

An Intelligent Robo-Vehicle for Mobility Service towards Watering the Agricultural Fields

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Abstract:

Today freshwater resources getting decline day by day due to be short of rainfall, at the same time the purpose of water usage is getting amplified. Consumption of water for agriculture and gardening purpose is maximum in our country, because the highest professions of citizen of India are farmers. So there is a necessity of reduction of water utilization or some advanced technology has to be introduced to reduce the water usage for gardening purpose. In the existing system, large piping with high powered motors is used to supply water to plant and crops periodically. Here, human power is needed to monitor, whether the water is evenly spreaded or not. In the proposed work, In order to reduce the huge water wastage, a robotic system that moves through the field with a water tank that sprays water all over the field with an adjustable nozzle once the machine is turned on is suggested. The robot has the capability to disperse water to the plants in the garden in an efficient manner. Arduino controller is used in the proposed work for controlling the robotic action automatically.

Keywords: Agriculture, Robot, Sprinkler, Controller, Irrigation

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Introduction:

Seventy percent of the Indian citizens are generally live in rural area and major basis of their revenue to lead their life is generated from farming, directly or indirectly. Even these 70% of people were having the capacity to produce, but still the production rates of the crops were very minimum. Because the farmers of our country were not utilizing the technology very well. Now a day's many machines for supporting agricultural work to save farmer's time, money, increase the production rate and profit are developed. Today, In India, hand operated sprayer or motorized sprayers are used for agricultural purpose. As an extension of the existing method, an automatic water sprinkling robotic system with a small four wheel vehicle with DC battery as a power source and which is operated electronically is proposed in this system.

India is a prodigious nation where scarcity of water is maximum in some regions. Preservation of water is very much important in agriculture due to the sun dry climatic conditions. Different techniques of irrigation methods should be adopted to deal with this problem. The alternative mode of irrigation technique to reduce water wastage to a greater extent is drip type of irrigation. In this proposed system the sprinkler mechanism for irrigation is proposed. Here, Double acting pneumatic cylinder is used to power up the sprinkler. The forward and backward stroke of the cylinder pushes air to the water tank. The air coming out from the cylinder, moves the water out of the tank, through the sprinkler. This way guarantees the suitable watering of the yield.

Section 2 of the paper gives a related work of in the field of water sprinkler. Section 3 discusses the system and its drawback. Section 4 construes

information with relevance to the proposed concept. Experimental setup results are given in the section 5. Section 6 highlights and narrates the future scope of the expected system.

(1) II. Related Work

Devdutt, et.al. proposed a work titled "Plant watering robot", which provides water to the plant as per the environmental conditions. The robot checks the moisturing level of the soil, and according per the condition it pour the water.

Hema N, et.al. proposed an idea called "Plant Watering Autonomous Mobile Robot". The system is fully adaptive which consists of a mobile robot and a thermal-dewiness detector element. The apparatus is extensively laborsaving. Wireless communication is used for interchanging the information.

Adeodu A.O, et.al. presented a paper titled "Development of an Autonomous Mobile Plant Irrigation Robot for Semi Structured environment". In this system to optimize the watering needs of the plant, a moisture sensing module with mobile robot is designed. The communication between these two components can be happened using Xbee Series wireless communication.

Sandhya.B.R, et.al suggested a technique named "IoT Based Smart Home Garden Watering System Using Raspberry pi 3". In this technique, based on the wetness of agricultural land and sunlight intensity, the time schedule of aqua distribution to the plant and trees are calculated, based on that watering over the plant happened. This system uses Android application to administrate and operate the gadget. Apparatus are connected to the gadget wirelessly.

Constantinos Marios Angelopoulos, et.al. Sotiris published a paper titled "A Smart System for Garden Watering using Wireless Sensor Networks". In their work, the authors presented a wireless sensor network based smart irrigation system. It comprises of,

special sensors, heterogeneous modes and detectors. The apparatus is entirely based on atmosphere weather situations and specific water needs of the different plants cultivated in the land.

(2) III. Existing pipe sprinkler irrigation

In the existing pipe sprinkler system, is used for irrigating the field and for watering the plants in sandy areas. Here, from one or more central locations water is piped within the area and circulated by elevated huge physical force waterers. Due to high pressure, Water is coming out from the pipe and watered above the yields by hanging pipe setups.

