

# Wireless Remote Controlled for Multi-station Irrigation

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**Abstract:** This paper presents the development of a wireless remote-controlled system with dual-tone multi-frequency (DTMF) signaling transmitter using android application system for multi-station irrigation and fertilizer dispersion. Fertigation are combination of two words which are fertilizer and irrigation. To be more precise, fertigation is the process of applying fertilizer through an automatic irrigation system. Plants need enough both of nutrients and water supply in order to grow up and produce a high market value crop. Inaccurate amounts of water and fertilizer can lead to unhealthy plants growth and the worst is, the plants will be dead. Although there are the timer-based fertigation systems, the system cannot control the exact amount of fertilizer and water needed by the plants as they operate by supplying same amount of water and fertilizer in a specific time set without considering the weather and soil condition. The android application system allows users to send commands from their smart phones to control various type of appliances such as lighting, watering, timer or even fertilizer. The system is equipped with Arduino Uno and relay drivers circuit for controlling the system appliances. The system is suitable for long range control applications which mean can be control by any device that using dual-tone multi-frequency signaling transmitter from anywhere in the world.

**Index Terms:** Wireless remote-controlled; Multi-station irrigation and fertilizer dispersion; Dual-tone multi-frequency signaling transmitter

## I. INTRODUCTION

All Fertigation are combination of two words which are fertilizer and irrigation. To be more precise, fertigation is the process of applying fertilizer through an automatic irrigation system. Plants need enough both of nutrients and water supply in order to grow up and produce a high market value crop. Inaccurate amounts of water and fertilizer can lead to unhealthy plants growth and the worst is, the plants will be dead [1].

Although there are the timer-based fertigation systems, the system cannot control the exact amount of fertilizer and water needed by the plants as they operate by supplying same amount of water and fertilizer in a specific time set without considering the weather and soil condition. Therefore, the systems will not supply the nutrients and water needed by the plants optimally. The investment in using the conventional system in doing fertilizers and pesticides spraying, such as backpack (knapsack) sprayer to spray pesticides and fertilizers and sprinkler irrigation method that will be wasteful and can cause to suffer lost in their profit due to

miscalculation of management for fertilizer and water.

DTMF signaling is an in-band telecommunication signaling system using the voice-frequency band over telephone lines between telephone equipment and other communications devices and switching centers. DTMF was first developed in the Bell system in the United States and became known under the trademark Touch-Tone for use in push button telephones supplied to telephone customers, starting in 1963. The Touch-Tone system using a telephone keypad gradually replaced the use of rotary dial and has become the industry standard for landline and mobile service. Other multi-frequency systems are used for internal signaling within the telephone network [2].

The use of Android Application and DTMF system to control irrigation systems based on the condition precisely will make the fertigation systems not just affordable, but very effective towards better crops production as well. By DTMF signaling and Android Application controller system, it can also help farmer reduce their time consumption. Mobile phone acts as receiver and transmitter to access and control the agricultural farm basic farming system remotely such as turn ON or OFF the solenoid valve [3, 4].

Farmers are mostly still using conventional methods such as backpack (knapsack) sprayer to spray pesticides and fertilizers. This method is used mainly involves a lot of workers which have many disadvantages in term of labor costs and unproductive yield. Most of Asian nations are at developing stage and they are facing the problem of high population and as compared to that agricultural productivity is much lower as compared to developed nations. This is caused due to low level farms, insufficient power availability to farms and poor level of farm mechanization.

In order to meet the requirement of food of growing population and rapid industrialization, there is a need of the modernization of agriculture sector. On many farms production because, delay in sowing, improper distribution of pesticides and fertilizers. Mechanization solves all the problems which are responsible for low production. It conserves the input and precision in work and gets better and equal distribution. It reduces quantity needed for better response, prevent the losses and wastage of input applied. It gets high productivity so that cost of production will reduce.

Therefore, this project is proposed to assist farmers in order to manage the activities of the farm pesticide and fertilizer spraying to be more effective. The new pesticides and fertilizer spraying method is developing by using Android Application and DTMF.

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The objectives of the development of a wireless remote-controlled system with DTMF signaling transmitter using android application system for multi-station irrigation and fertilizer dispersion are as follow:

a) To design, model and fabricate a prototype of DTMF signaling for water and fertilizers dispersion control system mechanism.

b) Verify the comprehensiveness of the prototype in term of reduce expenditure, increase crop yield and creating a more environmentally friendly farm.

