Micro Irrigation Engineering
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Lecture - 53
Automation of Micro Irrigation System (Part – 3)

Yes dear participants, I welcome you to the lecture 53. Lecture 53 is on automation of micro irrigation system; we divided the automation of micro irrigation system in 4 parts. So, first 2 parts we discussed. So, if you remember in the first two parts, we discussed about why to automate micro irrigation system, what are the role of ICT and IoT in micro irrigation automation, types of micro irrigation automation, parameters of MI automation and their components.

So, in this particular lecture, we are discussing about networks for data communication and software's, controller program, database, and graphical user interface. This will be the components in this particular lecture. So, as I told you that network could be wireless or wired or hybrid of both for data communication and then software, controller, program, database, and GUI this will be the content of this particular lecture.

So, just starting now, this particular slide basically it is giving what is the meaning of the different types of network which are used for data communication. So, what do we mean by the data communication? Data communication refers to the transmission of digital data between 2 or more nodes means here this could be connected with the computer, tab, sensors, controller, and mobile devices. There could be several devices it could be connected with the network. So, this is the part which we call it as data communication.

So, when we are talking about micro irrigation which is precision irrigation and automation, micro irrigation is data centric approach it requires real time field data. These real time means what is the current status of soil moisture content, what are the weather data which are there. So, atmospheric temperature, relative humidity, wind, atmospheric pressure there could be no doubt

several data and those data are used to correlate and then used for further processing and operating the system.

It involves the employment of these sensors to monitor the real time data and making useful information means using those data from the sensor for planning irrigation should we wait for few hours or should we give irrigation next day, today it does not require, such type of information will be used after getting the data from the sensors. The physical connection between the networks computing device is established using it could be either wire or by using the cables or without cable or wireless or it could be combination of both means some part it can be wireless and some part we are getting data by using the wire or cable system.

So, when we talk of physical connections, these physical connections could be of 2 types, it could be wired connection, it can be wireless connection. And then these could be involves a particular type of arrangement, how the data are in different nodes they are arranged. So, here network topology is used. What is network topology? Network topology it refers to the manner in which links and nodes of a network are arranged to relate each other, how they are connected, and how they are means the relationship exists between them.

So, a network topology diagram helps to visualize communicating devices which are modeled as nodes and connections between devices which are modeled as the links between the nodes. So, how they are connected and then what is the link between them they are used in this particular thing. So, these network topology it could be a star topology, it could be bus topology, it can be ring topology. All these have got their own meaning. So, mesh or hybrid means a combination of all these or combination of 2 or more.

So, when it says that is star topology. So, when we talk about the different types of network topology, so, when this is a star topology one of them here each device you can see here, it looks like a star and all these nodes are connected with a hub. So, each device or nodes in the network is connected to the central device which is known as a hub. Now, a star topology does not allow

direct communication between the node means it does not so, one say here the node 1 is not connected with the node 2 so, it does not transmit information from one to other.

Rather information which is coming to the hub and then hub will connect it will be connected with the 2 and then pass on information too. So, if one node, if one device or node wants to send data to other device or node it has to first send the data to the hub then hub will transfer the data to the designated node or device. So, this is the arrangement. So, here we can see here, let us say that it could hear it is being shown as 5, it could be more than 5. So, there will be 5 nodes and then the data from each unit each node is being received by the hub and then it is transmitting.

So, bus topology is another way of arrangement. Here, in the bus topology it consists of the main cable and they are arranged in a proper sequence, proper order which looks as if they are in order or series they follow and then it is in the bus manner and then there is a drop line. So, in a bus topology, there is a main cable and all the devices are connected to this main cable through drop line. So, node 1, node 2, node 3, node 4 all these what we see there is a drop line which is joining with the main cable. So, here all the data are transmitted over the main cable, there is a limit of drop lines and requires distance for the main cable means main cable requires a distance as well as the length will depend upon the how many number of nodes are being used in this type topology.