Nozzles are installed to hanging waterers fixed to a apparatus of waterer instrument buried in the earth; nozzles may be fixed or rotating one and used for correct intervals in the dispersion waterer instrument. In bestrewing method, refreshing effect occurs on plant & it apply less water than intake of soil so no run-off occurs. In the existing one sprinkler mechanism operates on either electric or hydraulic technology. This irrigation system consists of lateral line, mainline, pump unit, sprinklers and nozzles.

Usually, centrifugal pumps are used to take water from source & provide pressure. Pipes are either permanently installed or buried below ground. They distribute water to sprinklers. Sprinklers division is arranged to wet the soil surface and the system used for small as well as large scale applications. The figure 1 represents the existing sprinkler irrigation method.



Figure 1: Existing sprinkler system

The drawbacks of the existing system are:

- ❖ Operating cost is high
- ❖ Water will drift when there is a lot of wind.
- ❖ A stable water supply is needed.
- ❖ Saline water may cause problem.
- ❖ Water must be free from sand and salt.

(3) IV. Proposed system

In the proposed system the automatic water sprinkling robot which uses the single sprinkler that moves through the field with a water tank that sprays the water all over the fields is developed.

In the proposed system 10 RPM 12V Johnson DC gear motors are used for moving the vehicle over the field. Three ultrasonic sensors (HC-SR04) are used to find out the obstacles present in the field. Arduino Mega 2560 controller is used for controlling the vehicle to move in the right direction.

4.1 Block diagram

The figure 2 shows the block diagram of the proposed system.

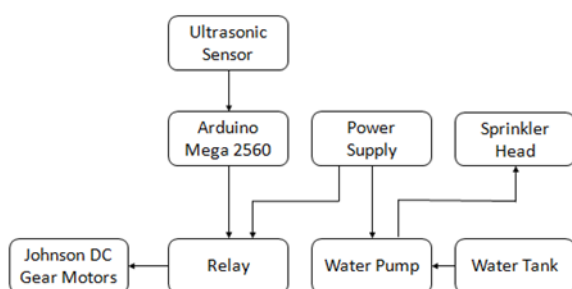


Figure 2: Block diagram of the proposed system

4.2 Circuit Diagram

The figure 3 represents the circuit diagram of the proposed method.

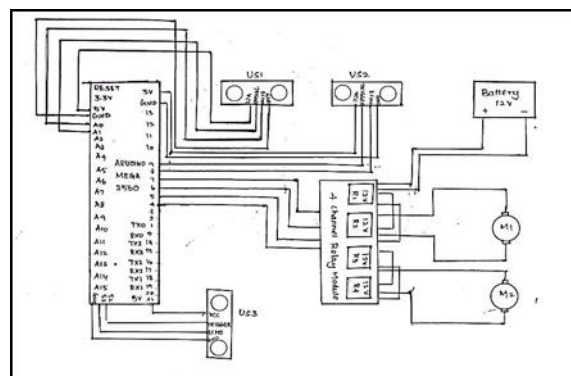


Figure 3 : Circuit Diagram of the proposed system

The figure 3 shows the overall circuit diagram of our proposed system. In this system, Arduino mega 2560 was used for controlling purpose. The battery is connected to the 4 channel relay module. Three ultrasonic sensors named US1, US2, and US3 were fitted in the right, left and forward directions of the vehicle for the purpose of obstacle avoiding. The Ultrasonic sensor has 4 terminals namely Vcc, Trigger, Echo and Ground. The US1 is connected to the A0,A1 pin of the controller and remaining two pins are connected to the Vcc and Ground. In the similar fashion, Trigger and Echo pins of US2, US3 are connected to 8, 9 and 52, 53 pins respectively. The 4 channel relay module receives the input signal from the digital pins numbered as 4,5,6,7 of the controller. The motor M1 and M2 are connected with common terminals of relay module.