The scope of project is mainly applying modern technology which is DTMF signaling and Android application on farm for controlling system on irrigation. The technology used, bring new change in producing a high productivity with high quality. Moreover, the precision of nutrients will create an advantage to farmer in reducing production cost as it creates high productivity. To ensure the project achieve goals with right direction the scopes has been defined as follow:

a) Build agricultural system that can be control by using phone through android application and dual tone multi frequency signal.

b) Design virtual irrigation system that consist of piping system for dispersion control system and farm layout by using SolidWork software.

The main hardware developed in this project are PIC Circuit (Arduino Uno) that used to store the program and manage the operation of embedded systems such as controlling relay and solenoid valve. Arduino Uno which have serial communication allow interfacing with smart phone to transmit and receive signal.

Arduino software are used in writing program that are to be used in microcontroller. The program will be compiling into source code where it needs to be right in assemble language before being transfer into microcontroller to execute all operation in this project.

Other than that, SolidWork2015 are used in designing layout of control system and farm to ensure the system is installed correctly and easy to understand by farmer. Piping system consists of water storage, fertilizer storage, valve, overflow system, motor, filter, main pipe, and mini tubing lastly into the dripper. For farm layout consists of piping system, crops and overall farm layout. By having this virtual design, it will make easier to install the system for farmer and easier to understand by other farmer that want to apply the system on their farm.

## II. LITERATURE REVIEW

Nowadays, Farmers attracted to toward organic farming which result in avoidance of losses and wastage of input applied to farm [5]. The attracted of farmers as can realize change technology from traditional to modern in increasing productivity and efficiency while keeping maintaining cost low. Choosing of fertigation system by distinguishes between advantages and disadvantages of drip irrigation system and overhead (sprinkle) system. Several advantages of drip irrigation system such as fertilizers that can be used through the dripping system when necessary. Reducing the size needed and the amount produced of each nozzle can be controlled by great effectiveness and great water application

efficiency and lower workforce rate due to the automated system [6].

Meanwhile, for overhead irrigation system there also have several advantages, but the disadvantages of this system such as higher potential for evaporation and wind drift issues compared to drip make it not suitable to be chosen to meet the object which is reducing cost [7]. After analyzing the advantages and disadvantages of these systems, dripping system is the most suitable to meet those require on object.

To meet the object, dripping systems have been choosing and that consists of several components. Moreover, the system components require several things such as water source, pumping and distribution systems. The pumping system move water through the distribution system from the water source to the field. Meanwhile, the distribution system transports the water from its source to the field. In addition, the drip tape is used to transports the water over a thin polyethylene tube to every plant. Besides, in order to prevent clogging condition, the filtration system is applied to guarantee the water particles is smaller than the emitter size. Lastly, the controls system devices permit the user to monitor the performance of drip-irrigation system and help to guarantee the required water amount is applied to the crop is attained during the growing season [8].

The blend of technologies that offered to overcome in reducing men-hands through the system as an entire cost saving particularly in the industrial sectors and for developing systems to fulfil running necessities rather than reengineering. In addition, the controlling system is a flexible instrument to develop in order to replace the outdated controlling practice. Moreover, the construction of the system is divided into three main parts which are: personal computer, cellular mobile network and integrated circuits to display, explain, and simplify the controlling signal conversion from a user to the controlled devices. Furthermore, the system structure consists of hardware and software tools. The hardware is applied via communication network for interfacing and sequences flow of logical control signal in between devices and user [9].

Proposition of novel remote-control method based on mobile abilities to regulate a driving motor circuit which in order will control and monitor the path of direct current motor. Furthermore, it shows how to regulate and monitor the path of direct current motor remotely using mobile methods. Hence, the certainty of usage of mobile in tele-remote system was stimulated by numerous factors for example, the vast number of publics that practice mobile phones in their everyday lives, small cost of mobile communication and present infrastructure that provisions mobile communication transversely the globe such as global system for mobile (GSM) [10].

