Remote Wireless Automation and Monitoring of Large Farm using wireless sensors networks and Internet

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Abstract— **The work includes designing and programming a control panel to watch and control the network by using LabView program which views changes values of the farm as well as the real values required for controlling max. and min. limits and the working sensing sectors. It helps in putting values of changes adapted by the user to the network (high and low controlling values, the number of the sensing nodes and controlling type). RF link has been built to connect the farm with the manager's house electromagnetically by building connection towers of (24m) height, the environment and physiological information transform from WSN network to the Central Unit Room inside the farm, then all data received by the system sensors will be sent to the manager's house which is 10Km far from the farm where a band width of nearly 171.1 Mbps can be obtained. Accordingly, the farm is completely controlled from the manager's house by using intranet network and a controlling system. Furthermore a video monitoring system (IP) and security system of different cams connected with a server and a processor which can be viewed according to the real time are used. It is also easy to control and monitor all changes in the farm in any place all over the world via the International Network where a user can login using the net by TeamViewer program which consists of special protocols for accessing.**

Keywords- IEEE 802.15.4, 802.11, WSN, ZigBee, Networks, Sensors

I. INTRODUCTION

Wireless sensor network (WSN) is most significant technologies in the last decade. It consists of small-size wireless sensor nodes Supported with radio and has one or several sensors. WSN is a granular solution to automate large farm due to cost, efficiency and reliability. In relation to communication protocol, ZigBee is considered as the main popular standard used in WSN due to its good features, low-cost, low power consumption, high capacity, high security and high reliability which they are encourage designer to use it. In this work, a monitoring and controlling system were designed. WSN are the main features of the designed system. The designed system consists of four node types namely: sensing nodes, coordinator node, control node, and gateway node. The system depends upon sensing nodes to collect environmental and physiological data such as temperature, relative humidity, dissolved oxygen in water, PH degree of water and level of water by using high accuracy sensors. The total number of the sensing nodes can be set or modify by manager of the farm from the monitor room or from the manager home "control center" by the way of "Link" . Moreover, if the network topology is forced to change for any reason such as node dead or measurement error, the designed system will adapt that change.

The dissolved oxygen in the water is the most important factor that affects the process of aquaculture, it is known that a lack of dissolved oxygen in the water for a certain limit leads to many problems, and if this continues, the shortage without interference from the breeder, the disaster would be a potential fish kills. One of the problems that fish face at the lack is oxygen: gradual or sudden death of fish. And lack of growth rates. And stress injury and emergence of various diseases. And stop eating and loss of appetite.

Another important factor that affected aquaculture is the pH of water, and it means the hydrogen ion concentration in water. Experts in the field of aquaculture, say that exceeded pH hydrogen amount of the range of 6 - 10 hampers the growth of the fish. It is known that the amount of pH freshwater variable, while the 8.1 to 8.3 salt water in the surface areas , and at least to 7.5 in the depths , and in basins that contain hydrogen sulfide gas reduces this value to 7.0 , is known to be affected by the presence of indicators of acidity aquatic plants consuming carbon dioxide , as influenced by the acidity of the soil itself. Many fish diseases appear as a result of the acidity of the water, where is generated from that swim slow, and harm the skin and warp the color of the gills, Low water pH turns water to be poisonous for most of fish in the aquarium, when pH equal to 5 fishes start mortality, which covered its body white layer, and secrete a large amount of mucus , and the parties to the gills turn to brown color.

In the case of the low level of the lake water, it leads to increased acidic lake water (PH decrease in water) and this in turn leads to a decrease in dissolved oxygen in the water and necessary for the growth of the fish, this situation leads to a decline in the growth of the fish naturally in the lake, to the unwillingness of the fish in the consumption of feed needed to grow in these conditions. In addition to increasing population growth and increasing health awareness led to increased demand for fish meat significantly in recent years. In order to solve the problems mentioned above and for getting the perfect growth and high economic, control system and remote sensing have been proposed, to control the proportions of oxygen(O2) and(pH)in lake, which ensures the ideal growth and abundant production, through the use of high precision sensors, for fast data transfer and a high accuracy. In addition to what is mentioned above there are another problems that faced the manager's farm which are: Fluctuation of the water level of the lake, where it has a negative impact on the process of aquaculture. And The difficulty of monitoring the behavior of a bird ostrich, day and night, so as to know the behavior of the animal bird constantly to see the fundamental problems in the breeding of this bird. And the importance of strong and continuous monitoring of temperature and humidity incubator hatching eggs of ostrich birds. The difficulty of manager arrival to the farm in severe weather conditions such as heavy rains and heat to the fact that these areas are rural areas with rough roads are unpaved.

The proposed system has a number of precision sensors assembled in nodes to measure the actual values of environmental variables (temperature of water in basin fish hatching , humidity, and water irrigation level of lake, the proportion of oxygen in the water of lake and the proportion of PH in the water of lake in addition to surveillance of farm for management and study the behavior of a bird ostrich by using distributed IP cameras) and send them to the central unit room "Gateway" in the farm , where the necessary changes are executed and then transmit the sensors information's that we already get it, with an IP video to show secure status of the farm and bird ostrich behavior to the manager's home, by link between the home and the farm, on a distance up to 10 km. On the other hand, the needs of Iraqi farmers such as low cost, robustness, friendly in use, and long life. In addition, the following main goals are considered in this paper are: The system depends on high efficiency, low cost components. And increase the growth of fish by controlling environmental variables such as the ratio of oxygen, pH and the level of the lake water. For precise control of the temperature in the basin of hatching fish, played a key role in the proportion of fish hatching eggs perfectly. And for precise control and monitoring of the relative humidity and temperature in the hatcher of the ostrich eggs. Ease of movement of the farm manager and saving time, effort, and ease of administration. Reduce labor and ease of control of the receivership by observation through remote monitoring. Real-time processing, real-time watching for the farm, average value, lake water vital parameters remote monitoring and controlling. And optimum power saving in sensing node. And the designed system support scalability. And Farm operator can diagnose system error. On other hand, the system must adapt error coming from sensors reading or network topology. And the design supports two control modes. Farmer can set one of them optionally.

