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RESEARCH ARTICLE

Cloud based garden watering system

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ABSTRACT

Plants play a vital role in our everyday life. They are an inseparable part of our ecosystem and hence it is essential that we nourish them properly. Watering plants is one of the basic steps of their nourishment. With the development of Internet of Things, most of the day-today tasks are automated. It will therefore be a great aid to the farmers and gardeners if the task of watering the plants is automated. The aim is to develop a system which waters the plants and also stores the moisture content value for future use. Agricultural industry is however based on a large scale. It is therefore evident that data generated will be large in terms of volume and variety. The main aim behind this project is to store the large amount of data generated by these sensors in a cloud storage. The solution we present is economically viable as well. The cost of sensors is very low and the prices of memory are also going down as well. Therefore, this becomes a very compelling approach. Moreover, the Internet of Things (IoT) is growing rapidly day by day. With advancement at this rate, the device to device communication will be easier and this will revolutionize everyday chores. We also aim at developing a less complicated circuitry i.e. which involves less hardware components and more software components so that any user, irrespective of their level of familiarity with operating the devices. In the software component, the modules should be pre-programmed and more user-oriented. In such a manner, we can develop a user-friendly and less complicated device for garden watering.

Key words: IoT, Android, ThinkSpeak, Cloud, Reliability, Resolution, Sensor, Synchronous.

INTRODUCTION

Gardening is essentially a manual initiative. In such a situation, the gardener is vulnerable to various health hazards. These hazards are mainly attributed to the long-time exposures under the sun, proximity with bacteria in the soil (which may be harmful). Such conditions have led to respiratory illness due to organic and inorganic dusts present in the gardens, lip cancers, myeloma and leukaemia due to phenoxyacetic acid present in herbicides (Kirkhorn *et al.,* 2001). To emphasise these harmful effects, we present an example of the survey conducted in Australia. Approximately 16% of the people in Australia died in farms due to reasons such as poisoning due to pesticides, sunburn and heat strokes. Adding to that between 2003 and 2011, there have been 356 deaths on the farms of Australia. This made farms one of the most dangerous workplaces in Australia (Farm safety risks and hazards). Hence, it is imperative that the process of watering the farms and gardens is as automated as possible. This approach reduces the man power involved in water gardening. An automated system will therefore not usually require the presence of the gardener or farmer. There are several ways in which the process of watering the gardens and farms can be automated. The Internet of Things (IoT) is one of the best possible ways to achieve this approach. The IoT is basically an interconnection of various devices which communicate with each via the Internet. This branch has evolved rapidly in the past few years. In its most rudimentary form, IoT began in 1832, in Russia when Baron Schilling created anelectromagnetic telegraph. The next year, in 1833, Carl Friedrich Gauss and Wilhelm Weber designed a code to communicate over a distance of 1200 m within Göttingen in Germany (Internet of things history). Since then, the developments in this field have been fast paced. Moreover with the addition of the various communication protocols, this field is essentially revolutionary. Statistically speaking, in the year 2016, IBM invested $3 billion in its IoT business. In the same year, Samsung committed to connect everything it sells by 2020 generating a multi-million dollar revenue (Mohammed, 2016) There is also a claim by Cisco's former CEO, John Chambers, that there would be 50 billion devices online within the next five years with a market worth $19 trillion. This worth enables IoT to even start a fourth industrial Revolution (Scott). Evidently, IoT is more than just a technology, it is a money spinner. Sensors are devices which can be used to achieve communication among various devices. They respond to optical and electronic signals. A physical parameter such as temperature, humidity etc. is converted to an electronically measurable signal. A good sensor needs to be highly sensitive, less power consuming and should create fewer disturbances. It should also have a very high resolution. They can be classified into many types based upon primary input quantity, transduction principles, material used, technology adopted for functioning, properties and applications (Deif and Gadallah, 2014). Some examples of

