Smart Agri-Robot

Butool Abidi[1], Simran Kodwani[2], Aishwarya Mathur[3], Kashyap Joshi[4]

[1,2,3]*Student, Department of Electronics and Telecommunication Engineering, SVKM's* NMIMS *MPSTME, Mumbai, India*
[4]*Assistant Professor, Department of Electronics and Telecommunication Engineering, SVKM's* NMIMS *MPSTME, Mumbai, India*

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Abstract: The objective of the research is to develop a robot for advanced farming system using an open source hardware. The research will discuss the concept of robot farming system along with the use of line following, obstacle avoidance, soil moisture detecting and caterpillar chain (for ploughing) to make a robot suitable for agriculture. One of the key elements of smart agri robot farming system is to make it more economical to the farmers. The important parts of the farming system are reliability, low-cost system, farming safety, quick response and accuracy.

Keywords: Agriculture, Robot, Line-Following, Obstacle avoidance

1. INTRODUCTION

Agriculture is the backbone of India's economy. Agricultural development is therefore, a precondition of our national prosperity. We live in a world where technology is at the heart of our everyday lives. Today, the agriculture has been highly mechanized [1]. The use of technology has reduced the risk factors in agriculture, particularly those unleashed by nature [1]. Not only that quick processing has been made possible, technology has reduced farmer's dependency on, and vulnerability to, the nature. The process of harvesting, which used to be months' long involving a large number of people have been reduced to a few days' work without engaging any major manpower[1]. With the use of technology, it has also become possible to minimize the risks involved in agriculture to which the early farmers were awfully exposed [1]. Unlike the olden day farmers, the new age Indian farmer is not the stereotypical 'kisan'. They are tech savvy and are open to adopting new technologies that can help them improve their income [2]. For instance, a Facebook group for organic farmers in India with member strength of 22,000 has become an engaging platform for farmers to seek help or advice from other farmers [2].WhatsApp groups are now used extensively by farmers to exchange knowledge and collaborate with peers. From ordering seeds online to seeking inputs on social media, there is rapid adoption of information technology by Indian farmers . Start-ups and technology firms are trying to break into India's agricultural landscape using newer business models [3]. These firms are tapping governments, banks, farming co-operatives, development agencies and even corporate social responsibility programs to create a viable business and help farmers [3]. Large companies that depend on agricultural produce want information on sowing and pre-harvest activities up to harvest [3]. Development agencies are keen to develop sustainable farmer livelihoods.

The advancement in technology has introduced a new economy, sociability and consciousness among the people [1]. The agriculture, with the help of technology, has got 4 transformed into an entrepreneurial enterprise and is gradually taking a capitalist character [1]. Some farmers have become capitalists in the sense that they make investments in their farms with fully calculated results to be achieved ultimately [1].

