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SOFTWARE DEVELOPMENT PROCESS FOR ABUAD FARM, ADO EKITI IRRIGATION SYSTEM

The software development process for ABUAD farm is the designing process to eradicate the problem of water shortage during the dry season. The software development process for the design of an automated irrigation system is discussed below.

1. CONCEPTUALIZATION

Irrigation is the artificial application of water to the soil for the purpose of crop production. Irrigation water is applied to supplement rainfall. During dry season, the amount and timing of rainfall are not adequate to meet the moisture requirement of crops and so the idea of irrigation comes forth. Considering irrigation system the prospect for the atomization of an irrigation system is thought of to reduce participation of the farmer in the working mechanism of the system

This automated irrigation system for ABUAD farm will be able to curb the problem of low supply of water in the farm during dry season which will better the yield, income, and profit from the farm.

This artificial application of water to the land or soil is used to ensure adequate moisture level and temperature that is conducive for growth of agricultural crops on the farm at all times even during the dry season. This irrigation system will include the synergy of sprinkling system, piping system, electronic system, a water tank and the use of a water tank.

2. SPECIFICATION

Specification involves dividing the irrigation system into modules which include the software and hardware modules.

HARDWARE MODULE

- Solid set Sprinklers
- Piping system (consisting of mainline, sub mainlines and laterals)
- Water tank and pump unit
- Switching tensiometers
- Sensor for soil moisture and soil temperature
- Weather station consisting of a thermostat & thermistor sensor, pressure gauge sensors, anemometers, pyranometers, and rain sensor.

- Solar Pumping unit
- Relay
- Converter (A/D interface)
- Automatic sprinklers valve
- GSM device (PC device)

SOFTWARE MODULE

- GUI
- Programming
- Satellite system
- Irrigation Timer
- Access control
- Error detection system
- Alarm system
- Microcontrollers

3. DESIGN

The design of the irrigation system involves breaking down into to step by step process of how the irrigation system will flow. The underground sprinklers are set at various location in the farm which are linked together in series when activated can cover all grounds on the farm with water. The sprinklers are set in close proximity to curb the problem of wind disturbance.

The design of automated irrigation systems covers various procedures which are explained below;

SPRINKLER & PIPING SYSTEM

The automated irrigation system which requires the use of sprinklers primarily works on transmission of signal (detected information).

Sprinkler irrigation is a system of watering your farm which works like the normal rainfall. Water flow passes around through a system pipes by pumping it. It is then separated through sprinklers so that it splits up into tiny water drops that fall to the ground. Spray head at the terminal distribute the water over the entire surface soil.

The sprinkler system consist of the following parts

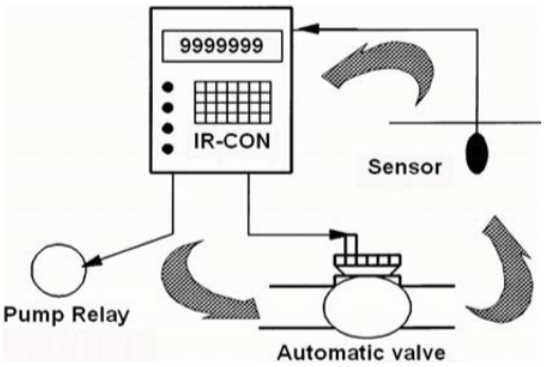
1. A pump unit which extracts water from the source and produces a discharge into the pipe system. The pump must be able to supply water at the appropriate pressure so that the water is discharged at an optimum rate and volume suitable for the crop and soil type.
2. Principal and secondary pipes (mainlines and sub mainlines) which carry water from the pump to the laterals. The pipelines are installed underground.
3. The laterals to transport water from pipes to the sprinklers and are permanent.
4. Sprinklers which are the water emitting devices that transform and disperse the water jet into tiny droplets. The arrangement of sprinklers is made so as to wet the soil surface in the desired area as evenly as possible.

These sprinklers can be used in a solid set permanent underground PVC pipe is installed throughout the farm with a sprinkler head on top. Where sufficient nozzles are installed to cover the farm

CONTROL SYSTEM

A computer based control system consists of a combination of hardware and software that acts as a supervisor with the purpose of managing irrigation, this is done by the use a of CLOSED CONTROL LOOP SYSTEM which works on a general defined strategy (strategy set up by the farmer) for the control system to command and make irrigation decisions of when to supply water and how much water to supply through feedbacks from one or more sensors to the controller. The feedback and control of the system is done continuously in the closed loop system.