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sensors are temperature sensors, proximity sensors, level sensors, pressure sensors and so on. However, for the implementation of this project we have used moisture sensors. Sensor can be understood as a collection of electrodes which bring about a change in the electrical components such as electrical permittivity of a circuit. The variations arise due to the inputs on these electrodes. Arduino is an independent platform which provides hardware and software services to build digitally interactive microcontroller kits and devices. It can interact with buttons, motors and even GPS units. The Arduino board has various components such as LEDs, voltage regulators and points to which wires are connected commonly referred to as pins (Schmidt, 2011). It basically interfaces the sensor with the computer through which the working of the Arduino can be controlled. It provides a software platform, in which programs can be written to control the Arduino components. The Arduino boards are available in different types such as Arduino Uno and LilyPad Arduino etc. (Schmidt, 2011). Based on the use, a specific Arduino family is used. In a given scenario the data generated by the sensors can be huge. For obvious reasons, this data cannot be stored in a computer. Hence we require cloud. It is one of the most sought after approaches to store data. Not only data storage, cloud computing provides Infrastructure as a Service (IaaS) and Platform as a Service (PaaS) to enable the user to create his/her own computing environment. It is used in profitable business ventures and is expected to expand its market to $40 million by 2018 (TongKe, 2013). It is cheaper in the long run. Data storage in cloud has many advantages. The data is relatively safe on the cloud environment than in our own computers. It is more secure as access rights are involved. Moreover, data on a cloud computing environment is safe from catastrophic failures such as earthquakes, weather changes and so on. We begin by discussing the related works in this and their limitations and then propose a system for the same. We then present the results of our experiments and end the analysis by discussing the future prospects of this approach. A familiarity with the structure of the Arduino UNO Board, its programming and electrical circuits is required to understand and appreciate this work.

METHODS

There have been commendable works in finding new, easier and cost-effective watering systems. The systems proposed in these works are based on the novel concepts of image processing, smart phones and so on. The main highlight of this paper is the emphasis on permanent data storage. One of the system proposed utilizes the image processing concept (Jagüey et al, 2015). In this approach relative wet soil estimation is done via obtaining images of soil with varying water contents and the corresponding histograms are plotted. An App is created in smartphone using Android Studio SDK. The algorithm then asks the user to give time as input in order to start the periodical process. The resolution of the camera is then adjusted and with the interaction of various components, according to the generated image, the farm or the garden is irrigated. One of the major advantages of this system is that it does not involve a lot of man power. The user is expected to give the input through the smart phone on the basis of which the image is taken, enhanced and then the watering starts. However, an input from the user is a must to initiate the entire process. Circumstance may arise in which the user may not provide the input and then the farm or garden will not be irrigated. In cases where, the user wishes to see the moisture content in the plants over a given interval, for example, a week, cannot be achieved as there is no permanent data storage. A similar approach is discussed in (Arvindan and Keerthika, 2016), which makes use of android smart phones. As compared to the above approach which uses an irrigation sensor, this approach uses moisture sensor. This system shares the same advantages as the approach mentioned in (Jagüey et al, 2015). In addition to that, instead of supplying a numerical value, the user has to just say ‘Yes’ (y) or ‘No’ to turn ON the motor. This is easy to understand from a layman’s perspective and at the same time involves less human intervention. The major highlight of this approach is that it focusses on reducing the greenhouse effect and also focusses on precision agriculture. However, the data generated is not permanently stored. Both the approaches, however, require smart phones. The circuitry is also quite bulky and complicated because the two systems are not very cost effective. This limits the scope of these approaches as not all the farmers or any other user have smart phones. Such people cannot make use of this technique by themselves. Another approach which is based on precision agriculture uses Wireless Sensor Networks (WSN) and the Global System for Mobile (GSM) module (Harun et al, 2015). As WSN and sensor systems are less expensive, this is a cost effective solution.

The major advantage of this module is the end user visualization. The architecture involves several XBee which capture the moisture. The data collected from the various areas of the field is transmitted to a central system which displays the data in graphical form. It is integrated with multiple routers present in the network in a mesh topology for wider coverage. However, there is a need to always power up the router for data availability. In catastrophic situations when the power is not available, the system will cease to work. Also, the mesh topology used results in a bulky setup. It is therefore difficult to use is small spaces. The methodology discussed in (Malge and Bhole, 2015) also uses a GSM module. This approach is however more precise. Instead of moisture sensors, temperature sensors, water level sensors, rain detector sensor and three phase detector sensor are used. The objective is to reduce the wastage of water. In case of rains, there is no need to separately deliver water. However there is no scope for data visualization and storage in this approach. Compared to (Harun et al, 2015), it involves greater number of sensors and is more precise.