The main problem and motivation for this paper have been presented now. The following sections of this paper present both the analysis and research that have been done to develop a smart farm automation system. These sections are arranged as follow: Section two" Wireless Sensor Network", discusses the theory background on the wireless sensor network and ZigBee standard technology, "RF Link parameters". Section three "farm sensors" provides essential background information about farm sensors and actuators which used in this paper. Hardware and software implementation of the system are presented in Sections four "deal with Implementation of Proposal Wireless Automation System". The experimental results are discussed then in section five "Result and discussion". Finally, the conclusions on this project are drawn and presented in Section six. An outlook of how future work can improve the already obtained results is also provided.

II. WIRELESS SENSOR NETWORK

Wireless Sensor Network (WSN) is a network of spatially distributed small and cheap devices called "Sensor Nodes" which equipped with sensing, computing, power, and short-range communication modules to monitor a certain phenomenon such as environmental data or object tracking.[14]. Sensor nodes are distributed over a particular area of interest to monitor a certain physical or environmental condition in a cooperated way. After collecting the desired information from the environment, each node processes that information and then sends them to a collection center, which is also denoted as a sink node using their wireless radios. The sink node sometimes acts as a gateway which relays the information further to the control center at a remote location to another network such as internet [15].

Wireless sensor networks concept's is based on a simple equation: (Sensing + CPU + Radio = Thousands of potential applications) [16].

The energy consumption of network operation is the main concern in WSNs. Sensor nodes depend on limited power supply (battery) in all them activities. However, for most applications, it is not feasible to replace the batteries of the sensor nodes after deployment. Therefore, power saving technique must be used with WSN to increase network lifetime [9]. Despite the limitations of individual sensor nodes resources and the design challenges, wireless sensor network has several advantages makes it form the most interest fields in the last few years [17].

The protocol is a common set of rules that manage the exchange of the data between two devices. Communication standard is a set of protocols with different functions making communication and networking of wireless devices form different Vendor is possible. According to Open Systems Interconnection (OSI) model, communication standard predefined in layers stack. Each layer is responsible for performing a specific one or more protocol, and dealing with the layers above and below it.

WSN protocol implemented in the each wireless node so that, it will affect by node resources limitation. To this end, many design challenges must be consider when choosing communication standard as : Power limitations of wireless sensor nodes. Processing limitation of wireless sensor nodes. Scalability. Fault tolerance. Distributed natural of wireless sensor network.

Several standards, for short-range wireless networking, including IEEE 802.11 Wireless Local Area Network (WLAN), IEEE 802.15.4 Wireless Personal Area Network (WPAN) and Bluetooth are suitable to use in WSN and each of these standards has its particular applications. In table 1, comparison is made between these standards to give a better understanding about advantages and disadvantage of each technology [19,20].

Table .1 Comparison of different wireless standard technologies

Feature	Wi-Fi (IEEE802.11)	Bluetooth (IEEE802.15.1)	ZigBee (IEEE802.15.4)
Radio	*DSSS*	*FHSS*	*DSSS*
Data rate	*11Mbps*	*1Mbps*	*250kbps*
Data type	*Video, audio, graphics, files*	*Audio, graphics , picture, files*	*Small data packet*
Range (m)	*100*	*10*	*40*
Battery life	*Hours*	*weeks*	*years*
Power consumption	*160 to 600mW*	*40 to 100mW*	*1mW*
Cost ($)	*100*	*40*	*22*
Complexity	*complex*	*Very complex*	*simple*

From the above table, it can be concluded that ZigBee is the best solution to apply in WSN among the other technology. ZigBee feature includes low data rate, low cost, long battery life, low power conception and support simple in size and complexity.

III. FARM ENVIRONMENT SENSORS

The productivity and crop quality of the farm including: aquaculture process and hatcheries of ostrich eggs, depend on many different factors such as dissolved oxygen concentration(O2)in water ,concentration of pH value , temperature of hatchery fishes, water level , humidity of hatcheries ostrich eggs. Farm manager must have a set of reference values to certain variables of environmental, and then the automation system works around values of these variables. Watching for the behavior of ostriches, securing and surveillant the entrance of the farm by using an IP cam can also be defined.

A. Farm Sensors

Many sensors are available in the market to fulfill farm automations system requirements. The control quality of the system depends in the first step on the quality of the data which collected by these sensors. Therefore, sensors selection is important to build high efficiency monitoring and controlling system.

1. The Water temperature

Fishes are cold-blooded organisms that any body temperature is not constant but change, depending on the temperature of the aqueous medium in it, and then had a water temperature no role effectiveness. In all physiological functions of fish growth and reproduction and respiration, movement and disease resistance and others affected by water temperature directly.[28]

2. The Dissolved Oxygen

Dissolved oxygen is the most important environmental factor for life , health and growth of fishes , and low concentration of oxygen in water leads to many problems the like: low immunity , low growth rates and in the case of the very low levels below the critical point this leads to the fishes death.

Some fishes types live in warm water can low oxygen level between (3 mg/L – 2 mg/L), whereas cold water fishes can't this levels.

In general , the concentration of dissolved oxygen in the water the fish farms is recommended to ensure the preservation of good health of the fish and the high growth rates is not less than 5 mg / L .[28]

3. The Concentration of pH

pH value ,expresses of the properties of aqueous acid or alkali, and each kind of fishes has its preferred "pH". In general, most types of fishes aqueous medium with light alkaline grades (7.5-8) .[28]

4. Hatcheries of Ostrich Eggs

The optimal air temperature inside hatching machine ranges between (35C-39C),depending on the control process on hatchery. The range of healthy relative humidity for successful hatching ranges between (25%-30%). In order to monitor and control these environmental factors, sensors and actuators are essential. Farm crops can benefit a lot of the use of WSNs, because they can collect environment information which is scattered over wide area and control actuators in efficient way. WSNs have a lot of application implemented in practical life. Each WSN application has unique sensors and actuators to perform a specific task. Sensors measure the state of the environment and report this to a control system, which then makes the necessary changes. A lot of sensor technologies are available on the markets that are ready to be attached to a wireless sensing platform. Therefore, this particular section of the paper will be looking at some of the sensor/actuator devices that are available on the market to be used in this work

5. *Environment Temperature Sensors*.