The elementary control of the system is shown below;



The closed loop controllers require data compilation from environmental parameters such as soil moisture& soil temperature, atmospheric temperature, wind speed, and relative humidity (weather analysis) and solar radiation.

The state of the system is compared against a desired state and a decision on this

comparison is made whether irrigation should take place or not. When using a computer based controller Irrigation decisions are based on feedbacks from soil moisture (switching tensiometer) & temperature sensors, the weather station sensors & measurement and with implementation of the results at the appropriate time (timer). This simply means every action taken by the microcontroller is to reach a desired output.

The system is designed for daily analysis of the soil moisture, soil temperature, and weather condition before finalising a result to supply water or not. The cases include;

- **SYSTEM CHECK:** A management checking is done to determine continuation of daily activities with no misconduct. System check includes water availability; if water is available it will proceed if not (that is insufficient water in the tank for irrigation) an alarm will be sent to the controller to pump water into the system. Discrete sensors are used to sound the alarm, maintenance check; a complete check is done on the system by the controller every 2 weeks, here the system checks itself for errors in coding, error in wiring, a fault in the piping or sprinkling system and a notification will be sent to the user.

- **WEATHER FORCAST:** What the system does is to do a weather analysis or forecasting of the day's weather to be able to tell the possibility of rain (rain gauge), degree of hotness for evaporation to take place (transpiration), wind speed (anemometer). All these can be done in a weather station.

- **DETERMINATION OF SOIL TEMPERATURE**: This can be done by the use of soil temperature detector. Soil temperature determination is done to determine the temperature of the soil at various interval of the day to predict absorption and transpiration time range.

- **DETERMINATION OF SOIL MOISTURE:** This is of most importance in an irrigation system. Determination of soil moisture can be done by a tensiometer which can tell the soil moisture when placed underneath the soil, if it is at its desired state, higher or less than the proposed state.

- **IRRIGATION SCHEDULE :** irrigation scheduling is a process to determine when to irrigate and how much water to apply. Applying too much (over irrigation) or too little water (under irrigation) in an untimely manner can result in yield reductions.

  Irrigation scheduling is important and can be achieved by monitoring soil water status with a switching tensiometer. After all the various steps have been followed the system will be able to determine by itself the time duration and interval for the irrigation system to be left this is also known as the Time

of operation (irrigation time- hrs. per day)

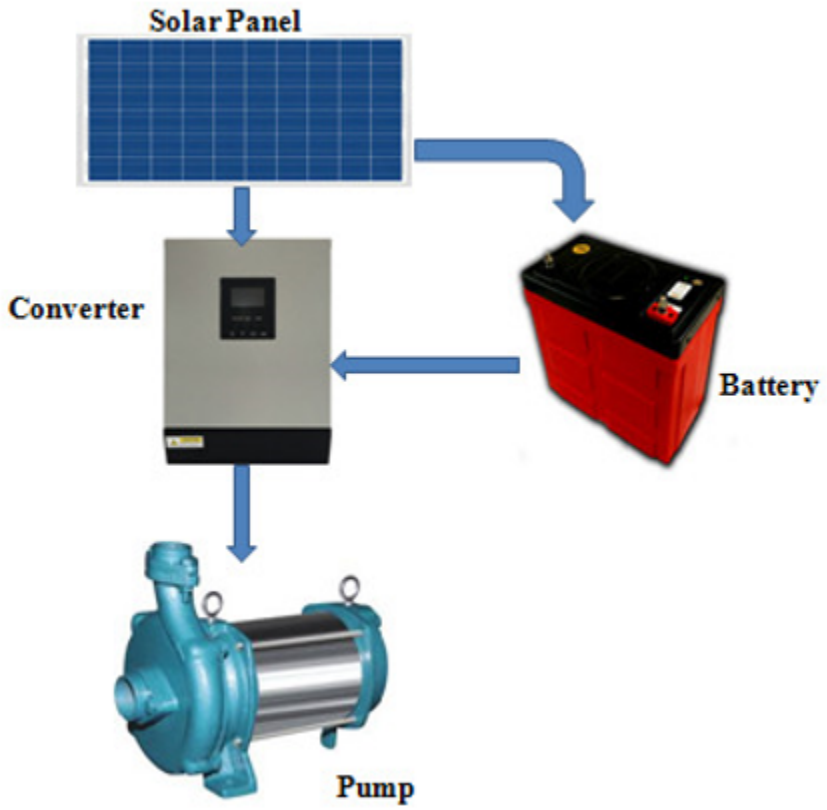
- **ACCESS CONTROL, REPORT AND NOTIFICATION:** This depends on the user accessibility only by password. A password is put in place to limit access. The controller sends all information in form of reports (all actions done in the farm) and notifications for errors and alarms. The irrigation system can detect error either in the software modules or in the hardware module (low or high pressure in the sprinklers application due to wear of the pump and pipes) and send this error detected as feedbacks to the user. A sounding alarm will be made only when the water tank is empty and needs to be refilled.