An algorithm which is based on the prediction of rain is also developed (Nagothu, 2016). The data from the Indian meteorological site us loaded into a microcontroller. Human command is required to ON or OFF the system. As per the dryness of the soil which is classified in two ways: ‘dry’ and ‘very dry’ necessary steps are taken. If there is a prediction of rain in immediate five days then the control of the system is left to the human. Consider a scenario when there is a prediction of rainfall in the immediate five days and the human decides to turn ‘OFF’ the system. However, in the course of the five days the dryness of the soil goes from ‘dry’ to ‘very dry’ but the human still does not turn ‘ON’ the system, the plant will be harmed. The ‘ON’ and ‘OFF’ commands are in control of the human. This system is therefore susceptible to human errors, like turning ‘ON’ the system even during rains which results in the wastage of water, decreases its reliability. The system may suffer setbacks due to the unpredictability of the weather or in cases when Indian metrological site is not reachable for reasons like maintenance etc. but the proposed algorithm does not handle these exceptions.

Proposed method

The proposed method involves data storage in cloud. The storage is permanent but can be deleted if the user wishes to. Additionally, the circuit is less bulky and is easily transportable. It is not restricted by the geographical constraints as it does not require a lot of space. Instead of using a GSM module, API in ThingSpeak(Acharya and Kuzhalvaimozhi, 2015) can be created which can be used to not only message but also email the results. They can also be uploaded on the Google Drive. We display watering only for one pot. Hence, we use only one moisture sensor. Based upon the number of pots, the number of sensors can be increased. Figure 1 shows the circuit developed. The various components of the project are described below.

Figure 1. Proposed system

Hardware Components

- **Soil Moisture Sensor:** It is used to measure the water content in the soil. The dielectric permittivity in the can be expressed as a function of the water content present in it. The sensor therefore generates a voltage proportional to the dielectric permittivity and therefore to the water content in the soil.
- **Stepper Motor:** It is a brushless, synchronous electric motor which converts digital pulses into mechanical shaft rotations. It can receive only one pulse and take one step at a time and each step is of the same length. In case of multiple pots, this is used to direct the pipe to the particular pot. After its operation it is reset to its initial position.
- **L293D IC:** It is a 16 pin IC based on the principle of H-Bridge. It allows the DC motor to drive on either direction. There are 4 input pins for this IC. Left input pins regulate the rotation of motor connected across left hand side and right input for motor on the right hand side of the IC. The motors are then rotated on the basis of the inputs provided across the input pins as 0 or 1.
- **Servo Motor:** It is controlled by sending an electrical pulse of desired width through a control wire. It can turn only 90° in either direction for a total of 180° movement. The servo motor expects a pulse every 20 milliseconds and it is the length of this pulse which determines how far the motor will turn. In the circuit it used for water supply. Once it starts rotating, the water can be supplied.

Software Component

The program for this circuit is written in Arduino programming language. Arduino provides a wide range of libraries for efficiently programming the circuit. The program in Arduino assigns a predetermined range of resistance value in a digital format (from 0 to 1023) for the moisture sensor. If there is a deviation from this range, the pump is switched ON or OFF depending upon the program. In addition to that, we have used a software called CoolTerm (A Simple Serial Port Terminal Application) in order to capture the results which were supposed to be obtained on the serial monitor, on the monitor of this software instead. These results are then captured into a text file so with time stamp so that it can be uploaded in the cloud.

Cloud Environment

The cloud environment is established on a platform called Thing Speak (Acharya and Kuzhalvaimozhi, 2015). A channel named Garden Watering System is created. The text file created is then uploaded on this channel.

Working

The sensor is dipped in the soil. It then reads the moisture content value which is then converted into an analog reading (from 0 to 1023). If the value read is less than the threshold value 600, the stepper motor rotates to the required angle and the Servo motor will start watering for 15 seconds. After this delay the stepper motor is given time to get back to the initial position and the process can be started all over again. The data obtained is then captured to Cool Term monitor and converted to text file. This text file is uploaded in the Thing Speak channel.

RESULTS AND DISCUSSION

Obtaining the Data

Once, the USB cable of the Arduino is connected with the cable, the stepper motor is set and the moisture sensor begins reading values and displaying them on the CoolTerm Monitor. We first configure the CoolTerm platform. Click on Connections->Options.

Step1: Choose the port as per the family of Arduino use and set the Baud rate. By default it is set 9600. The port used is COM4.