Lake and basin fish hatching environment Temperature can be measured via diverse types of sensors. All of them infer temperature by sensing some change in a physical characteristic. Thermal resistance or also called (Negative Thermal Coefficient (NTC)) represents another class of temperature sensors. It is based on resistance change in a ceramic semiconductor in the manner of resistance drops nonlinearly with temperature rise. The high sensitivity to temperature change makes the thermistor extremely well suited to precision temperature measurement. For example, a typical industrial-type thermistor with a 2000 Ω resistance at 25˚ C will exhibit a resistance change of 78 Ω /˚ C change in temperature [32]. Typically, thermistor measures temperature in range (-38 Co to 260 Co) with non-linear response. It has a lot of advantages over other types such as high sensitive, low cost, good stability, accuracy over small temperature rage, and fast response [30].

Signal condition circuit for thermistor is a simple voltage divider. The use of a thermistor in such a circuit results in much higher sensitivity than that obtainable with a thermocouple or RTD [34]. Form above circuit, NTC resistance can be computed according to the value of (V) which represented the result of voltage divider of (Vcc) between selected resistance (R) and NTC temperature dependence resistance (Rt). NTC voltage drop is convert to digital number by using high resolution Analog to Digital Converter (ADC) then fed to micro-controller to determine NTC resistance depending on the flowing formula:

$$R_{NTC} = (V_{NTC}) * \frac{R}{(V_{cc} - V_{NTC})} \qquad (1)$$

Where: RNTC: - NTC resistance at certain temperature.

V: - Voltage drop at NTC resistance. Vcc: - Supply voltage.

R: - Selected resistance.

After NTC resistance value computed, actual temperature degree can be calculated form Resistance-Temperature curve fitting. This curve gives us information about the behavior of NTC resistance when temperature rises or decreases. As mentioned before, NTC has non-linear response therefore the result of fitting process should be polynomial equation. A lot of applications use thermistor due to good features such as high sensitivity, low-cost, small dimensions, and relatively simple circuitry requirements. Form these applications we mention to temperature transducer, remote measurement, temperature control circuit, thermal conductivity measurement, and compensate for the effects of temperature on both component and circuit performance. Also, it is used in the physical and biological fields such as in the food industry or in medicine [32].

6. *Environment Relative Humidity Sensors*

Relative humidity at any temperature is the actual humidity divided by the value of saturated humidity at that temperature. For example, a relative humidity value of 50% at 20Co means that the air contains half of the quantity of water that would be needed to saturate it at this temperature. When it comes to humidity sensing technology, the most widely used and available of humidity sensor types are: resistive, thermal conductivity, and capacitive humidity sensor [34]. Resistive humidity sensors depend on natural phenomenon in which the change in resistances of many nonmetal conductors are relying on the water content of that material. Resistive humidity sensors have disadvantages which include sensitivity to chemical vapor, required complex signal conditioning circuit and lower operating temperature in compare to other sensor types [30]. Thermal conductivity humidity sensors depend on the thermal conductivity of gas to measure absolute humidity. It consists of two matched NTC thermistor in a bridge circuit; one is hermetically encapsulated in dry nitrogen and the other is exposed to the environment. The difference in resistance of the thermistors is proportional to the absolute humidity [31-36] . This type of sensors characterizes by durability, ability to work in high temperature environments and high

accuracy but it is very expensive. However, it is suitable for application such as kilns for drying wood, machinery for drying textiles, and food dehydration [30]. Capacitive humidity sensors are based on the changes in the dielectric constant of materials between plates of capacitors. The dielectric consists of a polymer material that has the ability to absorb water molecules. The absorption of water vapor of the material results in changes in the dielectric constant of the capacitor. By careful design, the capacitance can be made directly proportional to percentage relative humidity of the surrounding gas or atmosphere.[32]

The main advantages of this type of sensors are: cheap , small size, wide RH range (5% to 95%) with ±2% accuracy, high sensitivity, fast response, low temperature dependent , and high chemical stability with minimal maintenance requirements. These features make capacitive humidity sensors viable for many specific operating conditions and ideally suitable for a system where uncertainty of unaccounted conditions exists during operations [30] [33].

The signal conditioning circuit of capacitive humidity sensor. 555 timer in the stable mode is used to drive Capacitive to voltage (C/V) chip. The relationship between the measured capacitance (Cx), and output voltage (Vout) of C/V converter can be expressed by:

$$V_{out} = f_{in} * C_x * R_3 * V_{cc} \qquad (2)$$

Where: f_{in}:- The frequency of output signal of 555 timer

C_x: - Measured capacitance. R_3 :- The resistance that is connected to C/V chip for RC circuit.

V_{cc}: - Supply voltage

7. *Liquid Level Measurement*

Level measurement is required in a wide range of applications and can involve the measurement of solids in the form of powders or small particles as well as liquids. While some applications require levels to be measured to a high degree of accuracy, other application only need an approximate indication of level. A wide variety of sensors are available to meet these differing needs. This section will present some of the available level measurement methods that can be used for environmental monitoring application [35]. Ultrasonic level sensors emit sound waves, and the liquid surface reflects the sound waves back to the source. The transit time is proportional to the distance between the liquid surface and the transmitter. The measuring system evaluates the time-of-flight (t) of the signal from 3.3 equation:

$$t = \frac{2d}{v} \qquad (3)$$

Where: v :- Propagation velocity of the waves. And d :- The distance between water surface and sensor.

These sensors are ideal for noncontact level sensing of very viscous fluids such as heavy oil, latex, and slurries. Practically, there are limitations to this method, which include: Foam on the surface can absorb sound. Speed of sound varies with temperature. Turbulence can cause inaccurate readings.

