

Automatic Plant Watering System via Soil Moisture Sensing by means of Suitable Electronics and its Applications for Anthropological and Medical Purposes

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ABSTRACT

Herein we introduce automatic plant watering system, which is considered as one of the most commonly used and the most beneficial automated systems nowadays, which help people in their daily activities by reducing or completely replacing their effort. This system uses sensor technology along with microcontroller and other electronics in order to behave like smart switching system which senses soil moisture level and irrigates the plant if necessary. Purpose of this work is to show how someone can easily make own and cheap automatic plant watering system in just few hours by connecting certain electronic components and other materials required. In our experiment, we connected all required materials exactly as shown in this paper, in order to test whether our system will work properly or not. Although the system made in that way would be the most appropriate for home usage as solution for some daily and usual issues, there is a wide spectrum of possibilities of implementing these systems as a long-term solution for many agricultural and medical problems, some of which are undernourishment and air pollution as most prominent, dangerous and important ones. As one possible agricultural solution, this system can be very helpful in keeping vegetables and other useful and specific plants watered for bigger harvest, which enables farmers from all around world to breed crops of these plants which are the most wanted and the most commonly used in diet. As medical solution, these systems can be used for purpose of cultivating certain plants that are famous and well known by their ability to remove air pollutants and therefore reduce the concentration of toxic pollutants in the air as well the occurrence of respiratory diseases. Future possibilities include some challenging and demanding ideas like joining plants of similar variety and characteristics into complex connections of plants, called »Internet of plants«. There are also many other possibilities like using more than one sensor or solar power supply for experimental purposes, but the fact is however, that, independently of the materials used and the way in which they are connected, this type of automated systems can be very helpful in solving very wide of human-related problems nowadays

Key words: *plant, system, sensor, bioengineering, automatic, technology*

Introduction

Since nowadays, in the age of advanced electronics and technology, the life of human being should be simpler and more convenient, there is a need for many automated systems that are capable of replacing or reducing human effort in their daily activities and jobs. Here we introduce one such system, named as automatic plant watering system, which is actually a model of controlling irrigation

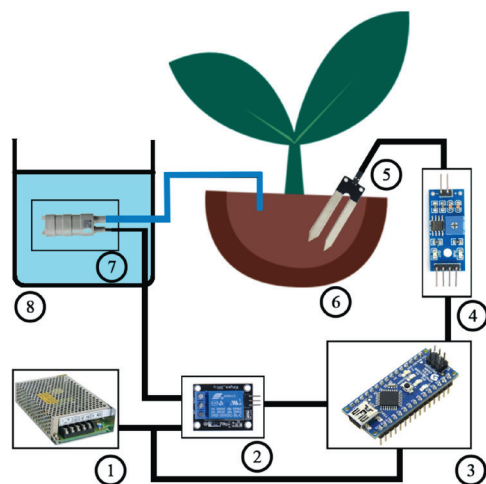
facilities that uses sensor technology to sense soil moisture with a microcontroller in order to make a smart switching device to help millions of people ¹. Can we automatically water our home and garden plants without bothering our neighbors when we decide to go on vacation or somewhere else for a long period²? Since irregular watering leads to the mineral loss in the soil and may end up with rotting the plants, can we then somehow know if the soil really needs to be watered and if so, when exactly do

we have to water the plants? Is it possible in any way from remote location to manage our plants to be watered ?? These are some questions that can be heard quite often and answer on all of them is encouraging and affirmative, because advanced technology provides us very wide range of possibilities nowadays. Actually, there is a very simple and economical solution for all these questions and perplexities. In the form of unique intersection between biological engineering and electronics, the solution requires only a little bit knowledge of electronics as well as that knowledge related to botany and plant physiology.

Materials and Methods

Although there are some companies selling these systems made in various ways, there is a simple way in which one can build his/her own plant watering system in just a few hours, if all required materials are available along with basic required knowledge about electronics.

For the purpose of building this system one will need to properly connect following:



- 1) Power Supply (12V)
- 2) Relay module
- 3) Microcontroller (Arduino Nano)
- 4) Amplifier circuit as part of a soil moisture sensor
- 5) Soil moisture probes
- 6) Plant in the flowerpot
- 7) Water pump
- 8) Water container

Fig. 1. All materials connected into one system.

Figure 1 below shows the connection of all above mentioned materials in the system. (Figure 1)

In our experiment, we connected all required materials exactly as shown in Figure 1 above, in order to test whether our system will work properly or not. Also, the overall behavior and the appearance of our plant, that was subject of the experiment, were observed in the following 30 days.