2. RELATED WORK

Introduces the BBC micro:bit and it's features & specifications [4][5][6]. The Micro Bit is an open source hardware ARM-based embedded system designed by the BBC to be utilized in computer education within the united kingdom [4][5][6]. The device is described as half the scale of a mastercard and has an ARM Cortex-M0 processor, accelerometer and magnetometer sensors [4][5][6]. Bluetooth and USB connectivity, a display consisting of 25 LEDs, two programmable buttons, and will be powered by either USB or an external battery pack [4][5][6]. It connects to other devices, sensors, kits and objects, and is supposed as a companion rather than a competitor to devices like Arduino, Galileo, Kano, little Bits and Raspberry Pi, acting as a spring-board to more complex learning The micro: bit features a ARM Cortex-M0 processor which is more powerful than the 5 AVR within the Arduino, meaning that any valid C++ program can run unmodified on the micro: bit using the proper GCC toolchain. However, the micro: bit could be a smaller amount powerful than a Raspberry Pi, which can be a whole computer that runs a full-fledged software package, while the micro: bit runs one program at a time. Typical micro: bit programs link to the run-time system, which provides various drivers for the display, buttons and extension ports, still systems support for memory allocation and cooperative threading variety of the latest achievements in agricultural robotics specifically, those that are used for autonomous weed control, field scouting, and harvesting [7]. Object identification, task planning algorithms, digitalization and optimization of sensors are highlighted as variety of the facing challenges within the context of digital farming. To optimize farming inputs and reveal denied or concealed information in agricultural field research is carried our to use robotics towards building a swarm of small-scale robots and drones that collaborate together to optimize farming inputs and reveal denied or concealed information. For the case of robotic harvesting, an autonomous framework with several simple axis manipulators is also faster and more efficient than the currently adapted professional expensive manipulators [7]. The rapid emergence of the Internet-of-Things (IOT) based technologies redesigned almost every industry including "smart agriculture" which moved the industry from statistical to quantitative approaches [7]. Such revolutionary changes are shaking the prevailing agriculture methods and creating new opportunities along a spread of 6 challenges. There is a potential of wireless sensors and IOT in agriculture, still because the challenges expected to be faced when integrating this technology with the quality farming practices. IOT devices and communication techniques associated with wireless sensors are being used in agriculture applications. There are sensors are available for specific agriculture application such as for soil preparation, crop status, irrigation, insect and pest detection are listed. How this technology helping the growers throughout the crop stages, from sowing until harvesting, packing and transportation is explained. A vision of how aspects of crop production may be automated within the longer term [8]. Although existing manned operations is also efficient over large areas there is a possible for reducing the scale of treatments with autonomous machines that may end in even higher efficiencies [8]. The event process could even be incremental but the concept requires a paradigm shift within the way we predict about mechanization for crop production that's based more on plant needs and novel ways of meeting them rather than modifying existing techniques [8]. They promote greater inclusion within the broader economy, raise efficiency by complementing other production factors, and foster innovation by dramatically reducing transaction costs [9]. Digital technologies overcome information problems that hinder market access for several small-scale farmers, increase knowledge through new ways of providing extension services, which they supply novel ways for improving agricultural supply chain management [9]. While there are many promising samples of positive 7 impacts on rural livelihoods—or "digital dividends"—these have often not scaled up to the extent expected. The foremost reason is that technology can always only address some, but not all of the barriers faced by farmers in poorer countries. With the increasing number of the population over the earth, the demand for agricultural products is additionally increased. So on extend the assembly rate, irrigation technique should be more efficient [11]. The irrigation techniques used till date isn't satisfactory, especially in an exceedingly developing country like India [11]. This paper has proposed a line follower robot for irrigation-based application which might be considered as a cost-effective solution by minimizing water loss still as an efficient system for irrigation purposes. This proposed system is an autonomous a system that doesn't require an operator to accomplish its task. This robot is completely portable and is given a microcontroller, an on-board water reservoir, and an attached pump. The realm to be watered by the robot is also any field with plants, placed in an exceedingly predefined path. it's capable of comparing movable objects and stationary plants to cut back water loss and eventually watering them autonomously with none human intervention.

3. METHODOLOGY

The proposed system consists of a micro: bit controller interfaced with a Ultrasonic sensor for detecting the direction of movement for the robot. This sensor will be detecting the color difference between the black and white for the smooth following of line. An obstacle detector prevents the robot from hitting any obstacles like stones and other soil residues by stopping the robot once any object is detected. It stops for few seconds and then takes a 90 degree turn and retracts its path. Another feature of the robot is moisture detection, where soil moisture content is checked with the help of moisture sensor and according to the output values water is pumped into the soil. This process is done with the help of nano Arduino.

