Patuakhali Science and Technology University

Faculty of Computer Science and Engineering

CCE 322 :: Computer Peripheral and Interfacing Sessional

Project Proposal

Project Title : Farm Droid
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Farm Droid

An Autonomous Agricultural Robot

1. Introduction

Agriculture is facing significant challenges due to labor shortages and the need for precision monitoring of crop health. “Farm Droid” is a prototype for a compact, autonomous agricultural robot designed to address these issues through smart automation.

Unlike traditional heavy machinery which is expensive and inflexible, Farm Droid utilizes a lightweight, terrain-adaptive mobile platform. This allows it to navigate through crop rows efficiently to perform monitoring and manipulation tasks. The system integrates modern embedded technologies, using a Raspberry Pi 4 for computer vision and decision-making, and an Arduino/ESP32 for real-time motor control and sensor data acquisition.

2. Objectives

The primary goal is to build a smart farming assistant capable of autonomous operation. The specific objectives are:

- **Autonomous Navigation:** To implement GPS-based pathfinding allowing the bot to travel to specific field coordinates.
- **Adaptive Mobility:** To develop a robust locomotion system (Rover or Legged) capable of traversing uneven agricultural terrain.
- **Computer Vision:** To utilize a Raspberry Pi Camera and OpenCV to recognize crops, weeds, and obstacles in real-time.
- **Robotic Manipulation:** To develop a servo-driven arm mechanism for grasping and moving objects.
- **Environmental Monitoring:** To integrate sensors for measuring soil moisture, pH levels, and weather conditions (Rain/Temperature).

3. Problem Statement

Conventional heavy farming machinery is often unsuited for small-scale precision agriculture or delicate crop fields. Large tractors cause soil compaction and lack the agility to perform individual plant inspection. There is a lack of affordable, modular robotic solutions that can perform both monitoring and physical manipulation tasks in such environments. Farm Droid aims to bridge this gap by providing a lightweight, intelligent, and versatile solution.

4. Scope

The project scope encompasses the mechanical assembly, circuit integration, and software development of the robot.

- **Hardware:** Custom chassis design, Motor/Servo drive system, Power distribution system.
- **Software:** Python-based vision processing, C++ based motor control firmware.
- **Limitation:** The prototype will focus on small-scale demonstration (e.g., a garden or test bed) rather than full industrial field deployment.

5. Methodology

5.1. System Architecture

We are adopting a "Distributed Computing" architecture to handle the computational load efficiently:

- **The Brain (Raspberry Pi 4):** Handles high-level logic, image processing (OpenCV), and path planning. It communicates via Serial/I2C.
- **The Controller (Arduino/ESP32):** dedicated to PWM generation for the motor drivers and reading analog sensors.

5.2. Technology Stack

- **Language**: Python (Vision/Logic), C++ (Arduino Firmware)
- **Vision**: OpenCV, TensorFlow Lite (Optional for object detection)
- **Hardware Interface**: I2C (Inter-Integrated Circuit), UART (GPS)
- **Power Management**: LiPo Batteries with Buck Converters (UBEC) for system stability.

6. Hardware Components

The core components for the Farm Droid include:

- **Actuators:** DC Gear Motors or MG996R Servos (Mobility), SG90 (Gripper/Arm).
- **Sensors:** NEO-6M GPS, Ultrasonic (HC-SR04), Soil Moisture, Rain Sensor, DHT11.
- **Controllers:** Raspberry Pi 4 Model B (4GB), Arduino Uno / ESP32.
- **Drivers:** PCA9685 PWM Driver (for Servos) or L298N/Motor Driver (for Wheels).
- **Vision:** Official Raspberry Pi Camera Module / USB Webcam.

7. Budget Estimation

The following is a detailed breakdown of the estimated costs for the hardware components required for the "Farm Droid" project.

7.1. Mandatory Components & Modules

Category	Component Name	Unit Price (BDT)	Qty	Total (BDT)
Controllers	Raspberry Pi 4 Model B (4GB)	14,100	1	14,100
	Arduino Uno R3	988	1	988
	ESP-32 Development Board	550	2	1,100