The system will only shut down completely due to the occurrence of rain by a water conservation device (rain sensor) and will come on when the rain stops.

POWER SYSTEM & WIRING SYSTEM

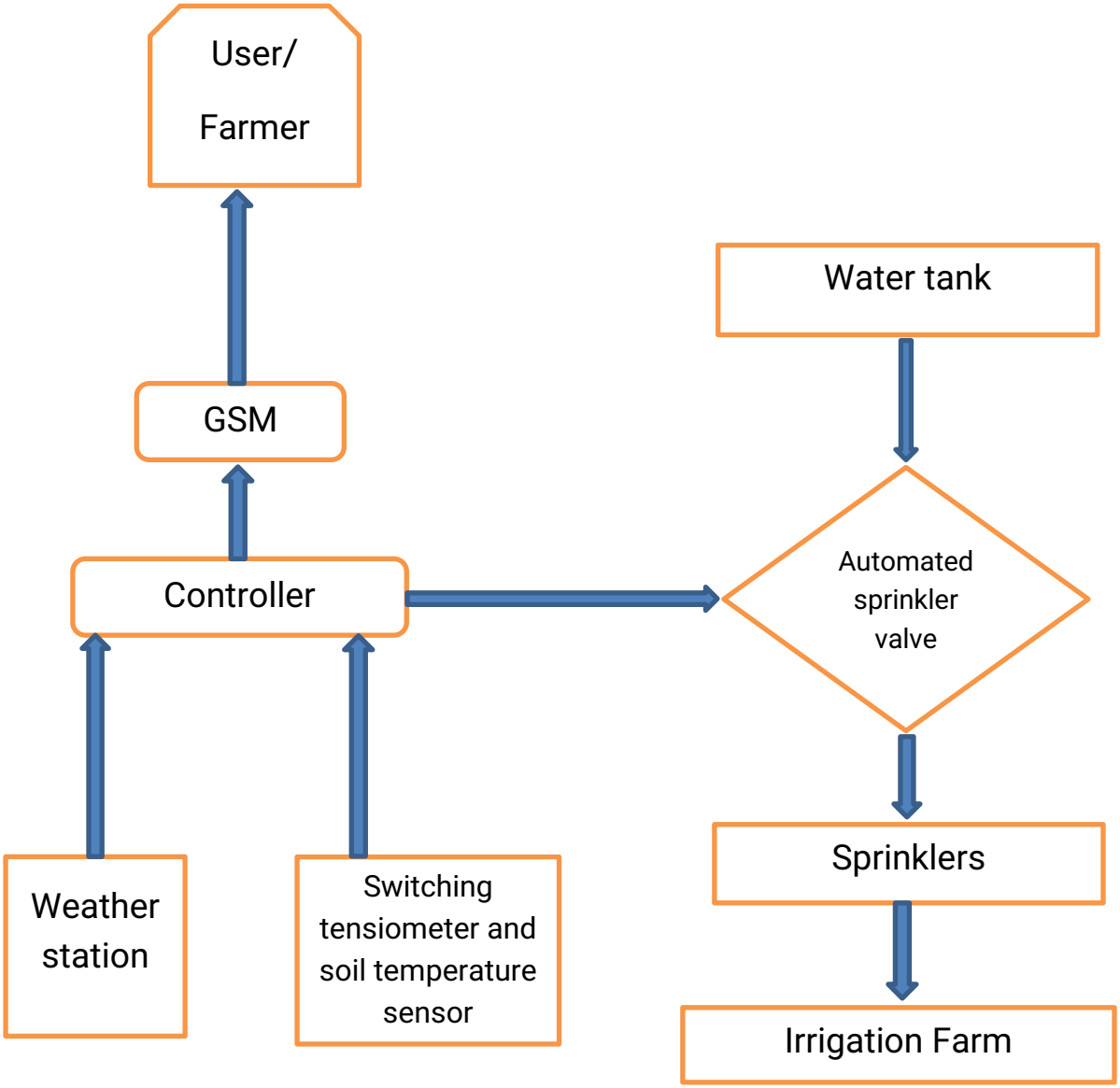
The irrigation system makes use of solar energy for the working of the entire system. The solar pumping unit is utilizing the solar energy to operate the pump. The solar energy is converted into electric energy with photovoltaic cells which are installed near the pump set. A controller circuit is designed for controlling the batteries.

