Micro Irrigation Engineering
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Lecture - 52
Automation of Micro Irrigation System (Part - 2)

Hello participants, I am now starting the new aspects of this particular course, it is a lecture 52, and of course it is in continuation to my previous lecture on automation of micro irrigation system. So, one component of this particular lecture, it was discussed in lecture 51. In this particular lecture, we are discussing about different components of automated micro irrigation system. In which different sensors, controllers, actuators they are the part of the components which we will discuss these topics in detail in this lecture.

In previous lecture 51, we discussed about why to automate micro irrigation system, we discussed about role of ICT and IoT in automating micro irrigation system. There are different types of micro irrigation automation systems, this also we discussed and then whether parameter, soil parameters which are considered while we are automating the irrigation system. So, we discussed on these points.

In this lecture we will be talking about components of automated micro irrigation system, these components are sensors, controllers, actuators, network wired or wireless or without wire system or data communication and software controller program, database, graphical user interface. My lecture will be limited to sensor, controller and actuators. So, in this particular lecture, we will be talking more detail about the sensors, controllers and actuators.

So, to automize micro irrigation system, as I told you it involves set of sensors, these sensors could be of different category maybe we are using weather sensor data, maybe we are using the pressure transducer to operate the filters, we are using the sensors for getting soil moisture data. So, those sensors and controllers, so, those parts controllers, actuators as I told you we will be going in detail about this part.

When we talk about sensor, sensor is a device which is used to convert physical process, physical phenomena in measurable form. So, this data which is being collected in analog voltage, sometime we express in terms of voltage or we can say current or the ohm with resistance form it is brought but it is converted to the digital signal. And this conversion is made in the form of human readable display for further reading and processing this data.

So, sensors output can be continuous or discrete in nature. Continuous here suppose we are collecting temperature data for whole day 24 hours and then every minute or every second you are getting data. So, there are some certain processes where every minute or every second is required but sometime we need maximum temperature when it had occurred, sometime we need only minimum temperature data. So, those data is not in the continuous form, but it may be in the discrete form.

They produce signal of the data which has been collected by the sensor, they produce signal maybe that I told you that it could be in the voltage form it could be in the current form means voltage, current means in the ampere we say, conductivity millimhos/decisiemons, capacitance. So, that means, there could be any other measurable electrical property. So a sensor should have these qualities one is that it should be sensitive to measure property, it should be insensitive to other property like encountered in the application and it should not get influence by other property when we are measuring. So, these are some of the important points when we are considering the data collected by any sensor.

Now, these sensors could be of different categories, it can be electromagnetic sensor and it has got its own application in different areas. So, electromagnetic, optical, mechanical, electro-chemical, air flow, infrared. So, these are the different categories of the sensors which are used.

Let us try to learn more detail about each of these sensors. As the name says electromagnetic sensor, so, it is an electronic device to measure physical quantity such as pressure, sound, value which will convert to electronic signal. Maybe as I told you that it could be a voltage form. So, example can be a metal detector or electric voltage sensor. Optical sensor, as the

name say it is the optical, so it is related with the light. So, optical sensor converts light rays into electronic signals and this could be ambient light sensors or image sensors.

So, we used optical sensor for automating the irrigation system. So, there where we kept in a tensiometer and when the water was being the soil moisture deficiency was taking place. So, mercury in the manometer it was going up when there is suction is created in the tensiometer and the diode which is used it was detecting the signal when the light was being obstructed because of the raise of the mercury in the glass limb of the mercury manometer tube so, it was giving so that is some kind of a sensor which was being obstructed, so light was not able to pass. So, this kind of a sensor these are optical sensor.

Mechanical sensor is the sensor that is some form of the mechanical deformation that translate and deforms into the electrical signal. So, potentiometric displacement sensor is one of the example or metal strain gauges, strain gauges for finding out any deflection when we are taking some of the tire pressure or some study which is taken when we are finding out the certain studies in the soil dynamics, so, such type of strain gauges are used for that studies.

Electrochemical sensor, as the name is given electrochemical means it is related to the chemical. So, concentrates of a specific chemical within an electrical circuit that it used. So, blood glucose sensor is one of the electrochemical sensor, Co2 that is a carbon dioxide sensor this is used for finding out the environmental sensor, finding out the Co2 level in the environment, particularly in greenhouse studies, electrochemical sensors their Co2 sensor is used.

Air flow sensor is a sensor that is used to determine the flow rate of air through a cross section, so volume air flow sensor, coldwire sensors are the examples of airflow sensor. An infrared sensor is an electronic device that measures, detects infrared radiation in surrounding environment. So, infrared heat gun, infrared image sensor are used. This is the one device, now, this device we are seeing here, image picture it is when we used in the experimental farm where the wheat crop was being grown and we were irrigating by using the micro sprinkler system. So, we found out the air temperature and then also the leaf temperature. The

difference in the leaf temperature and air temperature and then corresponding vapour pressure of the air and vapour pressure of the leaf, we found out the difference.

