PROJECT ABSTRACT

GPS Soil pH Mapping Rover using Arduino

Arduino survey rover with a NEO-6M GPS and a calibrated soil pH probe that logs geo-tagged pH readings to a microSD card; a Python script renders the survey as a color-coded pH heatmap. Built-to-order student kit with firmware, report, PPT and viva Q&A.

01. Title

GPS Soil pH Mapping Rover using Arduino

02. Introduction / Background

Soil pH governs which nutrients a crop can absorb: below about 5.5, phosphorus and molybdenum lock up; above 7.5, iron and zinc become unavailable. Precision agriculture addresses this with spatial soil maps, but commercial mapping rigs are far beyond a student or smallholder budget. This project brings the concept to classroom scale: an Arduino Uno, a u-blox NEO-6M GPS module and an analog glass-electrode soil pH probe on a 4WD rover chassis, producing a genuine geo-tagged pH dataset the student maps, analyzes and defends in the viva.

03. Problem Statement

Small farms typically manage fertility with a single blanket fertilizer dose because laboratory soil testing is slow, costs money per sample, and returns one number for a field that may vary widely across it. Manual grid sampling with a handheld pH meter is laborious and the readings are rarely geo-referenced, so no map can be drawn from them. The project addresses this by building a low-cost rover that drives to sampling points, measures soil pH with a calibrated probe, and stamps every reading with GPS coordinates for later mapping.

04. Objectives

- Build a Bluetooth remote-controlled 4WD survey rover carrying a calibrated analog soil pH probe, NEO-6M GPS, 16x2 LCD and microSD logger on an Arduino Uno.
- Implement a dwell-and-measure cycle: halt at each point, wait a configurable settling time (default ~45 s), average ADC samples, and log timestamp, coordinates and pH to CSV.
- Document a two-point buffer-calibration (pH 4.0 / 7.0) and probe conditioning/rinsing procedure the student performs before each survey.
- Deliver a Python mapping script that converts the survey CSV into a color-coded pH scatter map (PNG) and a KML overlay for Google Earth.

- Supply the complete student kit: firmware, wiring diagram, report, PPT and viva Q&A.

05. Proposed Methodology

The survey follows a fixed procedure. (1) The pH probe is calibrated with buffer solutions and conditioned per the included protocol. (2) The operator drives the rover to a sampling point over Bluetooth and triggers the sample command. (3) The Arduino holds position, waits out the probe settling delay, averages several analog readings, and parses the NEO-6M NMEA sentences for latitude, longitude and fix quality. (4) The record is appended to the microSD CSV and shown on the LCD with the running point count. (5) After the survey the CSV is copied to a PC and the Python script renders the heatmap and KML overlay for the report.

06. System Architecture / Working

Sensing: an analog glass-electrode soil pH probe with its signal-conditioning board feeds the Arduino ADC. Positioning: the NEO-6M GPS module streams NMEA sentences over UART. Control: the Arduino Uno runs the survey state machine and drives the 4WD chassis through an L298N dual H-bridge. Remote link: an HC-05 Bluetooth module accepts drive and sample commands from a phone terminal app (~10 m Class 2 range). Display and storage: a 16x2 I2C LCD shows live pH, GPS fix and point count while a microSD module logs CSV rows. Post-processing: an offline Python script (matplotlib) produces the color-coded map and KML export.

07. Hardware / Software Requirements

- Arduino Uno (ATmega328P), programmed in Arduino IDE (C++)
- u-blox NEO-6M GPS module (UART, NMEA); horizontal accuracy ~2.5 m CEP (datasheet), open sky required
- Analog soil pH probe with signal-conditioning board; 0-14 pH, ±0.1 pH at 25 °C after two-point buffer calibration (probe datasheet)
- HC-05 Bluetooth module, L298N motor driver, 4WD robot chassis
- 16x2 I2C LCD, microSD card module, 2S Li-ion pack with 5 V regulation
- Python 3.10 with matplotlib for the mapping script (runs offline on the student's PC)

08. Expected Outcomes

A working rover prototype that records geo-tagged soil pH readings, a survey CSV from a student-run field trial, and a color-coded pH heatmap with KML overlay generated by the included script. The deliverable is an educational demonstrator: GPS accuracy is the NEO-6M's ~2.5 m CEP, pH accuracy follows the probe datasheet after buffer calibration, and field runtime is approximate and load-dependent. The student kit includes

commented firmware, wiring diagram, calibration and survey procedures, report, PPT and viva Q&A.

09. Applications

- Precision-agriculture concept demonstrations at student scale
- Teaching aid for sensor calibration, GPS parsing and embedded data logging
- Geospatial data-handling exercises: CSV to heatmap to KML
- Agri-extension and soil-health awareness demos

10. Future Scope

- Autonomous waypoint navigation using the GPS fix (optional customization)
- Multi-parameter soil sensing: moisture, EC and NPK probes on the same survey cycle
- GSM/cloud upload of survey data instead of SD-card transfer
- Solar-assisted charging for longer field sessions