The layout of a solar pumping unit is show below;



Wiring of an irrigation control system should be done by a competent professional to insure that safety requirements are met and that the system meets the necessary codes.

The layout of the irrigation is shown diagrammatically below;



4. IMPLEMENTATION

When all the components (hardware and software) are activated, all the components will read and gives out the output signals to the controller and the information will be displayed to the user (farmer). The sensor reading which are analogue in nature are converted to digital using an analogue to digital converter (ADC). Then the controller will access information and when the motors are turn on/off it will be shown to the farmer.

When the irrigation system by sprinklers is set in place and is fully functioning and the software components are reading to be activated, the user insert the password to start the automated irrigation system by sprinklers to start running.

5. TESTING AND DEBUGGING

When all the modules and components are assembled together, the final hardware and software have been designed it will be ready to be tested. Testing will be done to check if all sensors are working properly if all sprinklers are being activated automatically without any interference.

This can be done by checking the moisture and temperature level of the soil (water level) using the tensiometer and temperature soil sensors. All environmental parameters send feedback to the controller then if the moisture & temperature level is found to be below the desired level (drop below a certain threshold), the sensing device sends feedback to the controller to close the circuit (on) and controller powers the automatic sprinkler valve to turn on, supplying water from the water tank by the use of sprinklers. When the desired moisture level is reached, the sensing device sends signal to the controller to open (off) the circuit, the controller will then turn off the control valve. This implies that the system will turn off automatically when the desired water level is reached.

Also to speculate the time interval per day (time of operation) for the sprinklers to automatically spray water, the weather station (accommodating all environmental parameters), temperature and soil moisture (water level) is used to predict the weather and crop water level & temperature to determine the time interval & how many times the sprinklers will be turn on each day.

This statistics is repeated each day to prevent water logging or water shortage on a daily basis; this is done because there is variation in weather. This irrigation schedule is done by a switching tensiometer alongside with other sensor.

Debugging of the irrigation system by sprinklers is done while testing, if any error or fault is seen while testing the system it will be eradicated. Testing and debugging both works hand in hand for the system to function. If the functionality of the system has been tested thoroughly and it’s functioning successfully then testing and

debugging has been achieved.

6. RELEASE AND UPDATE

When all necessary powering & wiring of the irrigation system, software programming, installation of sprinkler system (piping system) and other procedures have been met, the irrigation system and been be put to working on the farm.

Update of the irrigation system can be done after the performance of the irrigation system on the farm.

HARDWARE MODULES AND THEIR FEATURES

SENSORS

A sensor is a device placed in the system that produces an electrical signal directly related to the parameter that is to be measured. The various sensors are listed out below;

Soil Temperature Sensor

A soil temperature sensor is a sensor to utilize to check degree of the soil to help control transpiration, under irrigation and over irrigation. Soil temperature detector is able to tell the degree or temperature range of the soil to predict how much water will be absorb or lost (evaporation) for its desired level to be maintained. This will help set the irrigation timer for the day.

Switching Tensiometer

Tensiometers are soil water /moisture measuring devices that are sensitive to soil water change and useful for irrigation scheduling. Tensiometer is a device that measures the soil tension by acting as like a mechanical root. The tensiometer being used for this system is with electronic reader to be remotely read and used to automatically start and stop the irrigation system. The tensiometer is very sensitive to soil water change and the increase in soil water reduces the tension. Switching tensiometer continuously monitor soil water status. These switches are normally operated by an alternating current (AC) flow.