Step 2: Click on Receive and check the label “Add timestamps toreceived data”. This will enable the software to capture the readings with date and time (with precision upto seconds)

Step 3: Now Click on Connect. The readings will start appearing on the monitor. Now, the main objective behind this project is to store the data obtained at a permanent location so that it can be used for graphical plots and other types of analysis. To achieve this we capture the above data in a text file by clicking on Connection->Capture to Text File-> Start.

Step 4: When the user wishes he/she can terminate the connection by clicking on 'Disconnect'. The captured file will be available at the location chosen by the user. The text file is obtained in the following format:

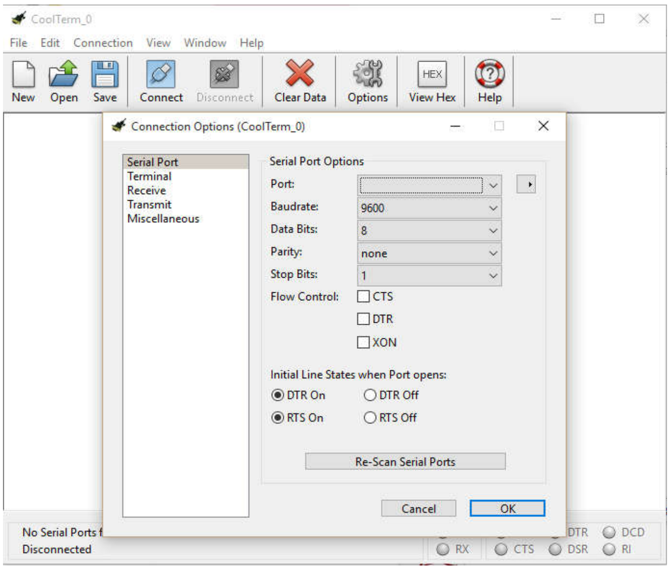

Figure 2. Selection of port

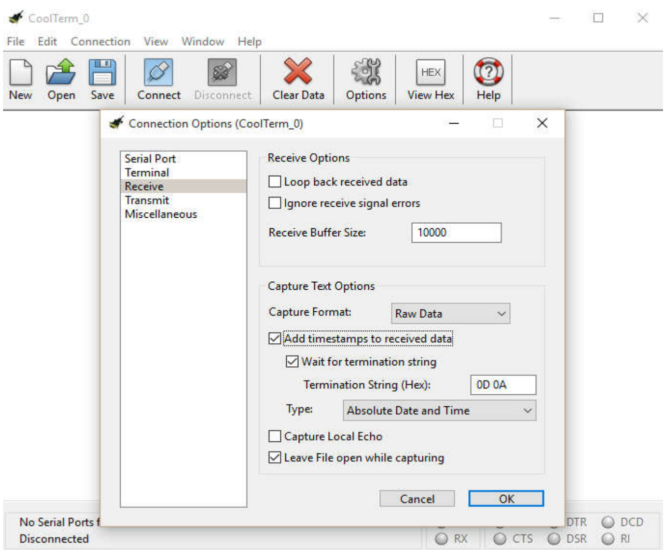

Figure 3. To add timestamp along with the readings

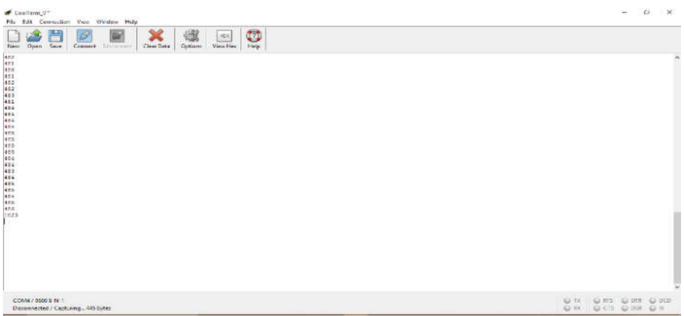

Figure 4. Serial Monitor outputs obtained on Cool Term Monitor

Storing the Data

Step 1: The data obtained needs to be copied in excel worksheet and it needs to be saved in .csv format. This data is then uploaded to the channel. For the above text file, the corresponding excel sheet is shown below.