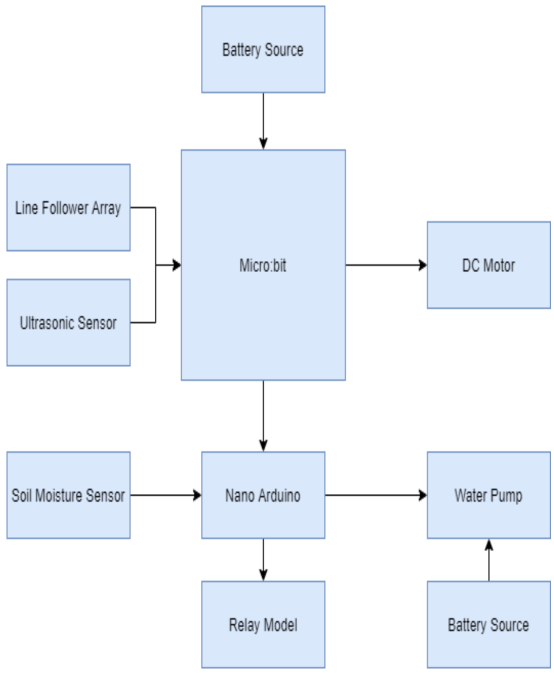

Fig 3.1 Block Diagram of Smart Agri Robot

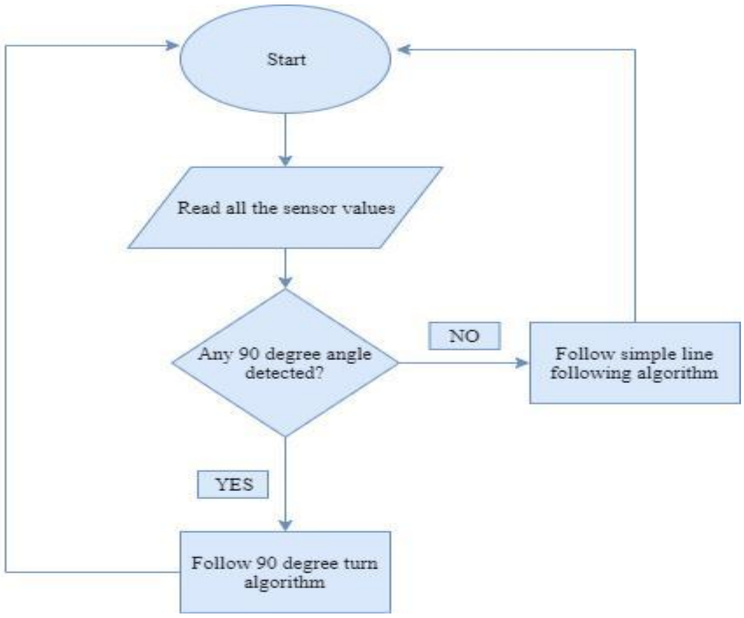

Fig 3.2 Flowchart for Line Follower

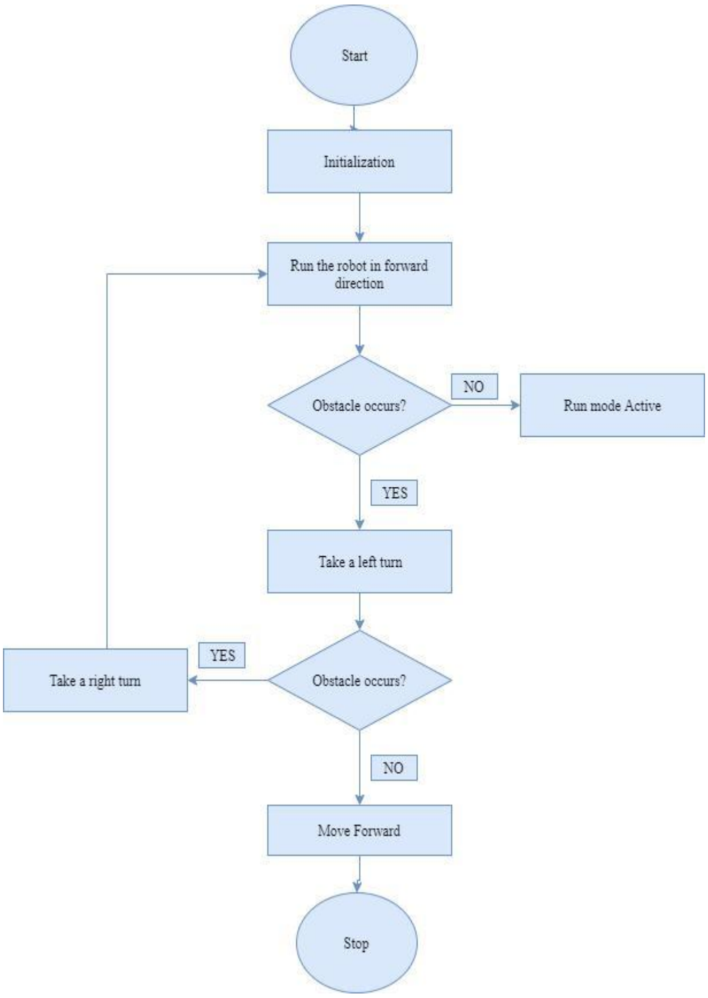

Fig 3.3 Flowchart for Obstacle Detection

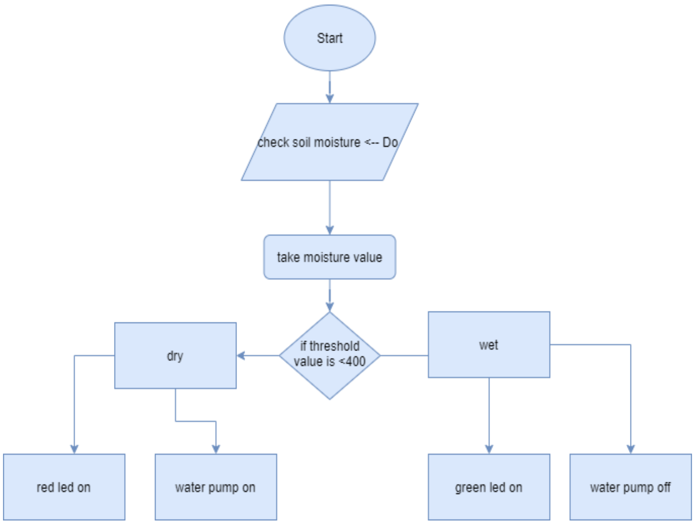

Fig 3.4 Flowchart for Soil Moisture detection and Water Pump

4. OPERATIONS

4.1 Operation: moisture test

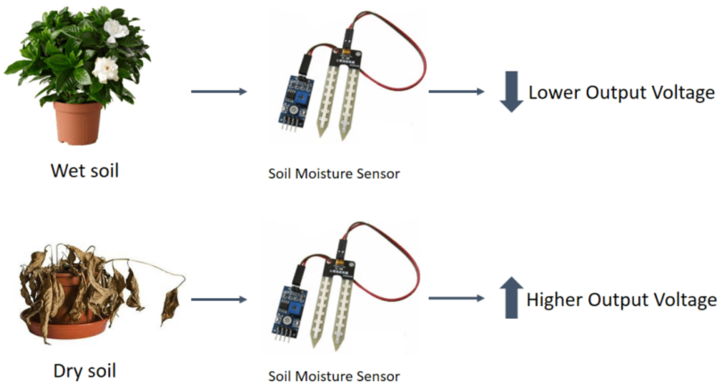

Fig 4.1 Soil Moisture Sensor indication

The Soil Moisture Sensor uses capacitance to measure dielectric permittivity of the surrounding medium [12]. In soil, dielectric permittivity is a function of the water content [12]. The sensor creates a voltage proportional to the dielectric permittivity, and therefore the water content of the soil [12]. The sensor averages the water content over the entire length of the sensor [12]. There is a 2 cm zone of influence with respect to the flat surface of the sensor with surrounding temperature of **10°C~30°C** but it has little or no sensitivity at the extreme edges. The Soil Moisture Sensor works with 5V, <20mA and is used to measure the loss of moisture over time due to evaporation and plant uptake, evaluate optimum soil moisture contents for various species of plants, monitor soil moisture content to control irrigation in greenhouses and enhance bottle biology experiments. This device shows high (red led), when shortage of moisture in the soil, else the output is low (green led). This sensor can be used for automatic watering