Motors & Drivers	Servo Motor MG995 (360 Deg)	770	8	6,160
	DSServo DS3218 20KG Digital Metal Servo with Horn 270 Degree	2350	2	4700
	Servo Motor MG996R	390	2	780
	Servo Motor SG90 (Micro)	150	4	600
	PCA9685 16-Ch Servo Driver	447	2	894
Sensors	Ublox NEO-6M GPS Module	430	1	430
	VL53L0X Laser Ranging Sensor	450	2	900
	MPU-6050 Accelerometer/Gyro	219	1	219
	GY-521 6DOF MPU-6050	350	1	350
	ADXL345 Triple Axis Accelerometer	418	1	418
	AS5600 Magnetic Encoder	314	2	628
	FSR402 Pressure Sensor	678	2	1,356
	HC-SR04 Ultrasonic Sensor	99	1	99
	FC-51 IR Obstacle Sensor	45	3	135
	HC-SR501 PIR Motion Sensor	93	1	93
	OV7670 Camera Module	350	1	350
Power & Audio	Breadboard Power Supply	76	1	76
	3 Watt 8 Ohm Mini Speaker	250	1	250
	Electret Microphone	15	2	30
Mechanical & Misc	PVC Pipe	300	5	1,500
	Syringe	20	5	100
	Pipe (Small)	30	5	150
	Full-Size Breadboard	120	2	240
	Half-Size Breadboard	75	2	150
	Jumper Wires (Male-Male)	100	4	400
	USB Cable (Arduino)	150	2	300
	3D Printer Strong Spring	49	2	98
	Screws / Hardware	100	10	1,000
	Magnet	50	1	50
	Copper Wire (26 SWG)	110	2	220
Tools	Digital Scale (10kg)	259	1	259
	Hex Saw	15	1	15
			Grand Total Estimated Cost	**39138 BDT**

Table 1: Detailed Budget Estimation

7.2. Optional Components & Modules

These components are optional additions for specific features like locomotion and monitoring.

Category	Component Name	Unit Price	Qty	Total
Sensors	Liquid pH Sensor (0-14 Value)	2,150	1	2,150
	Soil Moisture Sensor Dual Output	70	1	70
	Rain Drop Sensor	80	1	80
	DHT11 Temp & Humidity Sensor	120	2	240
Safety & Security	MQ-2 / MQ-135 Gas Sensor	139	2	278
	RC522 RFID Reader Kit	175	1	175
Rover Mode	Gear Motor with Wheel (Yellow)	155	4	620
			Optional Items Total	**3,613 BDT**

Table 2: Budget for Optional / Modular Components

7.3. Project Financial Summary

Mandatory Components Cost	39,138 BDT
Optional Components Cost	3,613 BDT
Grand Total Project Cost	**42,751 BDT**

8. Work Plan (Timeline)

Task	Month 1	Month 2	Month 3	Month 4
Mechanical Assembly (Chassis & Drive)	✓			
Circuit Integration & Power Dist.	✓	✓		
Locomotion & Motor Control		✓	✓	
Vision & GPS Integration			✓	✓
Arm Control & Final Testing				✓