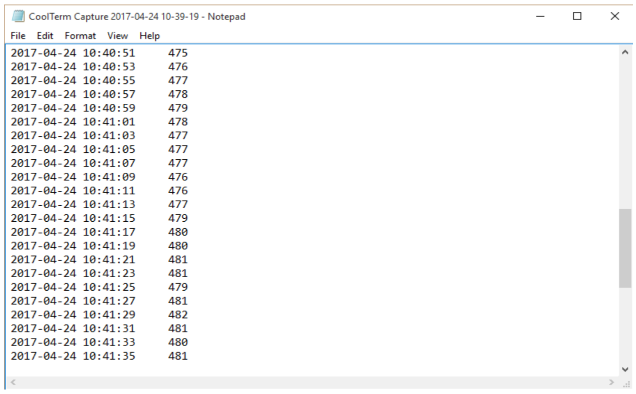

Figure 5. Text file obtained during the process

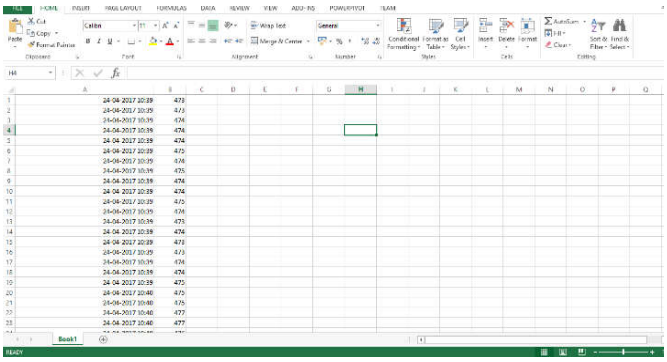

Figure 6. Excel Sheet which is obtained from the text file

Step 2: In the Thing Speak website, open the channel you wish to upload the file to. In this case, we upload the file to the channel named 'Garden Watering System'. This is shown below.

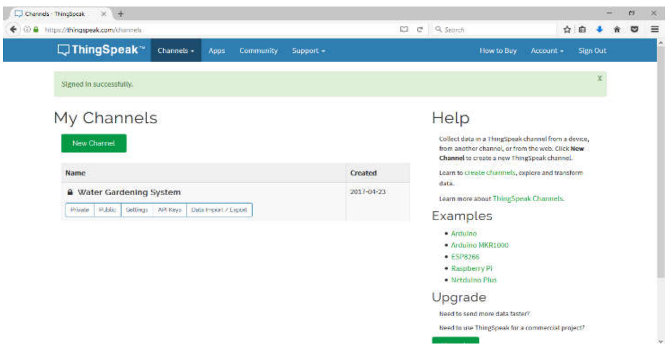

Figure 7. Channel created in Thing Speak to upload data

Step 3: Click on 'Data Import/Export' and browse for the file you wish to upload.

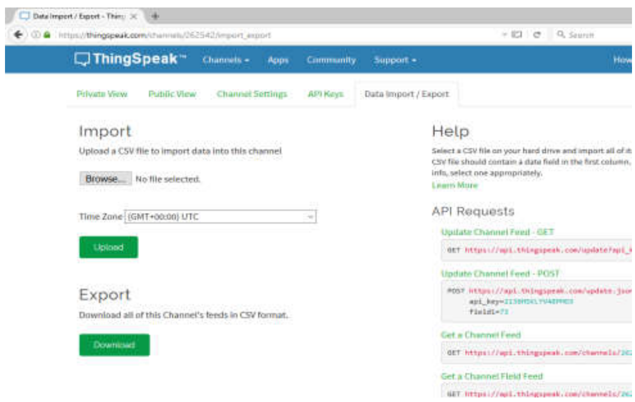

Figure 8. Browse the file to be uploaded

Step 4: Upload the file in .csv format.