4.2 Operation: Water pumping

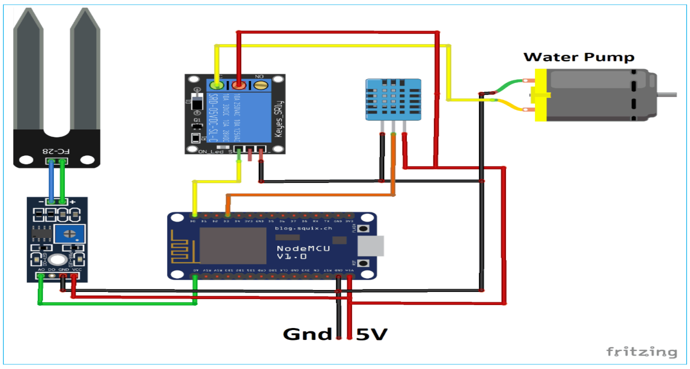

Fig 4.2 Circuit diagram of water pumping

A relay is a device which allows a low current device like NodeMCU to control a device with a high current requirement like a water pump. The relay behaves like a switch. We make a complete circuit to run the water pump (using a 12V DC power jack) and then use a relay to make or break the circuit. The relay has three terminals on the low current side- VCC, GND, and IN [13]. The relay also has three terminals on the high current side – NO, C, and NC – which stand for Normally Open, Common, and Normally Closed, respectively [13]. If the pump circuit is connected between NO and C, then the pump is initially OFF [13]. Giving a LOW signal to the IN pin will cause the relay to close the circuit [13], and the pump will run. If the pump circuit is connected between NC and C, then the pump is initially running [13]. Giving a LOW signal to the IN pin will cause the relay to open the circuit, and the pump will switch OFF [13].+V from power source connected to the negative terminal of the water pump to the positive terminal, then to the ground on the power source. On the other side of the relay board wiring is controlled ie from the Arduino it is connected +5V and GND on the board to the +5V and GND on the Arduino along with the connection of one of Arduino digital output pin to the relay pin.This pin will trigger the relay to flip.

