

Implementation of Greenhouse Roof Cleaning Didactic Robot to Improve Light Intensity Using Raspberry Pi

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Abstract

In this paper, we propose a very efficient Didactic Robot system using Raspberry-pi3. Due to the dust particles present on the roof, the growth of the greenhouse plants gets affected. The dust particles may prevent the intervention of sunlight. It causes problem in the photosynthesis process. As the roof is made of light transparent and translucent material, manual cleaning may cause severe damages to both roofs and humans. To overcome this, a Didactic Robot system is introduced for greenhouse roof cleaning. The sponge wipers are used for cleaning in wet/dry conditions. The proposed Didactic Robot cleaning method is very useful easy to remove in greenhouse roofs and flexible compared to the manual cleaning.

Keywords: Didactic Robot, GSM, Motor Driver, Greenhouse, Raspberry-Pi3.

1. INTRODUCTION

A greenhouse is used for greater control over the growing environment of plants. The growth of greenhouse plants may be affected by many factors. One of the main reasons is affected by amount of sunlight passing through it. Therefore photosynthesis process gets affected and that causes a plant growth. Dirt and dust particles may cause a scratch in the structure's plastic surface if it is not cleaned on a regular basis [1]. To avoid such a problem, the roofs must be cleaned once or twice in two weeks of time. The Poly Vinyl Chloride (PVC) sheets used to make roof material [2]. Manual cleaning of such roofs is causing the damages to roofs. It may take more time and it is difficult. The PVC plastic sheets are cost effective material. A greenhouse roof cleaning robot is being developed to overcome

many issues. GSM technology is used to initiate the cleaning and to make sure the cleaning process is completed. The robot is automatically start cleaning once it gets message from the owner/user and after the cleaning is finished, it will indicate the user through SMS as 'cleaning done'. The implementation of a cleaning robot for greenhouse roof is to improve the growth of the plants. [3]. It is used to help us to avoid accidents to human over cleaning the roof. The non-pressurized water system was dealt to clean the dust on the PV panels using water as well as a surfactant [6]. The monochromatic radiation is used to measure the directional hemispherical transmittances of the dry and the wet materials under laboratory conditions [7].

2. RELATED WORK

2a. Manual Cleaning

Manually operated brush type cleaner was designed to clean the greenhouse roof [5]. It consists of cylindrical brush mounted on a frame attached to adjustable handle. The cleaner was fixed with a wash mix dispenser. The water tank within the greenhouse was filled with water and the water pump was connected to the solution dispenser. The workman should stand at the bottom and the cleaning is done using the brush type cleaner as shown in figure.1.



Fig.1. Greenhouse Roof Cleaning Manually Using Brushes

Three bays can be cleaned in the same position and for further cleaning the worker should move to a distance. Then the cleaning of greenhouse roof is also done by climbing onto the roof to clean as shown in figure.2. As the roof is made of very light material this type of cleaning may lead s to huge accidents to the human as well as cause the damage to the greenhouse roof. It is labor intensive, time-consuming, imposes severe loads on roof that could cause failure [4].



Fig.2. Manual Greenhouse Roof Cleaning

2b. Automatic Cleaning

In order to avoid the accidents and the disadvantages caused during manual cleaning, automatic robot cleaning is introduced as shown in figure.3. The robot will start cleaning when it receives the message from the owner and it completes its action and send the task completed message to the owner. The robot structure is made of very light weight material of steel. The robotic movement will be very slower for effective cleaning. It will reduce the human work.



Fig.3. Automatic Greenhouse Roof Cleaner

3. BLOCK DIAGRAM OF PROPOSED WORK

The block diagram of proposed work is shown in figure.4. The Raspberry-pi3 controller controls the movement of the robot in the specified direction. It is the size of a credit card, which makes it perfect embedding it in the robot. It has a quad core processor and 1 GB RAM memory, which is used for sufficient storage. The controller has an advantage of easily get connected to a lot of actuators, sensors and other interfacing devices. This will be used to help to include any other changes to the robot.