Working principle

The main working principle behind this system is in connecting the soil moisture sensor, which was previously embedded into the plant, to the Arduino microcontroller, which is also connected to other electronic components listed above as shown in Figure 1. Measurement of soil moisture is done by the sensor which forwards the information and parameters regarding the soil moisture to the microcontroller, which controls the pump. If the level of soil moisture drops below a certain value, the microcontroller sends the signal to the relay module which then runs a pump and certain amount of water is delivered to the plant. Once the enough water is delivered, the pump stops doing its work. Power supply has a task to power the complete system and the recommended voltage should respect the input supply range for the microcontroller, that is, from 7V to 12V. Relay module is a simple circuit consisting of a single transistor, several resistors, diodes and a relay and it is controlled digitally by microcontroller. Since the complete system should be embedded in a small box, Arduino Nano is a perfect microcontroller for this purpose because of its dimensions and its work performance. Soil moisture module is consisting of the two parts: amplifier circuit and probes. This module has digital and analog outputs, where digital output is set to logical 1 when the threshold is activated. The threshold is set by potentiometer. Analog output gives the real time information regarding the moisture in the plant and this output is used in the system. Water pump is connected to the relay module and it only works when the relay module gets a command from the microcontroller, whose working principle is described via flow chart diagram in Figure 2 below as well as by the following pseudocode:

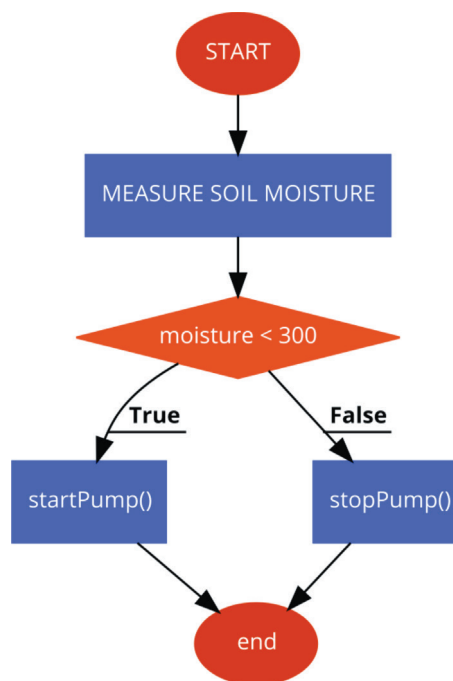


Fig. 2. Flow chart diagram of microcontroller.

Results

Figure 3 below represents results of our experiment in the form of the overall representation of our tested automatic plant watering system based on Arduino microcontroller and sensor technology. As it can be concluded from the picture below, the system has been designed and tested successfully in a successful manner. Also, functionality of the system, as well as the overall behavior of the plant, has been observed in the next 30 days and the results were great as expected and desired. As result of our observation we noticed that plant maintained its homeostasis in desired, regular and health manner without any deficiencies observed. Whenever a need for water was recognized by the sensor, microcontroller sent a signal to the pump to start watering the plant until enough quantity of water was not delivered. The URL of recorded video of this experiment can be found below in reference section⁶. (Figure 3)

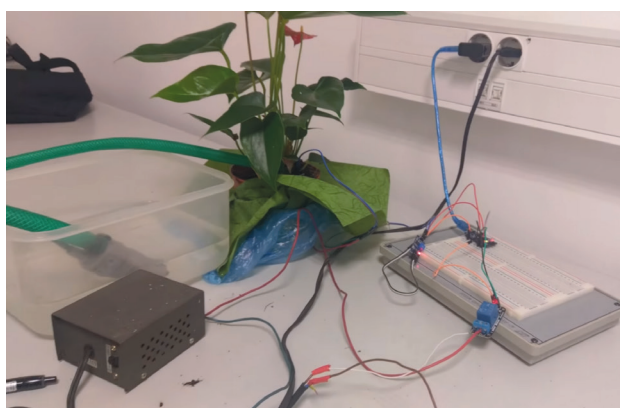


Fig. 3. Testing the automatic plant watering system.

Discussion

Great and expected results of our experiment were concluded from the fact that our plant has successfully avoided dehydration and kept growing without any problems and deficiencies, thanks to the sensor that is embedded within the plant measuring the soil moisture level and controlling the water pump. The system works on the principle of measuring the soil moisture level by means of the sensor technology which in turn controls the water pump via microcontroller in order to provide the plant enough amounts of water when necessary. Next few paragraphs discuss the possible applications of this system.

Automated plant watering system can be used to solve many problems in the world providing both narrow and wide applications and solutions, where for the former there is an example of automated watering of plant whenever someone goes on vacation and leaves plants alone at home, which enables the plants to get the exact amount of required water and prevents irregular watering which leads to mineral loss in the soil; and for the latter application,

there is an example of using this system for medical and agricultural purposes to solve some biggest human-related problems like undernourishment, air pollution and occurrence of respiratory diseases. Being ideal for purposes of having big gardens, plantations or specific plants with own watering needs, this system can be very helpful in agriculture to keep vegetable plants watered for bigger harvest with minimal loss due to water evaporation and runoff³. The fact is that automated vertical farming uses about 10 times less water and a hundred times less land than conventional farming and thus growing the food close to where it's consumed without transporting it large distances contributes to solving the undernourishment as one of the biggest problems worldwide⁴. Farmers from all around the world would be able to automatically and without excessive effort cultivate and breed crops and plantations of these plants that are the most significant, wanted and used nowadays in the diet.