The tensiometer operates as a switch that responds to soil water tension, when there is sufficient water/moisture in the soil; the tensiometer maintains the circuit (electric current) open. When soil water tension drops below a certain threshold, the electric current closes and sends a signal to the controller to open the sprinkler valve and the sprinklers are turn on for irrigation. With the process of irrigation the soil

water gets recharged and the signal is discontinued so the system automatically shuts down.

WEATHER STATION

A weather station is a facility on land with instruments and equipment for measuring atmospheric conditions (environmental parameters) to provide information for weather forecasts and to study the weather and climate. The various sensors include;

Pressure gauge sensor: The pressure gauge sensors are used to measure the pressure relative to the currently present atmospheric pressure.

Anemometer: This is a device used for measuring wind speed and direction. It is a common weather station instrument.

Pyranometer: This is a device that can measure solar irradiance in the desired location and solar radiation flux density.

Rain sensor: or a rain switch is a switching device activated by rain. The application of rain sensor is as a water conservation device connected to an automatic irrigation system that causes the system to shut down in the event of rainfall.

Thermistor sensor: The air temperature sensor is a thermistor, which means its electrical resistance changes in response to changes in temperature. It works the same as a coolant sensor. It uses voltage signal to calculate the air temperature.

SOLAR PUMPING SYSTEM

Solar Photovoltaic Panel: solar panel is an assembly of a photovoltaic (PV) cells electrically connected and mounted on a supporting structure. PV cells are made of semiconductor materials like silicon. Structurally when light strikes the cell a certain portion of it is absorbed within the semiconductor materials. The electricity absorbed by the semiconductor is called is called direct current (DC) and can be used immediately or stored in a battery.

Battery: electricity batteries are blend of one or more electrochemical cells, used to transfer chemical energy into electrical energy, in the irrigation system the batteries are used to store electricity produced by solar panels for irrigation operations.

Water pump: this is a device used for moving water in an irrigation system. Water pump are to raise it to the required pressure head so that it can be sprayed on the farm via piping systems (sprinkling).

Converter (A/D interface): since computer system work internally with numbers (digits), the electrical signals resulting from the sensors must be converted to digital data. This is done through specialized hardware referred to as the Analogue-to-Digital (A/D) interface. Discrete signals resulting from switch closures and threshold measurement are converted to 0 and 1.

RELAYS

It is an electromagnetic switch use to control the electrical devices. In the irrigation system the relay is used for switching between the controller and the GSM. Relay acts as a transmitter and uses electromagnet to activate a switching mechanism mechanically.

AUTOMATIC SPRINKLER VALVE

Valve control the flow of water to the irrigation system. With automatic valves wire runs from the irrigation controller to the valves. A solenoid on the valves receives electric signals from the main controller, and then the automated system is programmed to water the farm at a specific time. The Automatic sprinkler valve open and closed solenoid at once, according to the program set in the controller.

GSM DEVICE

The user personal computer can be used as a GSM (global system for mobile communication) device. The GSM is used for sending messages for every action taken by the controller and all feedbacks from sensors to the controller (as reports) to the user.

SOFTWARE MODULES AND THEIR FEATURES

GUI (Graphical User Interface): this is the interface for the mobile access control of the farm. The user can only access it via password and all information on the irrigation system will be seen.

Programming: this is the use of the required software and set of coding to run the controller irrigation system.

Irrigation Timer: Timers are an integral part of the automated irrigation system. A timer is an essential tool to apply water in the necessary quantity at the right time. Timers can lead to an under or over irrigation if they are not correctly programmed or the water quantity is calculated incorrectly. Time of operation (irrigation time- hrs. per day) is calculated according to volume of water (water requirement – litres per