4.3 Operation: line follower

The infrared sensor was calibrated by reading the raw value of each sensor responding to the black line and white surface using an Arduino.

Further, the sensor array was calibrated with the Micro-bit and the values were found to have a correlation with the values obtained using Arduino.

The working principle is as follows:

The line follower can follow a specific line by the use of ultrasonic sensor array. Any line can be formed with contrast to the base and it can be calibrated accordingly.

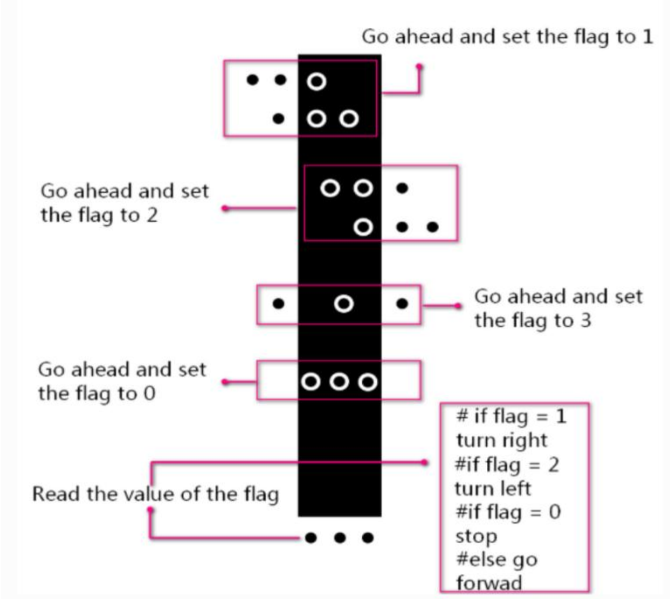

Fig 4.3 Working mechanism of Line follower

4.4 Operation: Obstacle avoidance tests

For the obstacle avoidance, the ultrasonic sensors were used, which have a range of minimum 2 cm and maximum 4 m.

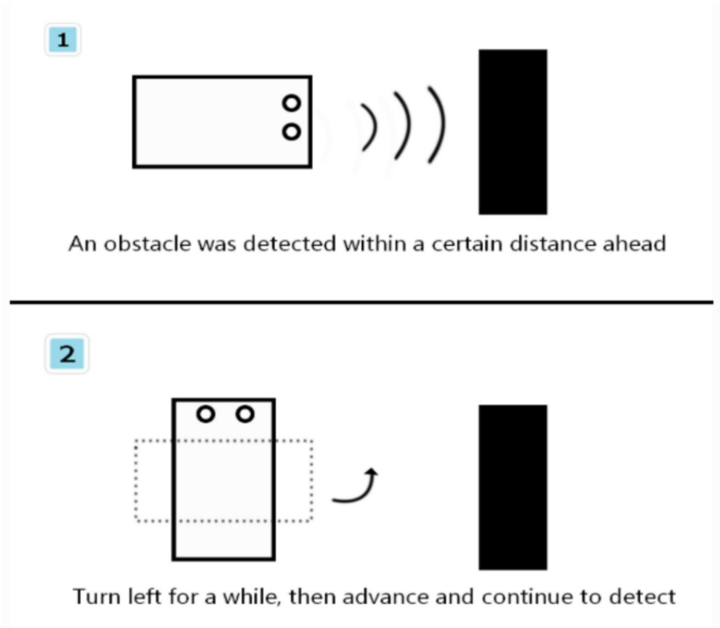

Fig 4.4 Working mechanism of Obstacle Detection

The working principle is as follows:

When the robot detects any obstacle at a certain distance such as stones, pebbles, weeds or any other crop in the farm, the robot takes a turn and then continues to move ahead.

5. RESULT

The variation in intensity of light received by the Rx of the Infrared sensor when exposed to black and white surfaces was recorded.. When light falls on a white surface it is almost completely reflected whereas in case of black surface light is completely absorbed.