Besides obvious and some listed benefits and utilities in the field of agriculture, there are also various applications of this system for medical purposes. As a medical solution, there is an option to implement this system in cultivating some plants that are effective in removing air pollutants and also in preventing and reducing respiratory diseases and lung dysfunctions, which would contribute to better air and living quality. Therefore, using this system people are able to automatically irrigate and cultivate medically significant and famous plants such as medical herbs, weeping fig, ferns etc., which contribute to the reduction of dangerous, harmful and toxic air pollutants and pesticides like CO, CO₂, formaldehyde, benzene etc.⁵. Also, it would make someone able save the money on medicine. Other problems addressed are time-consuming processes like manual watering of plants and also overuse of water, since sometimes while watering plants manually, people provide a plant more water than it actually needs, which can have various consequences.

Conclusion and Future Possibilities

Although it seems to be more demanding and challenging, there are many other possibilities like creating complex connections of plants of similar variety or so-called »Internet of Plants«. Also, using more than one sensor is another idea for an experimental venture, but there are also many other experimental and challenge-like ideas such as using solar power supply, timer for setting irrigation system etc. However, independently of the way used to construct it, there is no doubt that this system can be very helpful in solving many problems, from those that seem harmless to those that are on the scale of the most important and most dangerous ones for human population. By means of this system, it is possible to control the amount of water released from the process of watering the plant. Although it can be very helpful for humanity in general, agriculturists, craftsmen, and botanists are the people who could have the biggest benefit of using this system.

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AUTOMATSKI SUSTAV ZALIJEVANJA BILJKE PREKO MJERENJA VLAŽNOSTI TLA UZ POMOĆ PRIKLADNE ELEKTRONIKE I NJEGOVA PRIMJENA U ANTROPOLOŠKE I MEDICINSKE SVRHE

SAŽETAK

Ovdje uvodimo sustav automatskog navodnjavanja, koji se danas smatra jednim od najčešće korištenih i najkorisnijih automatiziranih sustava, koji pomažu ljudima u njihovim svakodnevnim aktivnostima smanjivanjem ili zamjenjivanjem njihovog napora pri radu. Ovaj sustav koristi tehnologiju senzora zajedno s mikrokontrolerom i drugom elektronikom, te se ponaša kao pametan komutacijski sustav koji mjeri vlažnost tla i na osnovu izmjerenih parametara zalijeva biljku ako je potrebno. Svrha ovog rada je pokazati na koji način netko može napraviti svoj vlastiti i jeftin sustav automatskog zalijevanja biljaka za samo nekoliko sati, povezujući određene elektroničke komponente i druge potrebne materijale. U našem eksperimentu smo spojili sve potrebne komponente u jedan sistem, na način kako je to opisano u ovom radu, a u svrhu ispitivanja da li će naš sistem raditi onako kako se to očekuje. Iako bi ovaj sustav koji je načinjen na ovaj način bio najprikladniji za kućnu upotrebu kao rješenje za neke svakodnevne probleme, postoji širok spektar mogućnosti za implementaciju ovih sustava koji mogu poslužiti kao dugoročno rješenje za mnoge poljoprivredne i medicinske probleme kao što su, primjerice, neuhranjenost i onečišćenje zraka kao najznačajniji, najopasniji i najvažniji problemi. Kao jedno od mogućih poljoprivrednih rješenja, ovaj sustav može biti vrlo koristan u održavanju povrća i drugih korisnih i specifičnih biljaka uzgojenih za veću žetvu, čime poljoprivrednici iz cijelog svijeta mogu uzgajati usjeve tih biljaka koje su najtraženije i najčešće korištene u prehrani. Kao medicinsko rješenje, ti se sustavi mogu koristiti u svrhu uzgoja određenih biljaka koje su u mogućnosti da uklanjaju toksične tvari u zraku i time smanjuju koncentraciju tih i drugih otrovnih i onečišćujućih tvari u zraku, kao i učestalost pojave respiratornih bolesti. Buduće mogućnosti uključuju neke izazovne i zahtjevne ideje poput spajanja biljaka sličnih vrsta i osobina u složene veze biljaka. Postoje i mnoge druge mogućnosti, poput korištenja više senzora ili solarnih napajanja u eksperimentalne svrhe, no činjenica je da, bez obzira na materijale koji se koriste i način na koji su isti povezani, ovaj tip automatiziranih sustava može biti vrlo koristan kao rješenje mnogih ljudskih problema.