Ring if you see here, it follows a particular manner means it follows as if it is in the circular manner. So, data from node 1 it goes to node 2 then it takes from the node 2 to node 3, from node 3 to node 4 like this and there could be more than 5. So, in the ring topology each device is connected with 2 devices on either side of it, either side of it means one is connected with 2 and then one is also connected with the node 5.So, in this system, device sends data to another but in one direction. Each device in the ring topology has a repeater. If the received data is intended for other device, then repeater forward this data until the intended device receives it. So, this is the way the ring topology it works.

Mesh topology. So, in the case of mesh topology, we can see here that node 1 is connected with the node 2, node 1 is connected with the node 3, node 1 is connected with the node 4, and node 1 is connected with the node 5. So, this is the types of all nodes are connected with the other nodes. So, each device or node is connected to every other device node on the network through dedicated point to point link.

Network consisting of n number of node must connect with n minus 1 number nodes means say this 1 it will be connected with the 4 excluding its own, so, n minus 1 so, we can say total number of links in a mesh topology will be n that is the total number of nodes multiplied by n minus 1 divided by 2. So, simply I can say the total number of links say in this case it will be 5 multiplied by 4 divided by 2. So, this will give 5 into 4 20 divided by 2. So, total number of links in this 5 nodes mesh topology will be 10.

Hybrid topology means it is a combination of 2 or more topology is known as hybrid topology. Ease of scalability as we can connect new computing network with existing networks with the different topology. So, we can see here, it is a ring topology and this is a star topology. So, and they can be when both of them they are used. So, such type of topology is known as hybrid topology. Ease of scalability we can connect a new means computing network with existing network with different topology, this is the case and in real sense when we are using so, we are using such type of topology in the system.

Having learned the different types of topology there are different types of protocols which is followed in the networking and this protocol is an established set of rules means there are set of rules which is followed to determine how data is transmitted between different devices in the same network. So, it allows connected devices to communicate with each other regardless of any differences in their internal processes.

A structure or design similar to the way that is speaking the same language simplifies communication between 2 people means, language which means the idea, this one, that same kind of data which are used or 2 different kinds of data which is used. So, when we are

communicating each other. So, similar to the way that is speaking the same language simplifies communication between 2 people.

Network protocols make it possible for the devices to interact with each other because of predetermined rules built into the devices, software and hardware. There are some standard organization or institution which are using the different types of protocols and they are designated for the different this kind of things. So, this is Institute of Electrical and Electronics Engineers IEEE is one Institution Organization then Internet Engineering Task Force IETF. Then the International Organization for Standardization that is ISO. This is in Switzerland headquarters available in Switzerland, and then the International Telecommunication Union ITU, the World Wide Web Consortium W3C. These are the groups or organization which are operating, setting the rules.

There are different types of network protocols. So, one is the communication protocols, another one is security protocol, and management protocols. So, communication protocols, these protocols formally described the format or and rules by which data is transferred over the network. Communication protocols also handle authentication and error detection as well as syntax the synchronization of the communication i.e. semantics so, we call it as HTTP that is Hypertext Transfer Protocol. Or when we say TCP these are the terms which we are using. So, transmission control protocol. So, this is falling and these types of protocols are known as communication protocols.

Security protocols this type of protocol ensures no unauthorized users, services, devices, access your network data and this works across all data types and network medium being used. So, network security protocols rely on encryptions and cryptography to secure data so that only a special algorithms, formula and logical keys can make this data.

Now, the examples are SSL that is the secure socket layer or HTTPS that is a secure hypertext transfer protocol. So, these are means these protocols which we read these are falling under the

security protocols means one cannot enter in the network. So, these protocols are being maintained. Management protocols is we come across the term called SNMP that is a Simple Network Management Protocol or ICMP. So, such type of protocols are known as a management protocol and management protocol helps to define the policy procedure used to monitor, manage, and maintain computer network that is essential for the stable communication and optimal performance across the board. So, that is the meaning of the management protocol.