VI. IMPLEMENTATION OF PROPOSAL WIRELESS AUTOMATION SYSTEM

In this paper, wireless sensor network is presents as practical application. Generally, in each node, two different kinds of modules were designed and implemented: The sensor/actuator module and the wireless module are based on special design of a 9600 b/s asynchronous wireless communication. The WSN follows the standard IEEE 802.15.4 and implements a routing protocol based on ZigBee. Smart farm automation system consists of ZigBee network with five nodes type, each node will take its name and position according to its function in the system. These nodes are: Coordinator Node (CRN), Sensing Nodes (SN), Control Nodes (CN), Hybrid nodes Control/Sensing, and Gateway Node (GWN).In addition to what mentioned above, we implemented a securing and monitoring system consisting of a network IP cams connected wirelessly. Figure .1 illustrates overall system for smart farm automation based on WSN.

In this work, coordinator node was installed on the lakeshore by using special designed stairway installed on the surface of the water and prepared especially for this purpose. It is worth mentioning, that we combined sensing node that responsible of monitoring O2, pH, Temperature and water level in the like farm with the coordinator in one node, because they are so near to each other. Each sensor node uses special sensors to collect environment information such as dissolved Oxygen in water, pH concentration temperature and water level in the lake farm and relative humidity and temperature for ostriches eggs hatchery or another temperature and level sensor in the basin fish hatching..

The Gateway node function is to connect ZigBee network to the computer via USB port to display the obtained data from the network and deliver data which is set by farm manager to the network. LabView program was creating as high level user interface application.

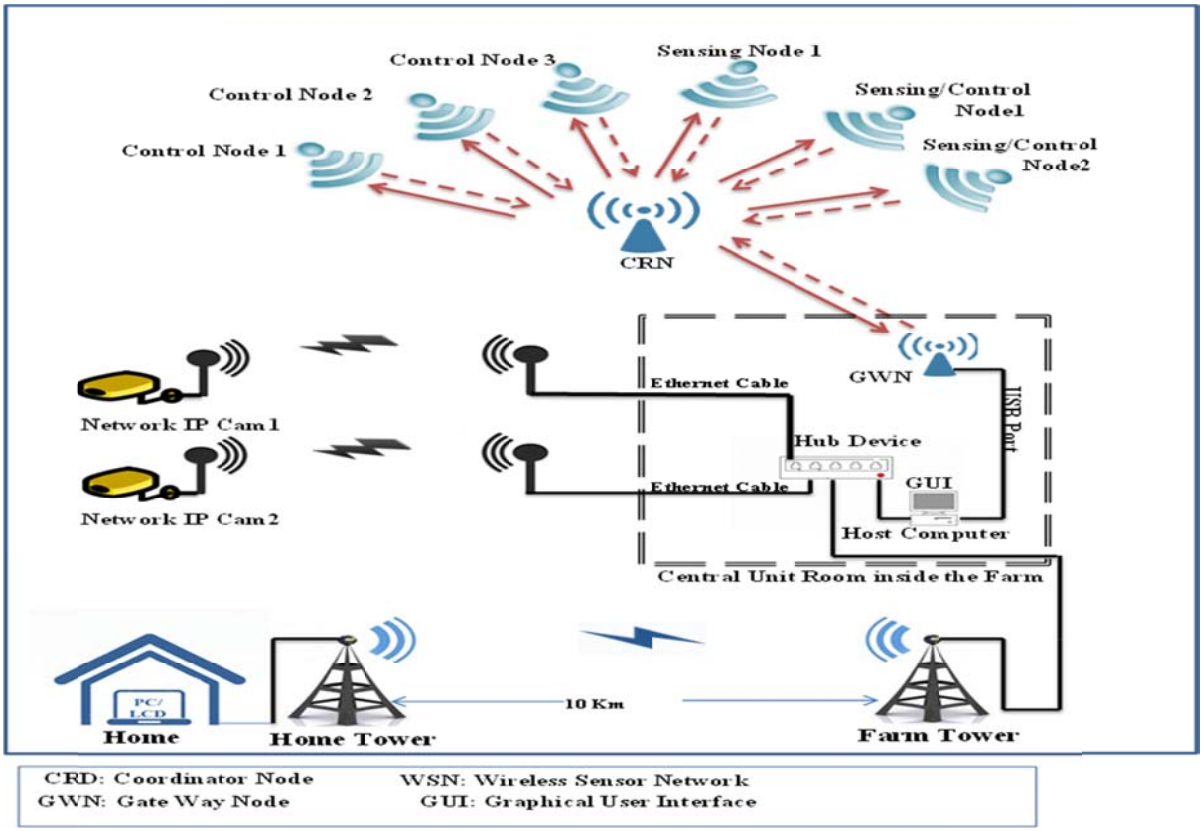
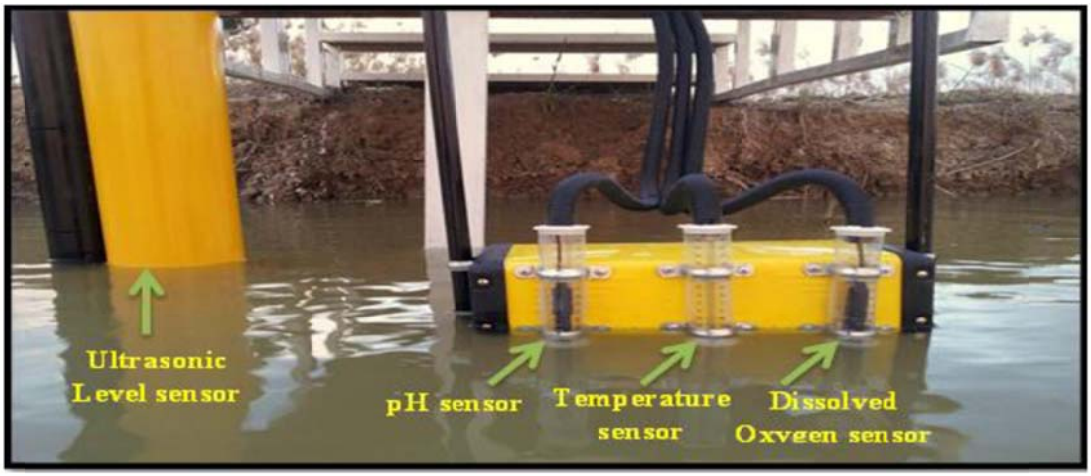


Figure.1 Overall system for smart farm automation based on WSN.

