't able to seed the sow properly in the pattern.

4 Implementation

Given the degree of complexity involved, we have divided problem statement into three subtasks:

Task 1# Sowing the seeds in a pattern

Task 2# Digging the hole to a proper depth in the soil of greenhouse

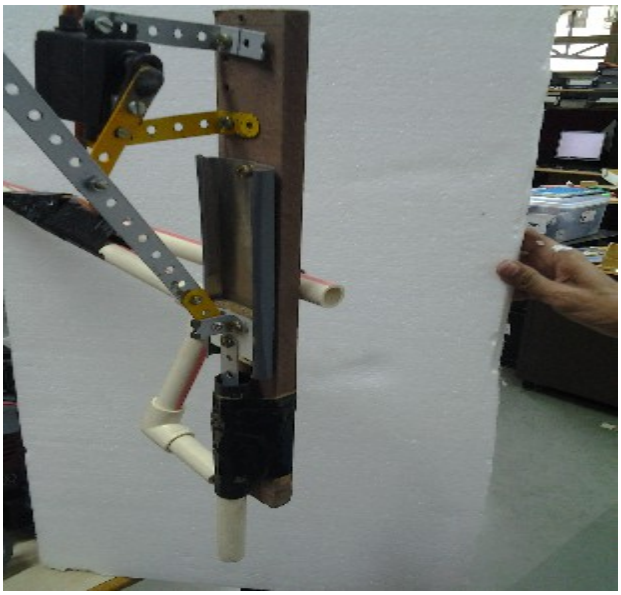

Figure 2: Digger

Task 3# Drop only one seed at the correct position.

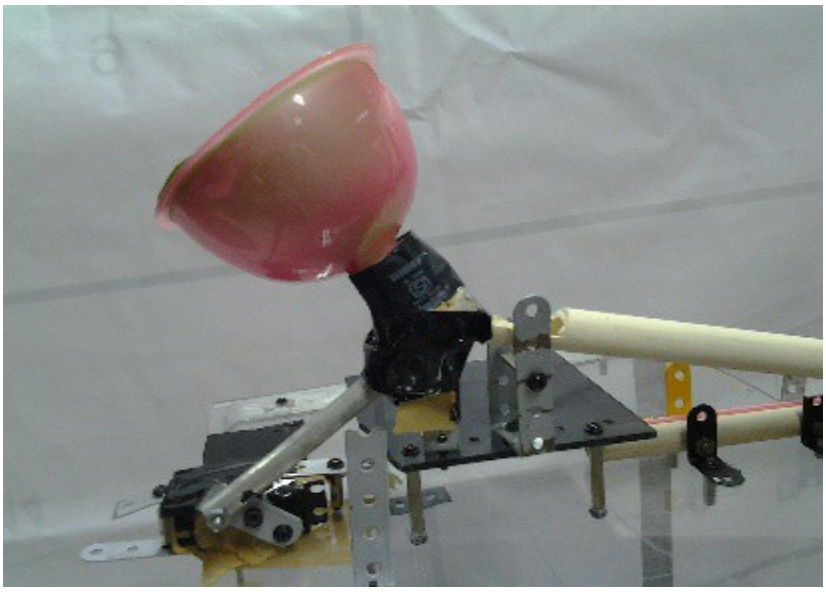

Figure 3: Seed dispensing mechanism

Task 4# then again push the seed to the proper depth by the digger.

Primitive	Use
Void initPeripharal(void)	This function initializes the peripherals of LPC1769 microcontroller and modules of Fire Bird VI Robot
`Void Delay100ms(void)`	Generate an delay of 100 mili second
`Void Delay100ms(void)`	Generate an delay of 10 mili second
`Void Delay100ms(void)`	Generate an delay of 1 second
UARTInit()	Initialize UART
I2C0Init()	Initialize Ic
I2C0Init()	I2C0Init()

Table 1 Bot Funcions

Task1 # This task is accomplish by the ultrasonic sensors which detect the distance of bot from the trough and accordingly takes actions. The function which we used for this task are listed below in the table 2.

Primitive	Use
Uint8 GetUltrasonicData(void)	Get the data of ultrasonic data
Update`ServoPos(angle,port)`	Move the servo motor to a particular angle

Table 2 Ultrasonic and motor function

Task2 # We fit a servo motor on the digger which make possible the vertical motion of the digger.The function of servo motor which we used for this task are listed below in the table 3.