So, difference was correlated to find out the crop water stress index. So, for such studies infrared sensor without coming in contact with the object from the distance the temperature is used. Sometimes temperature of the object is very high particularly say we want to find out the temperature of a furnace. So, one has to take observation from the long distance by using the remote data from the distance. So, there such types of sensors are useful for those studies.

Weather sensor which are commonly used for the MIS automation. So, this weather sensor say environmental temperature, humidity, solar radiation, rain, wind, atmospheric pressure these data are used to find out the evapotranspiration requirement of the crop. Air pollution, the pollution in the air that affect the ET value, affect the temperature, affect the solar radiation part. So, that data are also used in the sensor to find out the ET value.

Then there are sensors which are used to find out the soil temperature, to find out the soil moisture content, these data are important. From the soil quality point of view that what is the soil pH value, what is the soil nutrition value, NPK value sensors also used or even water quality data are also used for the automation of micro irrigation system.

These are the some of the sensors which are very commonly used mainly for finding out the temperature. So, you can see DHT11, DHT22, AM, LM all these numbers which are given these sensors which are listed here these are used to determine the air temperature as well as the air humidity. These sensors which are listed here this is for solar radiation, for rain for monitoring the rainfall. So, the sensors are used which are giving the data in the digital form. And that those data are used to find out the rainfall, wind, atmospheric pressure.

So, these data are used for finding all the environmental air pollution. So, this MQ 135, such sensors are use for weather monitoring. For finding out the evapotranspiration requirement of the crop accordingly the irrigation estimation is done. Then for the soil temperature and soil moisture content these are the some of the sensors name which are commercially available and they are being used for soil nutrition, soil pH level sensors are being used for monitoring.

So, DHT 22 which you see here these are the photographs which we have taken for this use. So, DHT 22 it is a capacitive temperature-humidity sensor sensing module, it produced the digital output and operating voltage ranges of 5 volts and then the range is from minus 40 degrees Celsius to 80 degrees Celsius, with the resolution of 0.1 degrees Celsius and plus minus 0.5 degree Celsius is the range of the data. And then the humidity range 0 to 100% with the error plus minus 2% RH and then the resolution is of a 0.1%. These are the features of the DHT22.

The soil moisture sensor means I am not reading but more or less you may find out this is the range which are used for power capacity temperature and humidity sensing more or less same then capacity soil moisture sensor this is the sensor which you can see this is available commercially. And then the range measures the soil moisture levels by capacitive sensing. So, the advantage here because it is measured by the capacitive sensing. It is not affected by the value of the soil salinity. So, this is the one advantage and then the ranges of data which we are getting that is 3.3 to 5.5 volt it operates.

This is the sensor which was developed at IIT Kharagpur by one of my PhD student he worked with me where we developed the sensor and then the sensor was working inductance point of view means capacity as well as the resistant property of the soil moisture content it was measured. So, we use the media that is a granular media which used an in order to neglect the effect of soil salinity. So, the gypsum wafer was used and there is a nylon cloth and then the steel electrodes.

So, we optimize the spacing between the these electrodes and then the thickness of the material we did and then the soil which we use this medium was the sand which was wash properly and then size was calibrated by conducting the large time experiment. And then we standardise the size which should be used in the sensor and then the sensor was used to automate first we calibrated sensor and then we used in the automated irrigation system.

Controller is another device after the sensor. Controller is another device which is used in the automation system. So, a controller is a device that converts the physical amounts such as soil

moisture content, soil temperature, soil humidity into some kind of electrical signal and this signal could be in the form of a voltage. Controller performs a simple accumulating function and send the raw data, raw data back to the control center.

So, data from a single sensor or set of the sensors it is combined by the sensor then it performs the local data analysis and that is before taking any action. So, this controller could be Arduino mega Uno Nano and then Raspberry Pi etcetera that these are the controllers which are used. A controller which you see here, this is one controller it has a microprocessor and it has got the memory card it has got the input output port and then there is interfacing control unit.

So, let us know about the components of a controller. A microprocessor, it is a device that is used for computational work. So, it is a central processing unit CPU on a single IC chip which is containing millions of very small components including transistors, resistors, diodes that work together. So, microprocessor use 3 step that is called fetch, decode and execute. These are the steps which are involved in microprocessor.

So, what is the fetching of the information that is the instruction set is copied from the memory into the microprocessor register. Decoding is one of the operations which is done. So, this means, this is basically it converts instruction to set into the machine language that determine what to do with the data. Then the next operation it involves that is an executing the instruction that is set and the instruction set and output the desired result that is the 3 steps which are used.

Memory is another components of the controller. So, this memory is a device or system that is used to store the information for immediate or delayed use in the computing device. So, it will depend upon how much storage of the data and how long we want to store the data depending on the amount of data it is being collected, which require. So, this is the part of the digital memory which we will be doing which is done.

So, it is the digital memory manufactured from the metal oxide silicon transistor on an IC. There are 2 main kinds of semiconductor memory one is the volatile or non-volatile memory.

Volatile means it loses data if it is without power. So, it needs the power. So, volatile means, if the data it is immediately it is transferred, then we go for the volatile. So, it is an example a dynamic random access memory that we call a DRAM or a static random access memory that is SRAM.