In general, our design implemented ZigBee star topology in which sensing node, control node, and Gate Way node set as ZigBee end device while coordinator node represented ZigBee coordinator. The work includes hardware design and software design / configuration for all system parts. However, in the next paragraphs each part of the block diagram in figure .1 will discuss in detail.

The system includes one coordinator node fixed on the lakeshore by using special designed stairway. Coordinator or communication master or main controller node is the heart of the designed system. It is the central node in our design without this node the network inactive and other nodes still waiting permission to send. Coordinator node has the flowing tasks: i. Starts ZigBee network. ii. Manages nodes communication. iii. Collects sensing nodes data and calculate average value of each farm parameter. iv. Take decision about actuator state depending on average value and predefine upper and lower limits of each farm parameter. v. Detects faults and error in the system. Coordinator node attached with dissolved oxygen , pH concentration , ultrasonic level sensor and temperature sensors, as shown in figure 2 below.



This work shows how to monitoring a fish lake using dissolved oxygen, pH, temperature and level sensors. Therefore; the researcher has used sensors with high accuracy and resolution. As mentioned previously, the researcher attached these sensors to coordinator node since it is placed on the lakeshore. One of the problems that were plaguing the farm manager, is the decrease in dissolved oxygen in the water drains used in the process of aquaculture, when the decrease of oxygen for a predetermined level happened , the coordinating node sends a control signal to the control node to control three- phase motor pump lake water to a certain height in the air which leads to mixing of the lake water that is poor of oxygen with oxygen air. The researcher called this part of our system " Lungs of the lake", where the process of exchanging oxygen take place. We will discuss the (control node 2) that responsible to actuate the 3- phase motor pump used in this part in details later.

In view of the fact that the water used in the lake is not fresh water rivers. The concentration of the pH of the recipe volatile and unstable, if earned decreased this ratio or increased levels specified earlier within the microcontroller, the coordinating node sends a control signal to the (control node1), to operate the motor pump, to raise new water into the lake, to equivalent the concentration of pH.

The water level of the lake, which is an important factor in the density of fish in the basin of the lake, as well as its importance in the nutrition and safety of fish diseases as the sun played an important role, maintaining a level (100 cm) is ideal for fish farming.

When the lake water decrease under a threshold value, the coordinator node send a control signal to the (control node1) that is responsible to drive / actuate 3-Phase induction motor to turn it ON to rise the water to the lake. When the water level arrives max. threshold , the coordinator sends a signal to the control node to turn the actuator OFF. The researcher used NTC type temperature sensor in both : basin fish hatching control /sensor node ,to ensure the successful hatching process and keep temperature in range between (22C◦-26C◦) by using heaters. In addition to using it in the lake with coordinator node to know temperature degree of the lake. Where the feed is given according to the temperature in the lake to reduce wastage happening in feed. Already, the researcher made calibration procedures for this sensor to use it optimally.

A. Processor subsystem

In this work Arduino platform are depend to drive Atmega microcontroller. Figure 3 shows Arduino platform. It contains everything needed to support microcontroller includes clock circuit, voltage supply, and USB to serial driver chip to program microcontroller or serial monitoring. In additional, a lot of compatible shields with specific tasks can connect to Arduino to increase its application filed such as relay shield, GSM shield, E-Health care shield… etc.

High level language with compiler was used to program this microcontroller. The IDE (Integrated Development Environment) is a special program running on computer that allows us to write sketches for the Atmega328P controller. It is open source software which depends on C/C++ languages.

The microcontroller was connect to environment sensors as shown in figure 3. Microcontroller spends most time in sleep mode and it still waits an interrupts to wake up to perform single task at a time. It enables each sensor individually by using control signal then read data from that sensor, process them, and finally sends processed data to transceiver due to serial connection T_X, R_X.

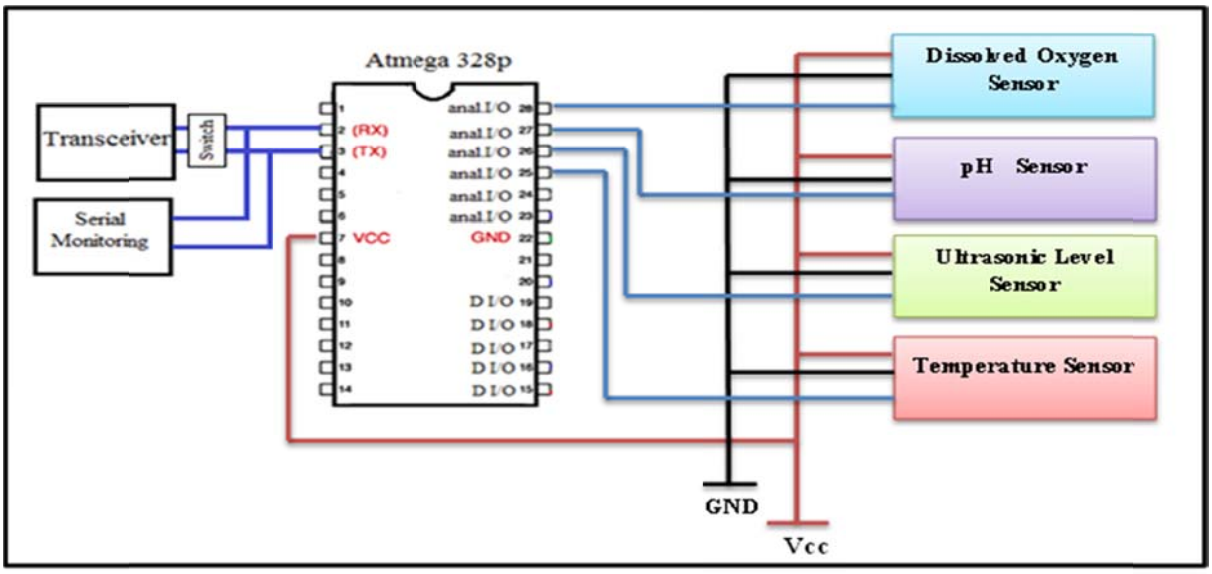


Figure 3 Practical sensors connection to the Atmega 328P diagram

In this node we used four analog channels; to read analog signal from dissolved Oxygen , pH consternation, ultrasonic level and temperature sensors . The ADC converts an analog input voltage to a 10-bit digital value using successive approximation technology. The conversion process returns integers from 0 to 1023 which represent ground and Vref voltage respectively.