Here, means from this particular diagram we are learning that how the wireless sensor it works and that is how the automation is being done. So, we see here this is the farm land 1 and then data communication we can see here the arrows are critically that is the how the data are communicating. So, we have a farm land 1 where the sensor is being used and from the data it is transferring by using the sensors, controller and actuator. So, it goes to the node to different nodes and then what is that? That it is giving an instruction it comes to the base station. So, node one means here it is your node 1 and then it comes to the base station from the node 1 then it will go to the base station, and from the base station the data are coming to the node 2 where again sensors and means your data controllers are there.

The data which are required it will go to the sensor of your server and it will be stored and then means based on the communication we will give to the server, it will again come to the base station and then it will transfer to the farm land and communication it is done. So, wireless sensor network allows faster positioning and integration of different types of sensors as most of these networks provide self configuration and self organizing, self healing and self diagnosing, capabilities to sensor nodes.

So, sensor node, this is one sensor node, which has got node 1 and this is another sensor node 2 and then finally, it is being the information which you find here that it will come here. So, sensor data are transmitted, then it goes there and then the pump or electric motor whatever is there it will actuate based on the control. So, communication via so, this could follow a particular type of system that is your WSN W means Wi Fi, Wi Max, Bluetooth mobile network depending on that

will be used to do the instruction and then the data will be accordingly programmed and then it will do like this.

So, when we call it a wireless sensor network based automation commonly used technologies could be LoRa, ZigBee, WiFi, Bluetooth, GPRS, 3G can be 3G, 4G, and 5G. Now 5G likely to come and then your worldwide the interoperability for Microwave Access that is WiMAX. So, these are the standard for these the commonly used technologies. So, a standard for this if it is LoRa, it is coming under the IEEE.

So, according to the IEEE the frequency bandwidth is a specified in this range that is a 433 megahertz to 868 megahertz that is used in Europe and then like this particularly for our India IEEE has specified the frequency band for the LoRa it is in between 865 to 867 megahertz. It has got the transmission speed of 0.3 to 27 kilobyte per second and then the communication range is 10 Kilometer plus in the perfect condition power it requires low power consumption like this there are other commonly used communication technologies.

So, this could be the ZigBee so, as per IEEE this particular is the standard it follows and then this is the thing then WiFi, this is another free standard. So, like this there are different standards and accordingly for technologies which are you say in case of WiFi. So, WiFi, is being according to the IEEE 802.11 a.b.g.n standard, it means this is a standard which follow the frequency using 2.4 gigahertz and then this is the data transmission that is 2 to 54 megabytes per second and this is the communication range i.e. 20 meter to 100 meter. So, if you look into the different locations it is the lower right hand card the 10 Kilometer plus and here it is in this case the Microwave Access this is 50 kilometer practically 10 Kilometer. So, this is the way it is being expressed.

What are the different advantages of wireless sensor network? It is easy to install that is one advantage. So, low cost, scalability is possible, so easy to install means a quick straightforward installation is one of the main benefits of wireless sensor system and then wireless systems are

only viable option where hard writing is difficult or impractical. For example remote, large agricultural fields, heritage building etcetera. This is another thing that this can be used.

Low cost, initial installation cost and components are cheaper than wire technology with the advancement of the wireless technology in the long run and maintenance cost is also low. It can be scalability it can accommodate any new nodes or devices with that can be included and it can be implemented at a very short span of time.

The other features of the wireless or sensor network is self-organization means wireless sensors network autonomously determine, it is a very known configuration parameters including addressing, routing, clustering, positioning and then power control etcetera. It has got flexibility in mobility means flexibility in the sense that it is mobile means at one can easily reposition sensors to get a stronger signal and if situation demands node can be moved in a limited distance without any additional changes.

There are some challenges in wireless sensors networking, those challenges are to be addressed by researchers and then that has to be taken care while someone is using wireless sensor networking. So, one challenge is energy consumption. Power consumption is one of the main issue. Battery or solar power is used by equipping with sensor nodes. So, we need a solar panel or battery and then there are some places where such problems it comes so the availability of power, solar system that also a problem it comes.

Energy consumption mainly depends on the sensors to nodes operation like communication, set sensing and communication and sensing and data processing. Clock synchronization it is serious system or service system problem in the wireless access network the main function of the synchronization is to offer an ordinary time scale for the nodes of local clock within the sensor networks. Such clocks must be synchronized with some applications like monitoring as well as tracking means this should goes simultaneously.