Chemigation is referring to the chemical application into or through the irrigation arrangement. It covers the submission such as fertilizers, chlorine, acids and pesticides. Fertigation is the fertilize application over the irrigation system. Acidification is the primer of an acid, for example phosphoric, acid hydrochloric or sulfuric into the irrigation



system. Meanwhile, chlorination is the outline of chlorine, such as chlorine gas and liquid sodium hypochlorite into an irrigation system. Since the drip emitters are small, they will clog straightforwardly. Furthermore, a suitable filtration system is essential to avoid the water-borne and soil particles debris into the drip tubes. Extra anti-clogging techniques comprise acidification, which removes or prevents mineral precipitates, and chlorination, which eliminates and avoids the development of algae and bacteria [11].

### III. EXPERIMENTAL

Fig. 1 show the block diagram that used in this development. A digitized command codes will be sent to another GSM cell phone which will be in auto answering mode at the receiving end. Then, it will identify the frequency of the key send by the first cell phone. After that, it will convert the frequency to a digital code. The Arduino will receive the codes from the receiving GSM cell phone. A specific programmed written in Arduino is used to recognize those codes. Then, based on the instruction embedded in the codes, the programmed in Arduino will activates all the related outputs through its relays and relay drivers. Then, microcontroller will control the relay when to turn On and Off depending on input signal. Meanwhile, Fig. 2 show the Arduino DTMF interfacing circuit and Fig. 3 show DTMF Decoder Interfacing.

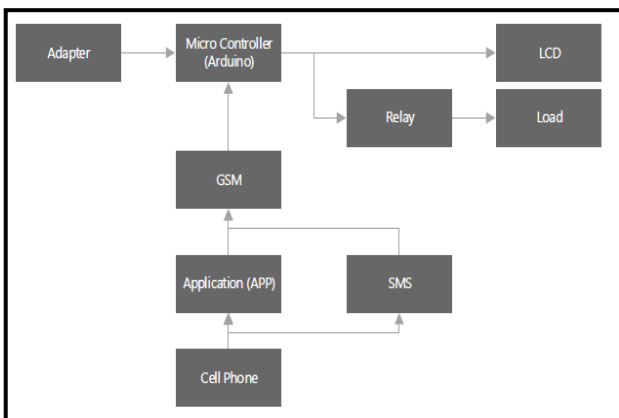


Fig. 1 Block diagram of DTMF and android application

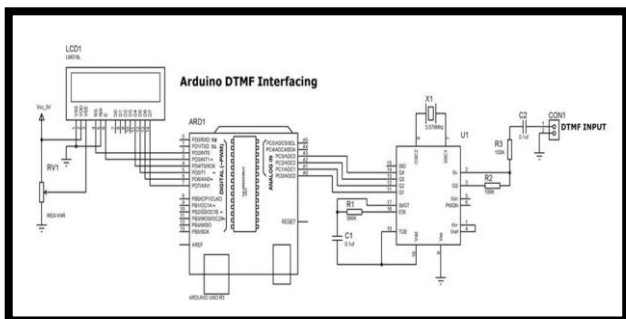


Fig. 2 Arduino DTMF interfacing circuit

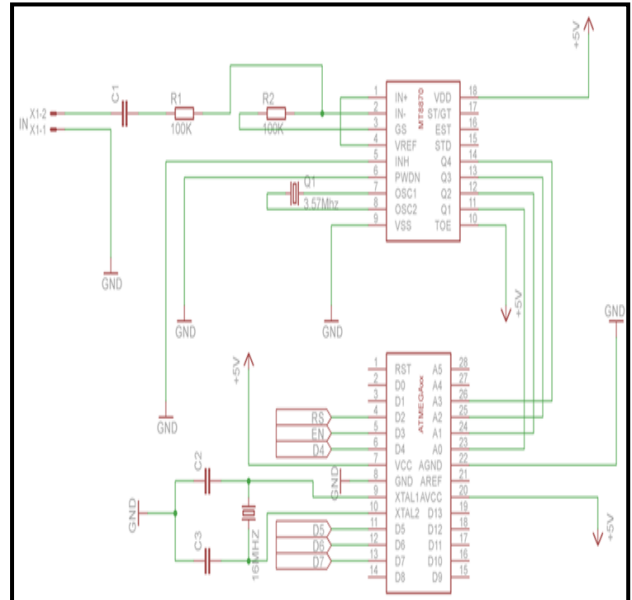


Fig. 3 DTMF Decoder Interfacing

The prototype used a 240V AC single phase power supply to power the control system. Its only need to plug in to the nearest socket outlet 13A. In the controller panel, there is a DC voltage power supply which power by the AC single phase. The DC power supply will reduce the 240V AC to a 12V DC for the solenoid valves and 5V DC for the electronic controller Arduino. If the system implements a larger size plant, so the power supply needs to be recalculated in order to eliminate power losses to the components and devices which will interrupt the running of the whole system.