As it mentioned before, Vref voltage was set to 2.5 volt so the microcontroller can calculate the output voltage by using the fallowing formula:

$$sensor(mV) = quantization\ level * \frac{2.5}{2^{10} = 1024} * 1000 \qquad (4)$$

Where *Quantization level* is an integer number from 0 to 1023.

After that, microcontroller manipulates sensors readings whose input values are the output obtained from eq. (4).Then the coordinator node send this data serially to the gate way node to be displayed by a LabView program on a monitor of desktop computer which is placed in the "Central Unit Room" (CUR), inside the farm. As we will see in this section.

B. Communication subsystem

XBee 63mW External antenna-Series B2 module from Digi International as radio transceiver is used in this system. XBee module is designed to operate within the ZigBee protocol and support the unique needs of low-cost, low-power wireless sensor networks [20]. The modules require minimal power and provide reliable delivery of data between remote devices. We use XBee shield to connect Arduino platform with XBee module. This shield provides the module with 3.3 volt supply by using voltage regulator. Also, it contains DIP switch to change the serial connection between XBee module and microcontroller or computer.
In practical work on the ground, we have been got many problems one of them was the weak in signal strength due to the long distance between the nodes and the presence of obstacles in the farm these previous reasons cause an attenuation in the signal . So, we have been solved this problem in these steps:

1. Used at least 3m length, SMA (Sub-Miniature Version A) connector is semi-precision coaxial cable. It is minimal connector interface for coaxial cable with screw type coupling mechanism. The connector has a 50Ω impedance. It is designed for use from DC to 18 GHz. Figure 4.15 shows male/female RF-connector.

2. Used dipole antenna with 8dBi , 2.4GHz. It is worth mentioning, that we were made a weather proof box for the coordinator node to protect the node from the hard climate conditions like: sun and rain .

C. Combination coordinator/sensing node software program

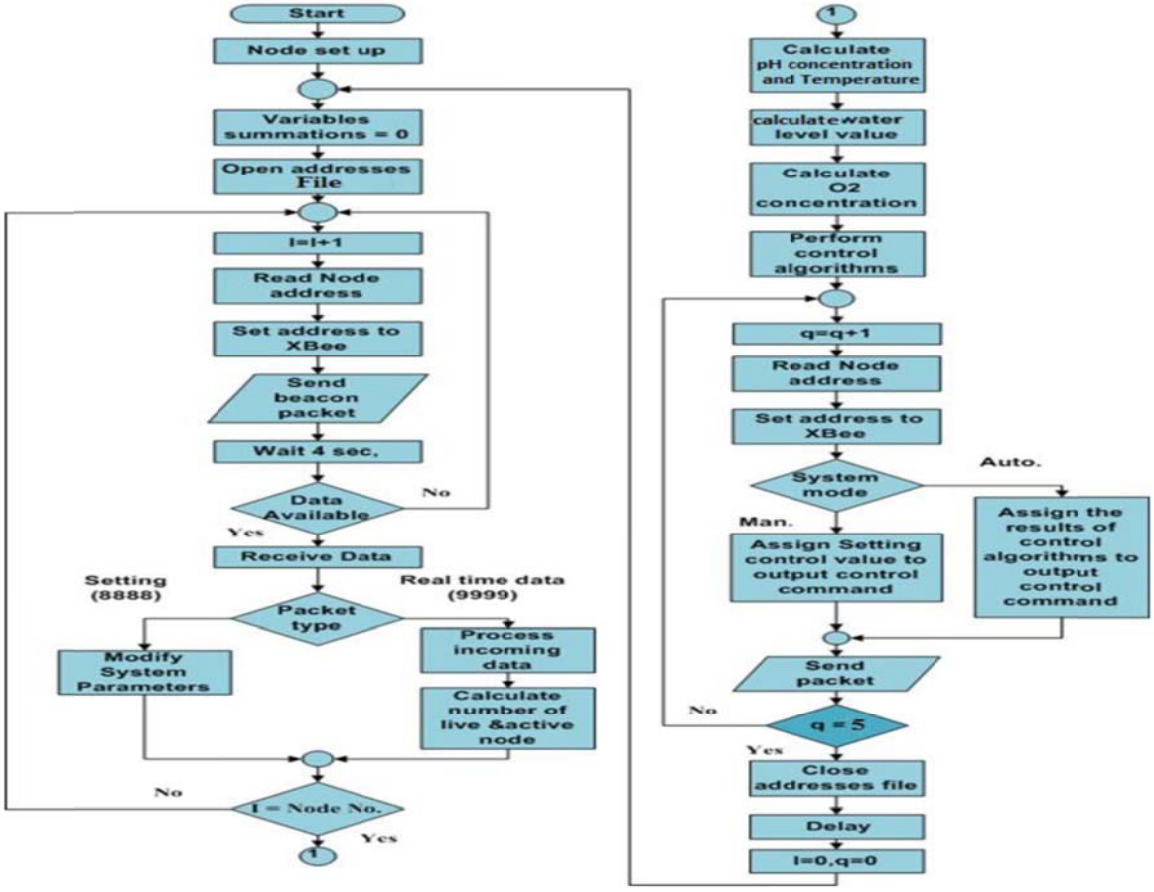
The reseracher's software design was divided into two parts, XBee configuration and MCU programming. As it mentioned before, XBee transceivers were configured to work as end device in ZigBee network while the MCU was programmed to preform specific tasks which includes controlling sensor, read sensors data, process them, and finally send these data to the transceivers via UART. XBee and MCU program flowchart is summarized in the following steps:

After turns the sensing node (ZigBee end device) ON, it joins to ZigBee network and still wake up for 4 second. The program operation can be summarized as follows:

1. During this period, it sends poll request to ZigBee network coordinator checking if there are buffered data waiting him.
2. If buffer data available, it received that data and pass them to arduino via UART.
3. If no data waiting on the coordinator node, it enter sleep mode directly for the 3 second.
4. When sleep period finished, it wakes up and start a new cycle.