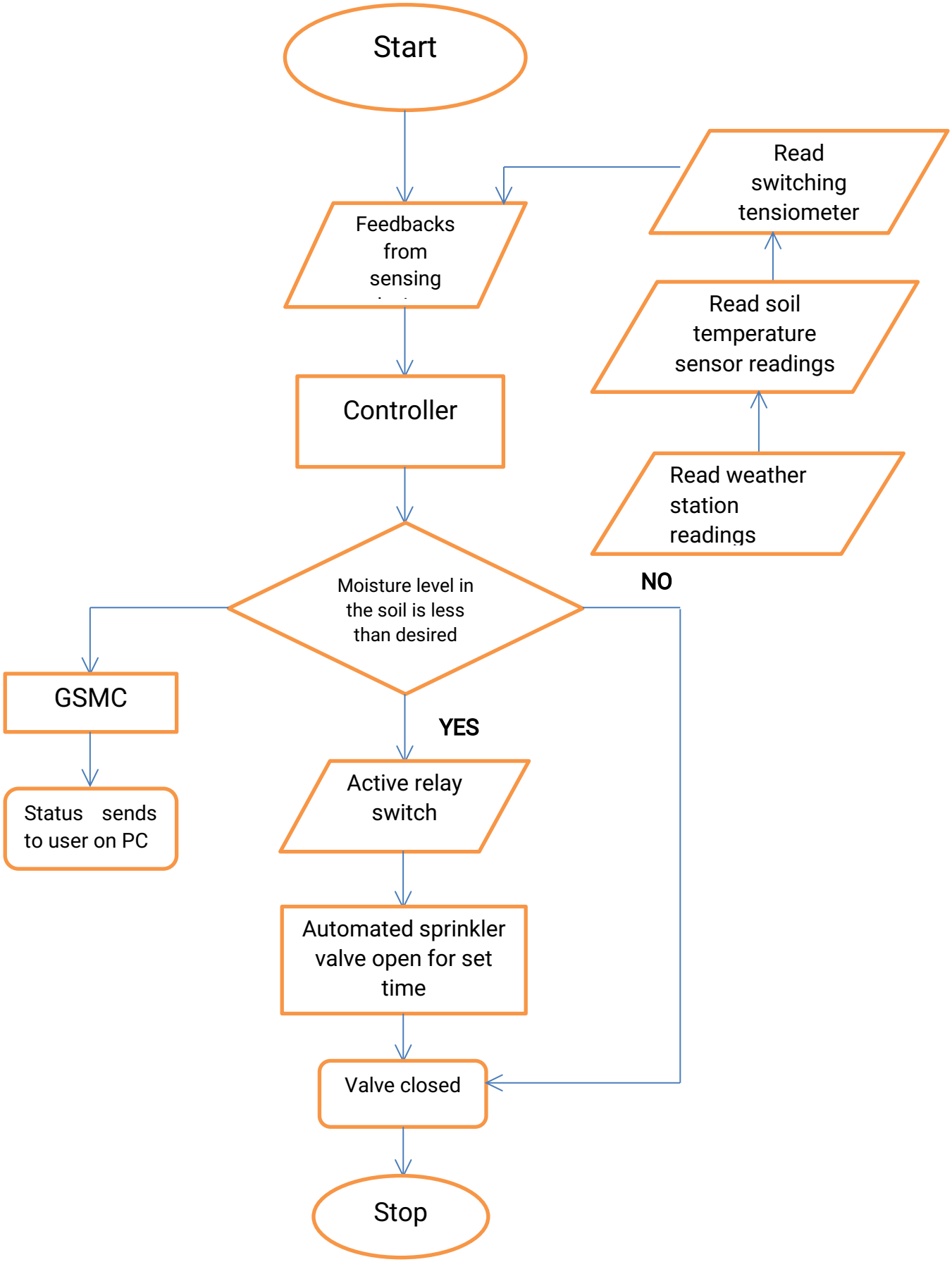
day) required and the average flow rate of water (application rate-litres per hours). A timer starts and stops the irrigation process.

Access control, error and alarm system: access control systems are the electronic systems that are designed to control through a network and they should have an access to a network. Access control system recognizes authenticates and authorizes password on entry into the system.

The alarm system works by sending out signals to the controller when there is insufficient water in the tank, the controller will respond based on the programming setting for that specified alarm, which the controller's response should be to pump water.Also for faulty sensors, faulty pipes or faulty wiring a notification will be sent to the user.

Controllers: controller is the heart of this system. Every sensor has to send signal to the controller. Then the controller has to take the decision according to the situation.

THE FLOWCHART FOR THE SPRINKLER IRRIGATION SYSTEM



ALGORITHM FOR THE SPRINKLER IRRIGATION SYSTEM

STEP 1: Start

STEP 2: read all feedbacks from sensing devices // read switching tensiometer readings, soil temperature sensor readings, and read weather station readings.

STEP 3: Get reading into controller system

STEP 4: If moisture level in the soil is less than desired value

If yes

Activate relay switch and the automated sprinklers valve turns on set time

Then

Valve turns off after set time

Else if

Leave valve closed

STEP 5: print result to the user

THE TOP DOWN DESIGN APPOROACH OF THE IRRIGATION SPRINKLER SYSTEM