The other challenge is quality of service means an interference. So, quality of service means quality of it is the data must be distributed in a regular timeframe and in an accurate manner. Because some of the real time sensor data sensor based application mainly dependent on time. So, if the error free data is not distributed on time towards receiver, then data will not be useful. This is another important they means if the data received and then there is a time gap. So, this may not be useful.

Then interference if there is any other electronic wave like high voltage electric line or other wireless sensor network industrial activity that involves the electromagnetic waves which are working there means such lines, so these are present so, they are likely to put interference. So, this should be taken care or we need to change the system accordingly. Physical security of the device as these network are deployed in the remote or unattended areas. There is a high chance of theft external natural forces as well as human and animal. So, that is another threat means threat one to take care about this part. So, it is a big concern to protect our network system. Data spoofing any wireless network is very high risk of network hacking and data is spoofing and this is a common problem. So, this would be taken care while we are going for WSN.

Now, software controller program database and graphical user interface. So, here the hardware components are operated by software and there are mainly 4 components that are used in modern day that is your e-Agriculture system which is the major component is the microcontroller program, cloud platform, database, web server and graphical user interface. So, microcontroller program is a programmable IC which is capable of multiple function depending on how it is programmed. So, typically they are programmed with the high level languages such as C++ or Java and that is one of the essential tool of design program and the IC means your integrated development environment that is IDE, so, microcontrollers means, understand assembly language instruction the how there are instructions are set.

And these are high level, this involves the high level programming languages. And these this could be uploaded and the examples of the microcontroller is Arduino with that is your

integrated development environment with C++ program. Cloud Platform allow the network of devices to be operated through the cloud based network and the cloud computing is the on demand availability of the computer system resources, especially data storage computing power without direct active management by the user. So, some of the platform these cloud platforms are Amazon Web Service, IoT platform, Google Cloud's IoT platform, Microsoft Azure IoT suite, IBM Watson so these are the cloud platform which is being used now when the data size is large.

Database is the collection of the information that these data are organized such that it can be easily accessed, managed and updated. Means this data could be aggregation of the set of files then means or it could be used data record and then typically it means the Data Manager database manager provides user the ability to control, read or write, access in a smart irrigation, micro irrigation systems, sensor data are stored in the database for intelligent decision making and for future reference. So, these databases also hold current status of actuators. So, these database examples are Oracle, Microsoft SQL Server, MySQL server these are the different server which can be used for the database storage.

Web Server is another important component, web server is the computer software and the underlying hardware that accept request via HTTP. The network protocol created to distribute web pages or its secure variant HTTPS. A user agent commonly a web browser, a web crawler initiates communication by making a request for a specific resource, HTTP and the server response with the content of that resource or an error message server can also accept and store files. In e-Agriculture end user make requests for the real time farm land data that is served by this web server. So, end user can also monitor and control actuators by making a request through web server. So, examples are Apache, IIS, nginx, GWS Cloudflare these are the examples of this one.

Now, here what you see the graphical user interface means instead of giving the data or files or text, this is in the graphical way it can be shown, that becomes for any person to use, understand properly even a farmer can operate. So, GUI displays object that conveys information and

represent action that can be taken by the user. So, this is in the interactive mode, this works to object changing the color, size visibility, so that it can be easily you see just what you are seeing here and the soil moisture content it is being shown here this the humidity and we can so here the temperature data. So, such type of information, this is displayed and that becomes the graphical user friendly system, it works. So, the GUI objects include icons, cursors, buttons and these graphical elements are sometime enhanced with sound, visual effects, budging sound or visual effects like transparency and drop shadows, apps, web pages are the common form of GUI for a smart irrigation system.

So, these are the references you can refer the references for more detail about this lecture. And we discussed in this particular lecture network data communication, we also discussed the different computer program, database, graphical user interface and in the forthcoming lecture, part 4 we will discuss about the other aspect of this particular system. Thank you very much.