For Microcontroller program flowchart

1. After turn's node ON, the microcontroller set up variables, serial connection baud rate and ADC reference voltage.
2. It directly enters to Ideal sleep mode and still waits an interrupt from UART.
3. If data received via UART, microcontroller wakes up directly and checks the received packet type. If it is beacon type packet, it start to read data which obtained by sensors.
4. Then, it checks error in the data which obtained from sensors. If no error detects, microcontroller sends collected data to the coordinator node. Otherwise, it sets all measured variables to zero and set existence bit to zero, and then send data to gateway node.



D. Hybrid control / sensing node

In our work, the researcher designed and implemented a special node type that contains both sensing and controlling mechanisms, to keep the environment conditions in its optimum case.

1. Hybrid control/sensing node for basin fish hatchery

Temperature played a key role in the proportion of hatching eggs fish perfectly. In terms of the stability of the temperature of the hatching of the utmost importance in improving the quality of production. So, we have installed this especial node to sensing the temperature and the level water in the fish basin

hatchery by the sensing algorithms, and from the other hand controlling the temperature degree by using controlling mechanisms represented by the heaters. Sensors/Actuators subsystem used temperature sensor and ultrasonic sensor to sensing temperature degree and water level, respectively, in fish hatchery basin. And used the heater as an actuator. In special node, the researcher used NTC temperature sensor, similar to that the researcher used in Lake Node "coordinator/sensing" node, but here, it has a little different in manufacturing design, so its calibration equation will be different. Ultrasonic level sensor used before with coordinator/sensing combination node.In this node the water warm is the most important factor that effect the hatchery process, so the researcher used six heaters in this basin as an actuator to regulate the temperature degree, to ensure the successful hatching process and keep temperature in a range between (22C◦-26C◦), So a relay circuit are used to drive these heaters. The connection of mechanical relay to the MCU is shown in figure 5. The function of relay is to drive the heaters . Microcontroller at this node makes the interpretation of the command from coordinator to actuators in addition to sending the captured data in order to adjust the environment conditions.

Communication subsystem is typically similar to that in coordinator/ sensing combination node and the same module is used also in addition to RP-SMA with RF-connector as shows in figure 4.22 above, and it's powered from a direct online voltage by using 9V AC adaptor.

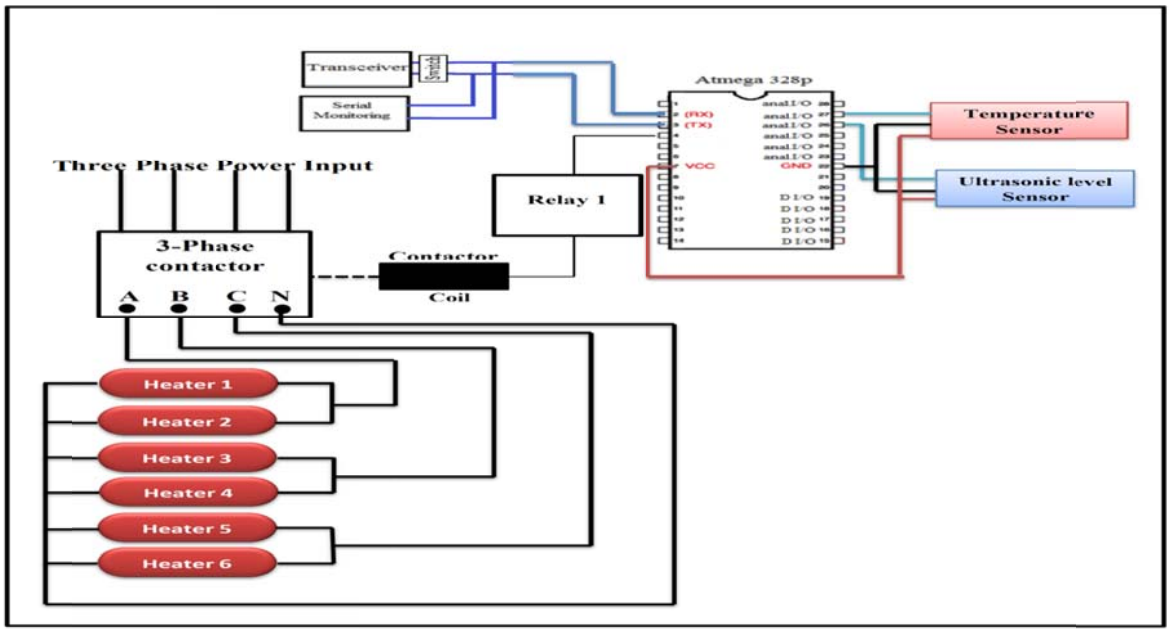


Figure 5 illustrate block diagram of hybrid node of fish hatchery basin

2. Hybrid control / sensing node for ostrich hatchery

In order to keep the optimum environment conditions for ostrich eggs to be hatching and reducing the loses with hatched eggs, we have develop this node. The following sensor used to sense both the temperature and humidity of the ostrich hatchery and as follows:

Relative Humidity (RH) measurements are highly dependent on temperature degree of atmosphere. Temperature of the Humidity Sensor may be increase due to heat transfer if the sensor shares same board with electronic components that produce heat, self-heating effects in case the measurement frequency is too high and from the surrounded climate. Therefore, it is necessary to use temperature sensor to compensate that change in temperature degree.

So, temperature compensation plays an important role and it needs special equipment to calculate temperature calibration coefficients. Therefore, we decided to use digital output Humidity and Temperature Sensor with high accuracy and sensitivity sensing elements to eliminate this problem and save a time. Digital output Sensor is an integrated circuit that consists of amplifier, microcontroller, analog to digital converter, and one-time Programmable memory (OTP). Temperature compensation coefficients (t1 ,t2) are saved in the OTP memory.