A solenoid valve is one of the main components in the development of the prototype. It will be control by the controller automatically. Solenoid valve is a valve which is operated electromechanically. It is also known as solenoids. In order to control the opening and closing of the valve, an electric current will be flown to the solenoid which will activate its anchor and open the valve. When the current it cut off, the solenoid will de-energized and deactivate its anchor and close the valve. It is used to control the flow of fluid or gases in a system. There are many types of solenoid valve such as one-way valve, two-way valve and three-way valve. Solenoid valve is widely used in the industry such as in sprinkler system and domestic washing machine due to its high reliability and compact design.

Fig. 4 show the App Inventor for Android application which is one of the open-source web application originally provide on Google, and now maintain along the Massachusetts Institute of Technology [MIT]. It allows new arrivals to computers programming to design software applications for the Android operating systems. Its use a graphic interface, very the same to as Scratch and a Star Logo TNG graphical user interface, which allow users to drag and drop vision objects to create an application that can run on Android's device.

In designing App Inventor, Google's drew upon significant prior analysis in educational computer, as well the

work already within Google on online development surroundings.

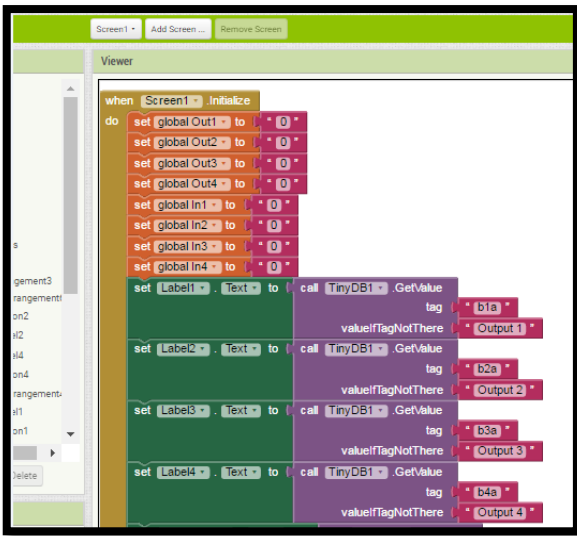


Fig. 4 Building block of MIT app

MIT App Inventor and the projects on which it is based are informed by constructionist learn theories, which impress that a programming can be a vehicle for attractive powerful ideas through active learning. Like, it is a part of an in-progress movements in computer and education that begin with the work of Seymour Papert and the MIT App Inventor Logo Group also demonstrate itself with Mitchel Resnick's work on Lego Mindstorms and Star Logo.

Fig. 5 show the SolidWorks design of a 3D prototype. SolidWorks is a computer-aided design (CAD) software which provide various solid modelling tools for the user. It is widely used in the education and industry sector either by students, lecturers, researcher or entrepreneurs. SolidWorks is based on Parasolid modelling kernel which is widely used in 3D modelling software.

It used numeric and geometric parameters. Examples of numeric parameters are length of line and diameter of circle. Meanwhile, examples of geometric parameters are parallel and tangent. In order to capture the design intent, by using relations, the numeric parameters are easy to be associated. The development prototype designed by using SolidWorks consists of complete piping system of real system which have water tank and fertilizer tank, which only cover eight crops.