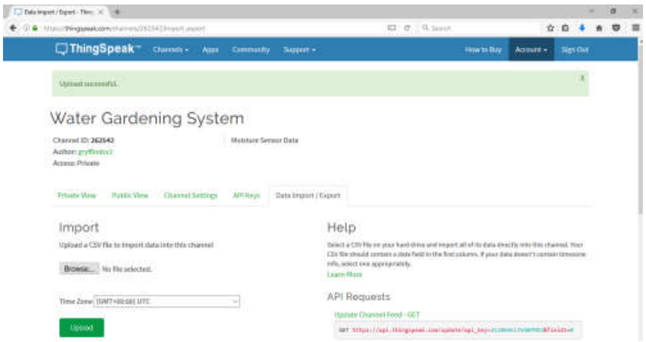

Figure 9. File is uploaded successfully

Conclusion and future enhancements

An automated garden watering system has been successfully implemented. Due to the low prices of sensors and memory, it is a very cost effective solution. Unlike other systems, this system in cooperates cloud platforms. The major advantage of this system is less complexity and permanent storage of data. This is particularly important in cases where the data is important to draw conclusions about a certain parameter or for statistical analysis during surveys. This will help improve the quality of the flora in the garden and help in identifying the flaws in people's way of gardening. We can also analyse the impact of the use of various chemicals on these plants and according mend our ways. Unlike its counterparts, this system is much more flexible. The human intervention in this system is minimal. This is particularly useful to farmers who now do not have to stay outdoors for long hours and expose themselves to various chemicals and bacteria. This will reduce chance of the various diseases which can be caused due to the exposure. Moreover, the system is less bulky and in case of multiple pots only the number of sensors needs to be increased. The cloud platform used provides options for developing APIs which can be used to automate the process of data transfer. Also, multiple channels can be created for different use in a single platform.
Plants require different types of soil for their growth and nourishment. Each type of soil has different water handling capacities. The system can be enhanced to support the multiple soil types. In addition to that, APIs available in Thing Speak can be used to create message transfer services. These services include mail, text messages to mobile and even the facility to upload on Google drive. Also, the sensors can be improvised so that they are sensitive to the plant requirements since each plant can also require different amounts of watering. In such situations, the sensors need to be "smart" enough in order to provide the right amount of water to the plant (Wang et al,2006). Such tasks can be accomplished using GPS modules which generates the coordinates of the location of the plant with the help of which the amount of water to be delivered can be regulated.

REFERENCES

Acharya, C. and Kuzhalvaimozhi, S. 2015. Irrigation and Internet of Things Platform.

Arvindan, A. N., and Keerthika, D. 2016. Experimental investigation of remote control via Android smart phone of arduino-based automated irrigation system using moisture sensor. In Electrical Energy Systems (ICEES), 2016 3rd International Conference on (pp. 168-175).IEEE.

Deif, D. S., and Gadallah, Y. 2014. Classification of wireless sensor networks deployment techniques. IEEE Communications Surveys & Tutorials, 16(2): 834-855.

Farm safety - risks and hazards https://www.betterhealth.vic.gov.au/health/healthyliving/farm-safety-risks-and-hazards.

Harun, A. N., Kassim, M. R. M., Mat, I. and Ramli, S. S. 2015. Precision irrigation using Wireless Sensor Network. In Smart Sensors and Application (ICSSA), 2015 International Conference on (pp. 71-75). IEEE.

Internet of Things (IoT) History https://www.postscapes.com/internet-of-things-history/ (accessed on 15 March 2017)

Jagüey, J. G., Villa-Medina, J. F., López-Guzmán, A. and Porta-Gándara, M. Á. (2015).Smartphone irrigation sensor. IEEE sensors journal, 15(9): 5122-5127.

Kirkhorn, S., Schenker, M. B. and Joseph, I. S. (2001, March). Human health effects of agriculture: physical diseases and illnesses. In Agricultural Safety and Health Conference: Using Past and Present to Map Future Actions.

Malge, S. and Bhole, K. (2015, May). Novel, low cost remotely operated smart irrigation system. In Industrial Instrumentation and Control (ICIC), 2015 International Conference on (pp. 1501-1505). IEEE.

Meier, R. CoolTerm: A Simple Serial Port Terminal Application.http://freeware.the-meiers.org (accessed on 15 March 2017).

Mohammed, J. 2016. "5 predictions for the internet of things in 2016.". Hämtadapril, 14.

Nagothu, S. K. 2016.Weather based Smart watering system using soil sensor and GSM. In Futuristic Trends in Research and Innovation for Social Welfare (Startup Conclave), World Conference on (pp. 1-3). IEEE.

Schmidt, M. 2011. Arduino.Pragmatic Bookshelf.

Scott, A. 8. ways the Internet of things will change the way we live and work..

Tong Ke, F. 2013. Smart agriculture based on cloud computing and IOT. Journal of Convergence Information Technology, 8(2).

Wang, N., Zhang, N., and Wang, M. 2006. Wireless sensors in agriculture and food industry Recent development and future perspective. Computers and electronics in agriculture, 50(1): 1-14.

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