4.3 Working of the proposed method

When the battery is turned on, the ultrasonic sensors which are fixed in the vehicle starts to detect the obstacles within the specified region of the vehicle continuously. Simultaneously, the water pump gets turned on and transfers the water from the suction end to the single sprinkler head which sprinkles the water all over the field. If any obstacle is present in the moving direction (say forward) the vehicle checks for the obstacle in the right direction, if there is no obstacle it takes the right direction, in critical condition obstacle is also present in right side then the obstacle detection is done on the left side

and takes the left path if there is no obstacle. In a worst case, if the obstacle is present in all the three directions (say forward, right and left) the vehicle starts move backwards. According to the mentioned priority the vehicle moves left, right and forward movements. For the forward movement of the vehicle relay channel 2 and 4 gets signal and drive the motor and for the backward movement the relay channel 1 and 3 gets signal and drive the motor.

Table 4.1: Digital Signals for the Movement of the Vehicle

Relays (R1, R2, R3, R4)	R1	R2	R3	R4
Motors (M1 & M2)				
M1 & M2 Clockwise Rotation (Forward Movement)	0	1	0	1
M1 & M2 Counter Clockwise Rotation (Backward Movement)	1	0	1	0
M1 Counter Clockwise Rotation (Leftward Movement)	1	0	0	0
M2 Counter Clockwise Rotation (Rightward Movement)	0	0	1	0

The Table 4.1 represents the digital signals received by the relay from the controller for the forward, right and left movement of the vehicle.

4.4 Hard ware components Used

4.4.1: DC Gear Motor

12V DC with 10RPM, 120kgcm holding torque , No load current 800 mA and Load current up to 7.5A. Johnson gear motor is used in the expected system. Figure 4 represents the DC gear motor used in this system.



Figure 4: DC Gear Motor

4.4.2: Arduino MEGA 2560

Arduino MEGA microcontroller used in the proposed system. The main reason to use this micro controller is the additional features that are inbuilt within this board.

4.4.3: HC-SR04 Ultrasonic sensor

HC-SR04 Ultrasonic sensor is used in the proposed system to detect the presence of obstacle during the movement of sprinkler system. The formula to calculate the distance by sensor is

$$\text{Distance} = \text{speed} * \text{time}$$

The distance is found by triggering the trigger pin for some micro seconds which is mentioned in a program and this will be in some frequency. This triggered wave will caught by the receiver side if it is get reflected by an object (what's distance to be measured). The MCU calculates the distance based on this triggering time and receiving time.

4.4.4: Four Channel Relay Module

A five volt four channel actuator board and all the channel of the four channel relay module requires a 15-20mA driver current. It is installed with huge ampere actuator that work below AC 230V 10A or DC 30V 10A. It has a standard interface that can be controlled directly by MCU. Figure 5 shows the four channel relay module.



Figure 5: Four Channel Relay Module

4.4.5: High pressure water pump

12V DC & 3A, 100 PSI High Pressure Diaphragm Water Pump is used in the proposed system.

(4) V. Results and discussion

The figure 6 shows the Mechanical Setup of vehicle with water tank of the proposed system. In this four wheels are used i.e., two wheels are fixed with motors and another two wheels are used to change the directions of the vehicle.



Figure 6: Vehicle setup with water tank

The Figure 7 shows the Vehicle Setup with water tank. The ultrasonic sensors are fixed with three sides of the vehicle with the controller. It is the main core part of the robotic vehicle then the high pressure water pump is to be fixed with lower part of the water tank. The 4 channel relay module is used to control the gear motors and water pump. The relay has capability to turn on and turn off the motors.



FIGURE 7: VEHICLE SETUP WITH WATER TANK.

CONCLUSION

In this proposed system, an automatic water sprinkling robot which automatically sprinkles the water all over the field without the human intervention is developed. This proposed system is used for both gardening and agricultural purposes. The main concept of this system is to reduce the water usage in fields and gardens. By using this system, man power is reduced and it is also economical for the farmers in our country. This system is used where to reduce the manpower and save the money.

Future work may include some additional features like fixing the moisture sensors in the several places according to the gardening area. It senses the soil moisture content and sends the message to the controller. After that robot moves near the plant and sprinkle the water to that plant and moisture is still sensing by the sensor. This movement of vehicle is done using IoT and wireless sensor networks technology. When the moisture reaches 100%, the controller receives the message and sends back the robot to its original position. This prevents the repeated watering of the same plants and this will be the main advantage.

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