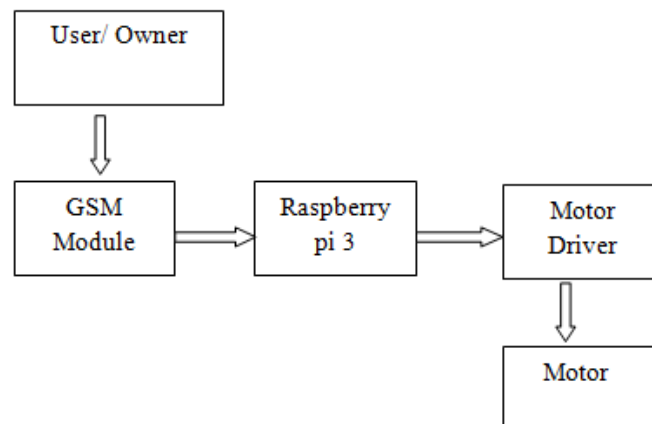


Fig.4. Block Diagram of Greenhouse Roof Cleaning Robot

The 12V supply motor is used to support the robot movements. The motor controls the wipers used along with the sponges. The speed of the motor should be 30 rpm. The pressure should be less than 30 N/s. When the robot starts moving after the command received from the user/owner then the robot will move along with the movement of wipers on both sides. The robotic cleaning device has use of controllers, GSM modules, brushes, motor drivers and motors. The GSM module used to help us to communicate with the robot automatically. The SIM card mounted in the GSM modem upon receiving the digit command by SMS from any mobile send that data to the MC through serial communication interfacing device. After receiving the command the robot starts to move from one end to another end. The interface between the GSM and the controller makes the robot to move.

4. EXPERIMENTAL RESULTS

The experimental implementation of Didactic Robot Model using Raspberry-pi3, GSM Module, and Motor Driver is shown in figure.5. The length of the greenhouse roof is measured previously and distance of the robot movement is programmed. After reaching the end, it should move backwards with the same movement of wipers till the starting point. This backward movement is for effective cleaning. After reaching the starting point, the robot will send a message stating that the task has been completed.



Fig.5. Experimental Implementation of Didactic Robot Model using Raspberry-pi3

4a. Light Intensity Measurement

Light is an important factor, which is used in cultivating plants such as crops and vegetation. The light creates a photo synthetically active radiation (PAR) must be present in order to occur for photosynthesis. Lack of light may hinder plant growth. The most efficient method to control this is to measure the amount of light that plant is receiving and try to match it to its optimal light intensity. Light meters or light detectors are used in illumination.

$$\text{Illuminance} = \text{light falling on a surface}$$

The amount of light falling on a surface is known as illuminance, and is measured in lux. One lx is equal to one lumen per square meter. In this robot design we used light meter app to measure the intensity of light. The figure.6 shows the light transmitted inside the greenhouse roof before cleaning and light intensity is measured before cleaning is 320 lx.



Fig.6. Light Transmitted Inside the Greenhouse Roof before Cleaning

The figure.7 shows the light transmitted inside the greenhouse roof after cleaning and light intensity is measured before cleaning is 550 lx. The average transmitted light inside the greenhouse

and outside the greenhouse is calculated and the percentage of light absorbed and transmitted by the greenhouse roof after and before cleaning is calculated. The transmittance of light before cleaning is small compared to the transmittance of light after cleaning. Therefore cleaning the greenhouse roof is increased interns of transmittance of light, which in turn increase the productivity of plants.

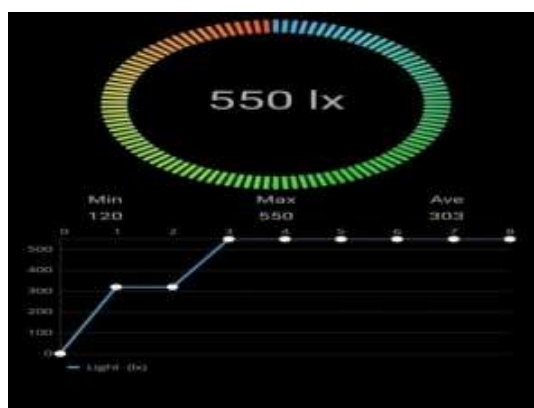


Fig.7. Light Transmitted Inside the Greenhouse Roof after Cleaning

5. CONCLUSION

A very efficient Didactic Robot Model using Raspberry-pi3 has been implemented. The system is controlled by on board controller, electrical power requirements can be met directly. Due to the no supply of liquids requirement in this system, it gives more efficient and cost effective compared to the previous methods for dry and hot environmental conditions. Compared to the previous methods of dust removing in greenhouse roofs, the proposed Didactic Robot cleaning method is very easy to install, and is flexible. All these features make the system user friendly and very useful in real time applications.

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