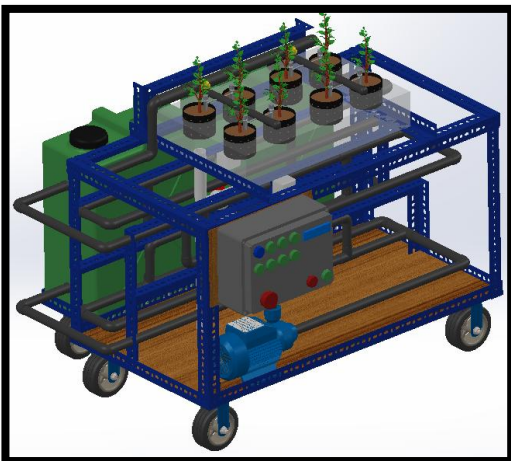


Fig. 5 3D view design of prototype using SolidWorks

Fig. 6 show layout of components using Fritzing. Fritzing is one of the open source hardware available in the electronics industry and education sector. It is user friendly software which provide software tools to make learning become easier and fun. While making project more accentuated such as for students or researcher. The user can present the project for example the layout of the components and circuit wiring in a better arrangement so others can understand it clearly and easily.

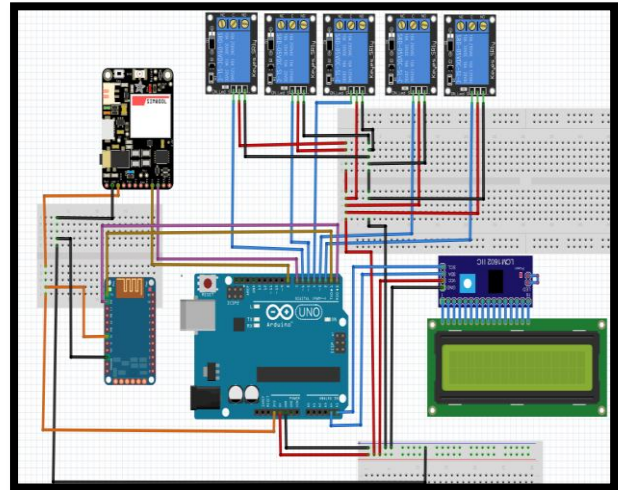


Fig. 6 Layout of components using Fritzing

#### IV. RESULTS AND DISCUSSION

Fig. 7 show the initial start of application, which have two boxes, one for setting and the other one is begun to start the system. In setting function, it will set the number that use for system and command to turn the system on and off. Once complete, the setting will be saved and press the begin box to begin the system by set all the timer for each function.



Fig. 7 MIT App Inventor layout for Android Application

Fig. 8 show the complete prototype of the system. Components are placed safely and can be access easily for maintenance purpose.



## V. CONCLUSION

All electronic components are placed away from heating elements such as power supply and grouped together. All electrical components are properly installed and wired. Piping and tubes are properly installed.



Fig. 8 Prototype of the complete system

Fig. 9 shows the system is ready after the LCD displays the status "SYSTEM READY" and all indicators turn off except "Source".



Fig. 9 Indication of the system in ready mode

Fig. 10 shows the system is in the first command mode (Motor), which opens the pump for the water tank. The water will flow from the water tank into the piping system.



Fig. 10 Pump is on

Generally, this project is mainly for the agricultural sector in controlling a farm remotely from a long range of distances or locations. The first objective is achieved, mainly to design and fabricate a prototype of DTMF signaling for water and fertilizer dispersion control system mechanism. This is proved when the system is fully functional with all the commands given by the user. By having this system, it benefits the farmer in controlling their farm with their own self as a result in reducing man power and labor cost.

This situation makes the second objective well achieved, which reduces expenditure, increases crop yield, and creates a more environmentally friendly farm. The product is assumed to be user-friendly and suitable to any type of farmer and class of owner. It is very easy to install and free maintenance. The conventional system can be easily upgraded to this system. The system can be controlled manually or electronically from a distance, which gives more advantages to the farmer. If compared to existing marketed products, this module is still considering lower cost besides being affordable to be installed into the farm.

## RECOMMENDATION

There are few recommendations that need to be done to fabricate an effective model and upgrade the programming. These recommendations are as follows:

a) The control system should add a pH sensor in order to detect the pH level of water or liquids like fertilizers. By having a pH sensor, it will make the system become more precise in giving water and fertilizer that is needed by each crop. Moreover, an acquired quantity of water and fertilizer will produce a high quality of plant and increase crop yield.

b) A sprinkle system can also be integrated and not just focusing on a drip system only. This will make the product become more valuable and user-friendly by the farmer as it offers a variety of functions.

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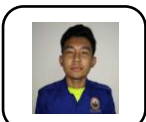


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