5 State Chart

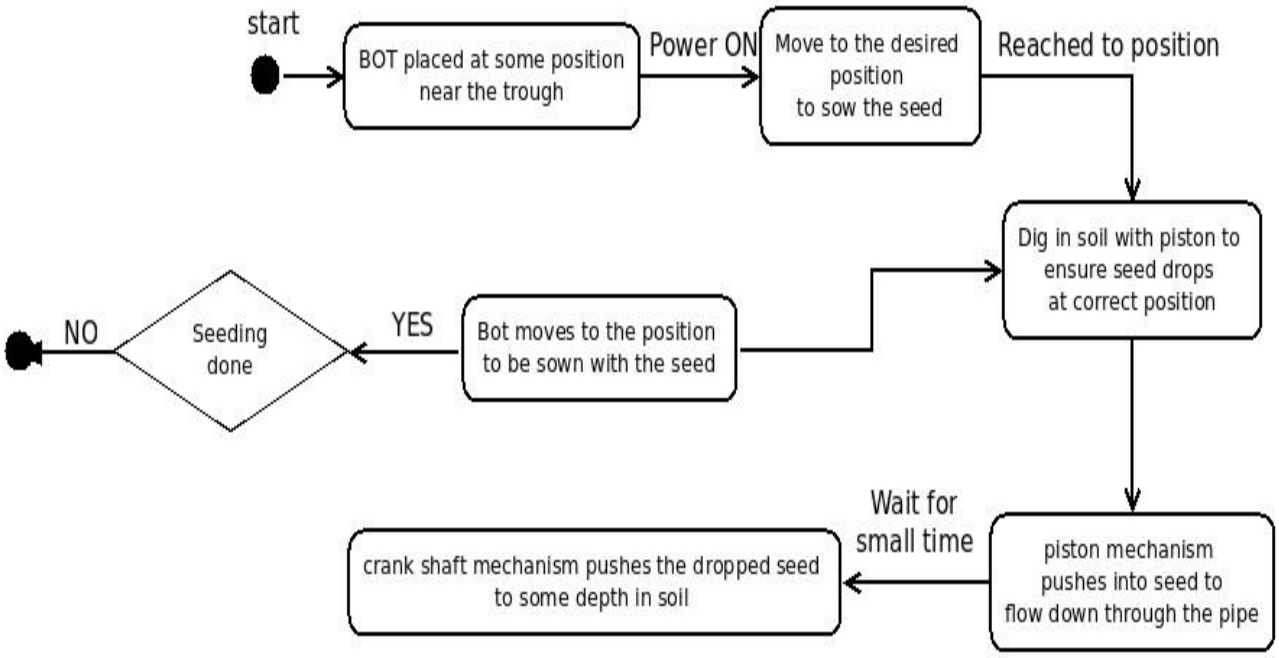

Figure 2: State Chart

6 Testing Strategy

We first test robot for locomotion we only check that how accurately robot move according to the pattern this reveals the bad precision of ultrasonic.

We than check for digging mechanism of the robot and check the depth from which it dig the hole .

7 Design Challenges

Ensuring reliability and correctness of the project was the major design concern. We aimed

for simple but effective Bot design. We chose modular design approach with each module providing well defined services to other modules.

7.1 Digger

Digger is attached to the Bot arm and its task to dig the hole at correct position in the trough soil and after drop the seed in that hole again push it to make sure it will sow at the proper depth this digger design is very complex.

7.2 One seed drop mechanism

The most difficult task to drop one seed at a time and it will be drop at the correct position where the digger make the hole for this task we use single pipe in which digger move and seed comes.

8 Future Work

We have identified following possible improvements for future projects.

8.1 Flexible Arm

Our Robot seeding arm in which digging and dropping mechanism is attached is not flexible and that's why its not able to get into the trough automatically so we expect to make a flexible arm it only need a high power servo motor(industrial servo motor) to make the arm flexible.

8.2 Good Locomotion

We are using ultrasonic sensor to move the robot in pattern but its precision is about 1 inch which makes difficult to move the robot in pattern in future we expect to use some good sensor whose precision is good or use some other way to do this task.

8.3 Seed Type

This mechanism is only limited to sow rounded seeds which are not very small it is able to sow elliptical seed but that time its accuracy may suffer.

9 Conclusion

This project is a real example of seed sowing on an actual Greenhouse which makes possible to automate seed sowing in greenhouse. Although it is only a demo but the actual one is not much different than this it only need to be robust and good error handling at the time when it perform seeding in greenhouse but this implementation is not able to sow small seeds like tomato.

Embedded systems suffer curse of hardware inaccuracies and physical faults. But, good design can overcome them. Predictability and accuracy can still be guaranteed within certain known bounds. Layered, module based design and right abstractions simplify development of complex systems.

References

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[2] FireBird VI Hardware Documentation . IIT Bombay & NEX Robotics Pvt. Ltd.

[3] FireBird VI Software Documentation. IIT Bombay & NEX Robotics Pvt. Ltd.

[4] LPCX presso user manual.