Following figures show the reflection of light from black and white surfaces. These values are used for detection of the track. When light rays fall on white surface, they are reflected back and perceived by the array sensor, which generates an equivalent voltage change. When light rays fall on a black surface, the light is absorbed by the surface and no rays are reflected back, thus photo diode does not receive any light or rays.

Following this concept, the robot follows the black line and fulfills its functionality as a line follower robot. It also checks for presence of obstacles in its path. When an obstacle is detected, it shifts the robot control to left direction. If there is another obstacle in the left it turns right. After the avoiding obstacle, the line follower module is again activated.

Several functions are used in code to reduce complexity and increase precision of robot. The project integrates the use of line following, obstacle avoidance, soil moisture detecting and caterpillar chain (for ploughing) to make a robot suitable for agriculture.

Furthermore, the robot checks the moisture content of the soil with the help of moisture sensor. The output of the moisture sensor is then compared with the threshold value of the moisture content in soil and the water is pumped as the requirement. The process is indicated by the leds.

- A line follower and obstacle avoidance robot designed.
- Soil moisture content sensor application included in the robot (for irrigation and fertilizer spraying)
- A water pump and small water storage is added to the robot (for irrigation).
- Wooden plow tool added to the chasis for loosening or turning the soil before sowing seed

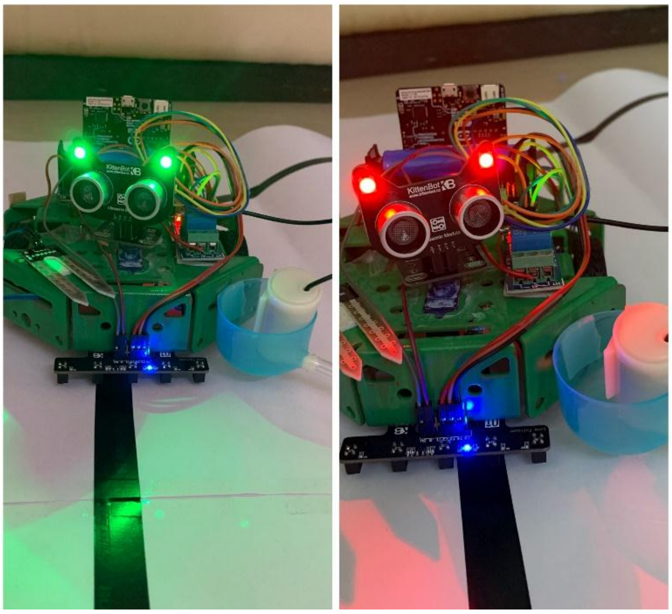

Fig 5.1 Line follower & Obstacle Detection.

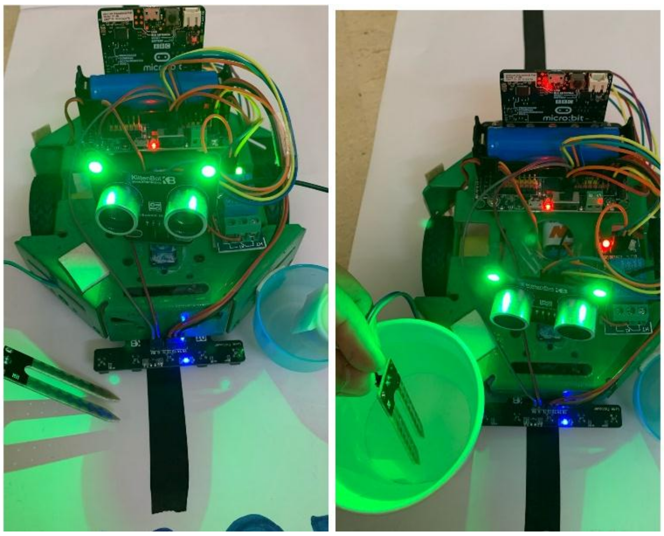

Fig 5.2 Soil moisture detection and water pumping.

6. CONCLUSION

Robots starts with ploughing the field, as it continues to plough, moisture content of the soil is determined via moisture sensor where moisture content value is compared with the threshold value and accordingly water is pumped. The robot then moves further following its line and stops until the end of line or when any obstacle is detected via an ultrasonic sensor. The robot further retracts its path back to the starting point.

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