Automatic Agriculture Drip Irrigation System using Penman Monteith using AWS (Amazon web services)

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***ABSTRACT*: India holds the record for the second-largest agricultural land in the world, with around 60% rural Indian households making their living from agriculture. Drip irrigation is a method of controlled irrigation in which water is slowly delivered to the root system of multiple plants. The irrigation requirement for any crop is the amount of water that must be applied to meet the crop's evapotranspiration. Penman Monteith equation is used to compute the actual evapotranspiration. Here difference between actual and desired evapotranspiration is one of the input parameter to fuzzy inference system. The longer the crop growth period the higher is the water requirement. Input parameters of the evapotranspiration included temperature, heat radiation, atmosphere pressure and wind speed therefore month after sowing a crop is also an important parameter taken into consideration. RASBERRY PI was used as the IoT end device connecting sensors and actuators to the platform via Wi-Fi channel. We created smart Farm scenario and designed IoT massages satisfying the scenario requirement.**

***Keywords*: Penman-Monteith Equation; AWS; IoT; Raspberry pi.**

1. INTRODUCTION

Agriculture is the main source of livelihood of many people in different parts of the world. It is the most important occupation of many families in India. In conventional agriculture, the first idea to overcome water storage is usually to install irrigation facilities. Farmers know that it is more important to first improve the water retention and the infiltration of water into the soil. The ability of a soil to absorb and store water largely depends on the soil composition and on the content of organic matter. Soil organic matter acts as a storage of water, just like a sponge. Soils rich in clay can store up to three times more water than sandy soils. Unfortunately, farmers are still reliant on traditional techniques that have evolved hundreds of years ago. Drip irrigation can apply water both precisely and uniformly at a high irrigation frequency compared with furrow and sprinkler irrigation, thus potentially increasing yield, reducing subsurface drainage, providing better salinity control and better disease management since only the soil is wetted whereas the leaf surface stays dry.

The farm irrigation systems in the previous years used simple timers and switches to control the irrigation mechanism for a predetermined time period irrespective of the weather conditions or moisture content present in the soil. The use of IoT in agriculture incorporates advanced technologies and solutions for real-time monitoring of agricultural fields via real-time collection and analysis of data.

Aim of this research work is to help in irrigation management by estimating water requirement of the crop using FAO Penman Monteith equation and implementing a model of irrigation controller using Raspberry pi. Estimated Evapotranspiration is compared with the required Evapotranspiration of crop.

2. LITRETURE REVIEW

System and the complexity of the system are directly related to the requirements of the system's application. Control systems are broadly classified as either closed loop or open loop. An open loop Control system is controlled directly, and only, by an input signal where as in close loop feedback from the output is also fed to input side. The major factor in the irrigation process is the time. Therefore, the open-loop controller uses a periodic irrigation policy [3].

Fuzzy Logic Controllers have been widely applied to both consumer products and industrial process controls. exists or the mathematical model is severely nonlinear, because Penman Monteith can easily approximate a human expert’s control behaviors that work fine in such ill-defined environments [2]. Factors which determine the total water requirements of a crop are Evapotranspiration, Permeability of soil, Drainage, The length of the growing season, The levelness of the soil surface. Some of these parameters are fixed for the session and are of an agricultural and some of them vary and should be measured during the irrigation process. These parameters are of a physical nature (such as temperature, air humidity, radiation in the ground, soil humidity, etc.). So, when these conditions change, the amount of water being used for the irrigation should change also [4].

This system is designed for two parameters evapotranspiration and the length of the growing season. The length of growing season is going to vary with the type of crop. Here the fuzzy controller is specifically designed for rice. Growing season for rice is 6 months.

3. MATHEMATICAL MODELING

Theoretically, water consumption of agriculture area is proportional to the water lost caused by ground evaporation and plants transpiration on this area. This called as evapotranspiration. Evapotranspiration condition refers to the reference evapotranspiration (ET_0). In the application, ET_0 is rarely measured, but it is commonly used in mathematical equation such as Penman-Monteith, in which the input parameters include temperature, radiation, atmosphere pressure and wind speed.

$$ET_{P-M} = \left[0.404\Delta(R_n - G) + \gamma\frac{900}{T+273}u_2(e_s - e_a)\right] / \left[\Delta + \gamma(1 + 0.34u_2)\right]$$

where:

ET_0	=	reference evapotranspiration [mm/day],
Δ	=	$\frac{-4098[0.610\exp(\frac{17.27 * T_{mean}}{T_{mean} + 237.3})}{(T_{mean} + 273.3)^2}$
exp	=	2.7183 (base of natural logarithm),
T_{mean}	=	mean daily air temperature at 2 m height [°C],
R_n	=	net radiation at the crop surface [MJm^{-2}/day],
G	=	soil heat flux density [MJm^{-2}/day],
γ	=	$(C\rho\ P)/\varepsilon\lambda\ \pi r^2$,
u_2	=	wind speed at 2 m height [ms^{-1}],
e_a	=	actual vapor pressure [kPa],
e_s	=	saturation vapor pressure[kPa],
$e_s - e_a$	=	e_0(T)=saturation vapor pressure deficit [kPa],
P	=	atmospheric pressure [kPa],
λ	=	latent heat of vaporization, 2.45 [MJ/kg],
C_p	=	specific heat at constant pressure, 1.013x10-3 [MJ/(kg°C)],
ε	=	ratio molecular weight of water vapour/dry air =0.622