Table 4: Gantt Chart for Farm Droid Development

9. Visual Models

9.1. Circuit Diagram

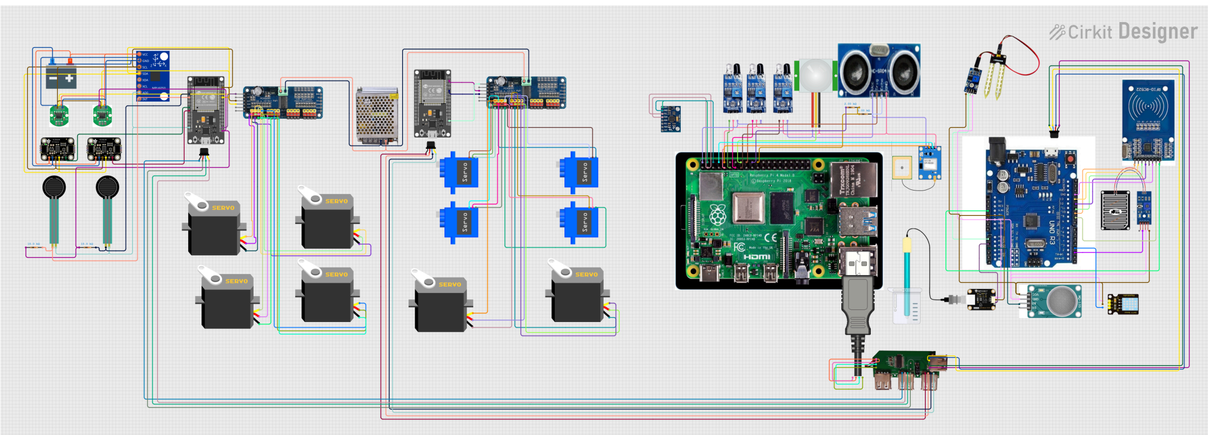

Figure 1: Circuit Diagram of Farm Droid System

9.2. Data Flow Diagram

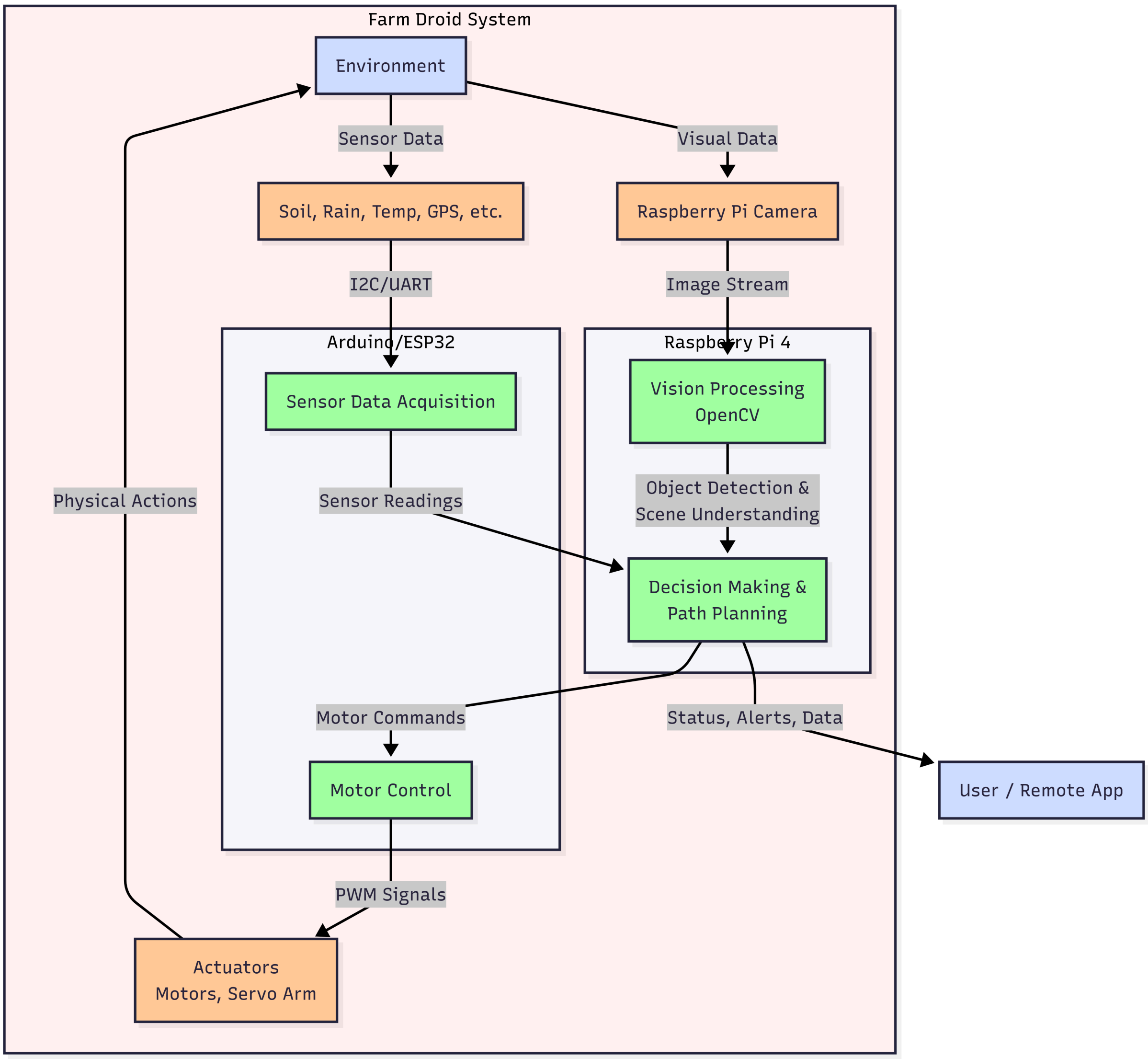

Figure 2: Data Flow Diagram of Farm Droid System

10. Future Plans

1. **Machine Learning:** Training a custom dataset for specific weed/crop identification.
2. **Mobile App:** Developing a Flutter-based app to monitor the bot's status remotely.

11. Conclusion

Farm Droid represents a step towards modernizing agriculture through robotics. By combining autonomous mobility with computer vision, this project aims to demonstrate that farming automation can be agile, intelligent, and accessible. The successful completion of this project will provide a functional prototype capable of navigating autonomous paths and performing basic agricultural tasks.

The End