Patuakhali Science and Technology University
Faculty of Computer Science and Engineering

Project Proposal: Farm Droid

An Autonomous Legged Agricultural Robot

Submission Date : 21 January 2026

Submitted to,

Your Supervisor Name
Designation,
Dept. of Computer Science and Engineering,
Patuakhali Science and Technology University.

Submitted by,

Team Farm Droid

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Contents

1. Introduction

Agriculture is facing significant challenges due to labor shortages and the environmental impact of heavy machinery, which causes soil compaction. "Farm Droid" is a prototype for a compact, autonomous agricultural robot designed to address these issues.

Unlike traditional wheeled tractors, Farm Droid utilizes a legged locomotion system (Quadruped/ Hexapod design) driven by high-torque servos. This allows it to navigate uneven terrain without damaging crops or compacting soil. 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 (using NEO-6M) allowing the bot to travel to specific field coordinates.
- **Legged Locomotion:** To design and program a walking gait using Inverse Kinematics on MG996R servos to navigate rough 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 expensive and often unsuited for small-scale precision agriculture or delicate crop fields. Furthermore, wheeled robots struggle in muddy or highly uneven terrains where they may get stuck. 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 terrain-adaptive solution.

4. Scope

The project scope encompasses the mechanical assembly, circuit integration, and software development of the robot.
- **Hardware:** 3D printed chassis, 12+ Servo motors, 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 16-channel servo driver (PCA9685) 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 high-current servo isolation.

6. Hardware Components

The core components for the Farm Droid include:

- **Actuators:** MG996R (Legs), 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 16-Channel 12-bit PWM Driver.
- **Vision:** Official Raspberry Pi Camera Module / USB Webcam.

7. Work Plan (Timeline)

The development is divided into phases to ensure the complex mechanical and software systems work together.

Task	Month 1	Month 2	Month 3	Month 4
Mechanical Assembly (Body & Legs)	✓			
Circuit Integration & Power Dist.	✓	✓		
Walking Algorithms (Kinematics)		✓	✓	
Vision & GPS Integration			✓	✓
Arm Control & Final Testing				✓

Table 1: Gantt Chart for Farm Droid Development

8. Visual Models

8.1. Block Diagram

The system connects the Raspberry Pi to the PCA9685 Servo Driver via I2C to control the legs. Sensors are connected to the Arduino, which feeds data back to the Pi.

8.2. Flow Chart

The operational flow is as follows:
1. Initialize Sensors & GPS.
2. Check Destination Coordinates.
3. Calculate Path & Begin Walking Gait.
4. **If** Obstacle Detected (Vision/Ultrasonic) -> Stop & Reroute.
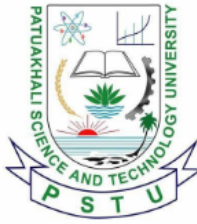5. **If** Target Object Detected -> Activate Arm Sequence.

9. Future Plans

1. **Solar Integration:** Adding solar panels for prolonged field operation.
2. **Swarm Technology:** Enabling multiple Farm Droids to communicate and work together on large fields.
3. **Machine Learning:** Training a custom dataset for specific weed/crop identification.
4. **Mobile App:** Developing a Flutter-based app to monitor the bot's status remotely.

10. Conclusion

Farm Droid represents a step towards modernizing agriculture through robotics. By combining legged locomotion 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.

End of Proposal

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