4. SYSTEM ARCHITECTURE

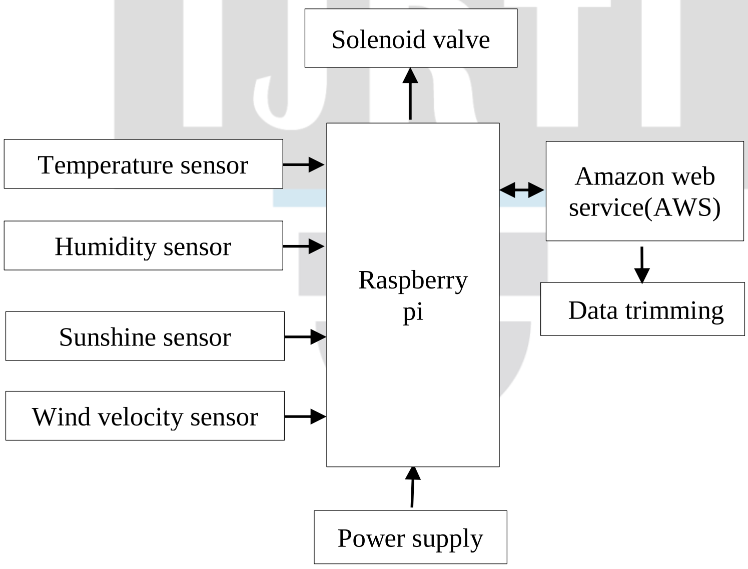

Figure 1 System Architecture

The overall system architecture depicts the idea of smart drip irrigation system. The actuator/node is controlled by the microcontroller being placed at irrigation system. That in turn communicates with the user through cloud system.

The aim is to design a micro-controlled and computer driven automated drip irrigation system. An ADC connected to microcontroller gather the humidity values for soil at various points. These values must be envisioned in software using graphs. A

PC interface is provided for easy programming of the hardware. The graphs generated from sensor values located across the entire field will helps us to visualize, explain and take decisive actions for the particular situation. In this a mobile send command to PC to control drip irrigation as shown in Fig. Here we use various sensors like humidity, temperature, light etc. for identification purpose. These sensors send the real time values to micro-controller and these values send to PC by microcontroller via serial communication. According to the sensor values the graph will be display on computer and mobile side and by using this graph user can switch on or off the drip devices. In this we keep the threshold value for every sensor. The drip irrigation technique can be control by mobile from anywhere and also, he can change threshold values of sensors via mobile. This Technique is more advantageous for agriculture area.

5. METHODOLOGY

There are two sections in project one is transmitter section which is placed in farm as sensors and another section is receiver section is users PC. Soil moisture sensor is used to measure the amount of moisture content present in soil. Moisture sensor data are fed to the Raspberry pi. Raspberry pi acts according to the control algorithm. Sensor output is analog in nature in the range of 0-5v.

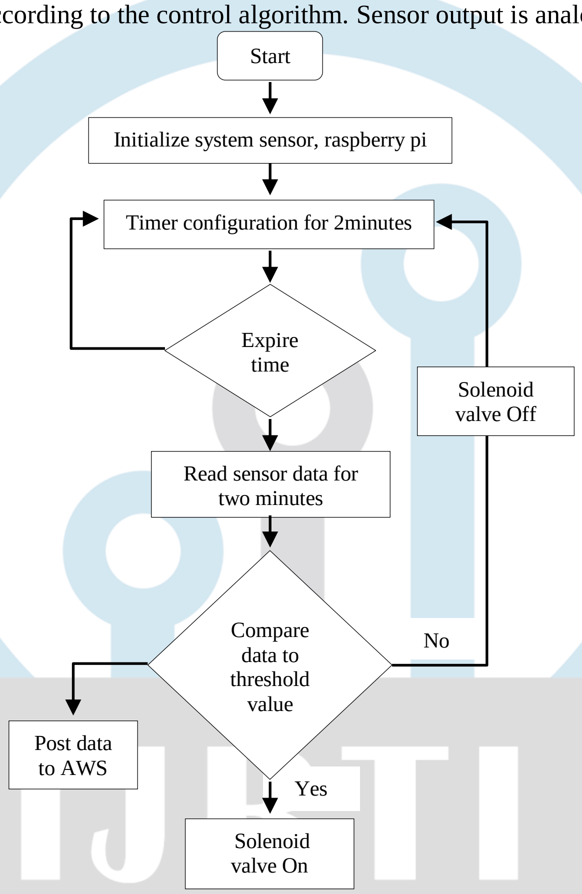

Figure 2 Methodology

When the moisture content present in the soil is dry, then water flow in a tank starts to flow in a pipe by turn ON the Solenoid valve. When the moisture content in the soil is high, then the water flow in a tank stops to flow in a pipe by turn OFF the solenoid valve.

These sensors have been installed in the agriculture field to collect the data, and thus data is mitigated into the cloud with the help of IoT hub (AWS database). So, user can have a real time data visualization, with the help of Amazon Analytics analysis user can predict the future parameter values. By predicting the moisture value user can have control over the agriculture field by using a HTTP, by sending commands. HTTP is a machine to machine communication protocol which is based on pub-sub service.

The remote monitoring solution that we offer can be monitored in real time through any remote devices including mobiles or tablets. This provides the flexible for the data visualization, data understanding, and the predictive analysis also given the scope for the farmers to prepare for the advanced data which might appear in the future.

6. CONCLUSION

The Microcontroller based drip irrigation system proves to be a real time feedback control system which monitors and controls all the activities of drip irrigation system efficiently. The present system is a model to modernize the agriculture industries at a mass scale with optimum expenditure. They can provide irrigation to larger areas of plants with less water consumption and lower pressure. Using this system, one can save manpower, water to improve production and ultimately profit.

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