Non-volatile the data remains, is stored with or without power. So, example read only memory that is a ROM, Programmable Read Only Memory that is a PROM, Erasable Programmable Read Only Memory that is an EPROM or flash memory. So, this is the one and the ROM that is your read only memory is stores controller program in the microcontroller. So, RAM holds the data waiting for processing by the microprocessor this is the data which hold and then this is used for the further processing of the data.

Input output ports, this particular port you know these ports are the connections to your device sensor or actuators. So, ports act as input from the sensor to the device. The I/O ports maybe it could be a digital or it can be in the analog form. So, digital ports are simple logic which we use yes or no type of input or output. Analog ports could be of continuous input output like temperature we are collecting data of the temperature relative humidity or it can be in speed form.

So, micro controllers are the digital devices, so that signals moving in or out must also be in the digital format. So, input from the analog sensors used an analog to digital converter that is what we call as that A to D converter.

Then the fourth component in the controller is a control interface, control interface is a protocol allowing peripheral devices and then the microcontroller to communicate with one another. So, there are different peripheral devices that use different protocol. So, example, here it is a given as 12C that the inter integrated circuit that is the IC which is used for organic light diodes that OLED display our Serial Peripheral Interface that is SPI Controller Area Network that is a CAN communications protocol etcetera.

So, the functions of these controllers are on a particular controller, it has the sensor data accumulation and the sanitization of the data then synchronization with the time

synchronization means the data which it is receiving from the sensor and then when it is transforming, so, this would synchronize with the both the systems, then the data are sent to the processing unit or server.

Receiving the command from user or autonomous server, monitoring and operating the actuator based on the received commands, notifying any kind of anomaly in the system and protect the system from erratic behaviour. A controller consists of these functions means these are the some of the characteristics of the controller and these characteristics it should have.

Now, actuator is another component, it is a component of a system or machine that converts energy. This energy could be in the form of electrical, it can be the air it can be hydraulic, it received command from the controller. So, it received command from the controller. So, an actuator can have the functions of the different components and so, it is the one is the power source it provides the energy input which is necessary to drive the actuator. These are often electric or fluid in nature.

So, power converter, the role of the power converter is to supply power from the source to the actuator, there is a hydraulic proportional valves or electrical inverters are the examples of the power converter which is used in the industrial purpose and then mechanical load the energy converted by the actuator usually it uses the mechanical device and mechanical load this to the mechanical system that is being driven by the actuator.

Actuators could be of hydraulic, pneumatic or mechanical type, so, hydraulic, pneumatic, electrical or mechanical. So, electrical type could be of these 5 types which are explained in the further in those slides. So, you can see here the hydraulic actuator it is one of the example is given here is the hydraulic brake system. So, hydraulic actuator consists of a cylinder or fluid meter that uses the hydraulic power to facilitate mechanical operation. So, hydraulic brake or hydraulic lifter they use hydraulic type of actuator and where there is a brake pedal when it operates. So, there is a disc and then disk it is causing, stopping the wheel when it is in operation.

Pneumatic actuator, it uses the air power or force to produce the rotary or linear motion. So, it uses the piston and diaphragm which develop the motor power and then the air pressure or force, forces the diaphragm to move the valve or rotate the valve to control the system. So, this is one kind of device which is shown here for the pneumatic type of controller.

Electrical actuator, so, there could be electromechanical actuator, this is which uses the mechanical actuator where the control knob or handle is replaced by the electric motor and then the rotary motion of the motor is converted to the linear displacement. So, the electro hydraulic actuator EHAs replaces the hydraulic system with self-contained actuator solely by the electrical power. So, linear actuator is an actuator that creates motion in a straight line.

The types of actuator this is the another electrical type of actuator it could be a thermal device, a thermal actuator, where it is actuated by the thermal energy to a solid state material and thermal actuators can be triggered by using the temperature as the sensors which will be giving the information in terms of the heat that the Joule effect is being used.

Magnetic type actuator, it is an actuator which works on the basis of the electromagnetic principle for energy conversion is called electromagnetic actuator. Electromagnetic actuator convert the electronic magnetic energy into the mechanical energy. Solenoid valves are the examples which are now used in micro irrigation system to actuate the pump or actuate your particular line maybe it is a mainline it can be sub-mainline or it can actuate the each individual lateral pipeline. So, that will be that is used.

Then mechanical actuator, a mechanical actuator converts one form of the motion to another form such as rotary motion to another such as a linear motion to carry out the movement. So, an example is a rack or pinion. So, the operation of the mechanical actuator is based on the combination of the structural components such as the gear, rail or pulley or chains, so these are the different types of actuator mainly you will find in our case, in case of micro irrigation system, we use the solenoid valve or electromagnetic.

And these are the references which you can refer in this particularly to go deeper about this topic.

So, in this particular lecture, we discussed about the components that is a sensor we discussed about the sensors, a commonly used sensors for micro irrigation system, controllers, we discussed about the different types of actuators. Now, in the coming lecture, we will be discussing about the automation of micro irrigation system part 3 where we will discuss about the different types of network, different types of software which are used in the forthcoming lecture. So, thank you very much.