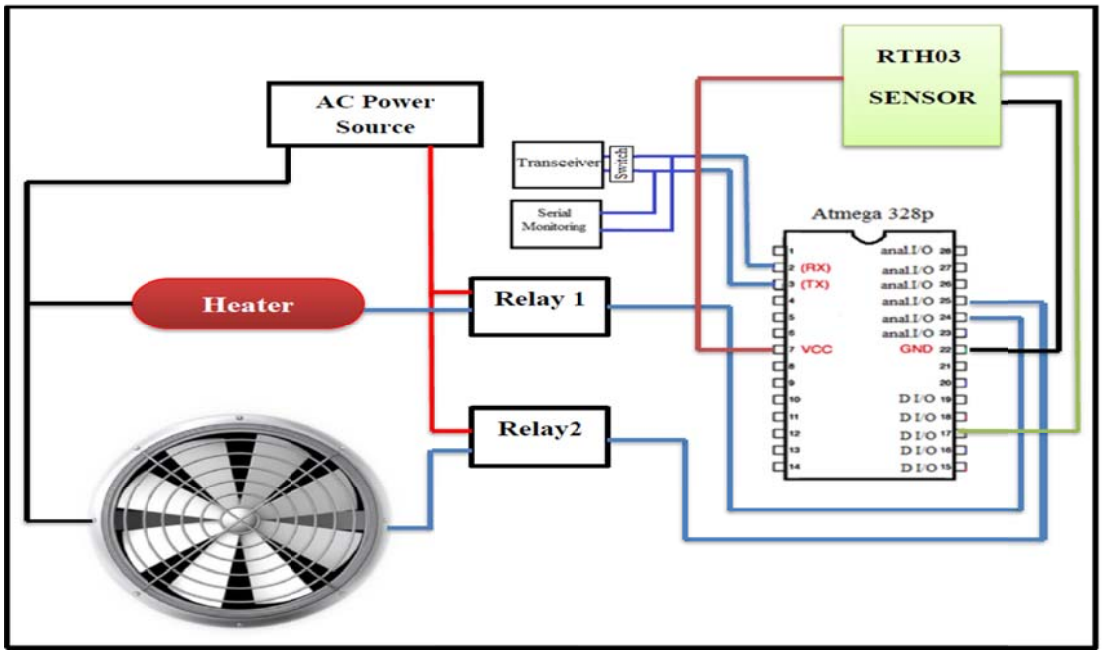
In this work, RHT03 (DHT22) digital output humidity and temperature sensor from Max Detect Technology Co., Ltd is used as shown in figure 4.23. The sensor consists of NTC and Polymer capacitor (MC02) as sensing elements for temperature and humidity respectively. Every sensor of this model is temperature compensated and calibrated in accurate calibration chamber and the calibration-coefficient is saved in the OTP memory.

The typical electrical connection circuit of RHT03 sensor is presented. The sensor has 4-pin namely: VCC, Data line, Ground, and one NC pin. This sensor needs 3.3 to 5.5 volt as Vcc and 4.7KΩ resistance to connect between Vcc and data line to provide a pull-up on the data line. Output data is taking serially form pin 2 by using especial one-wire communication protocol. Finally, pin 4 is connected to a ground and pin 3 used to mount sensor in printed circuit board.

Max Detect 1-wire bus is used for communication between MCU and RHT03. It is specially designed by Max Detect Technology Co., Ltd. The serial output data form sensor containing five bytes divided as two bytes for humidity value, two bytes for temperature value, and one byte for checking sum to detect error in communication. As a rule, every bit's transmission begins with low-voltage-level for 50µsec, the following high-voltage-level signal's length that decides the bit is "1" or "0". Logic one is represented with 70µsec, while logic zero represented with 26µsec. In additional to humidity and temperature measurement, RHT03 sensor provides error codes which they give us indication about sensor status. The mechanism of detecting these errors depends on check sum bits, sensor response and behavior.

In this paper, we connected RHT03 sensor to Atmega328p microcontroller. Microcontroller uses digital output port to turn sensor ON by changing port state from "0" to"1". This change will apply +5 volt at Vcc pin of the sensor. After that, the controller waits two seconds (which is the response time of the RHT03 sensor) to enable

sensor to collect environment data. When response period finished, microcontroller reads environment data from that sensor by using a special software library written by C++ languages then turns the sensor OFF by applying logic"0" to Vcc pin of the sensor. A ventilation and a heater used as an actuators with this node, this node is responsible of controlling the environment inside the ostrich hatchery box, by sensing the environment and correction the variables by these actuators. So, the researcher used the same mechanical relay circuits. As in all nodes, Atmega 328P has been used. The connection of relays to the MCU is shown in figure 6. The function of each relay is to drive one actuator to control the overall environment of ostrich hatchery box. Communication subsystem is typically similar to that in coordinator/ sensing combination node and the same module is used also in addition to RP-SMA antenna and it's powered from a direct online voltage by using 9V AC adaptor. Figure 7 below shows practical node



E. Control Nodes

Control nodes were installed inside the weather proof box designed for actuators and according to Farm Manager requirements. These nodes are responsible to drive heavy load three-Phase induction motor, depending on a control command coming from coordinator node. Actually, control node consists of actuator subsystem instead of sensor subsystem in additional to other remaining subsystem.

1. Control node for lake pump motor

This control node was designed to actuate a heavy load induction three-phase motor pump to raise the water drainage into the lake. So, when the water lake level decreased to threshold point predetermined, already the water level gauged by ultrasonic sensor as we mentioned. The coordinator node sends a control signal to turn the heavy motor ON, more over when the water level arise to another threshold point (Max.) ,the coordinator node send control signal to turn the motor OFF.

It should be mentioned that the pH sensor, coincides with previous mechanism, so when the pH concentration decreases or increased between two permitted ranges mentioned previously, the coordinator send control signal to turn the motor ON and OFF to equivalent to acidic water.

1.1 Actuator subsystem

A heavy load three-phase induction motor was designed as an actuator. Already, we have been designed a Delta/Star starting circuit because the motor needs a high starting torque at the instant of the operation due to the moment of inertia at the motor shaft. Figure 8 below shows the block diagram of the starting circuit whereas figure 8 shows practical circuit. To drive this circuit, the reseracher used relay shield from Seeed Studio Inc. As shown in figure 8. The Relay Shield is an Arduino compatible and it can be directly controlled by Arduino through digital IOs with external 9V DC supply. This shield includes four mechanical relays providing an easy way to control high voltage.

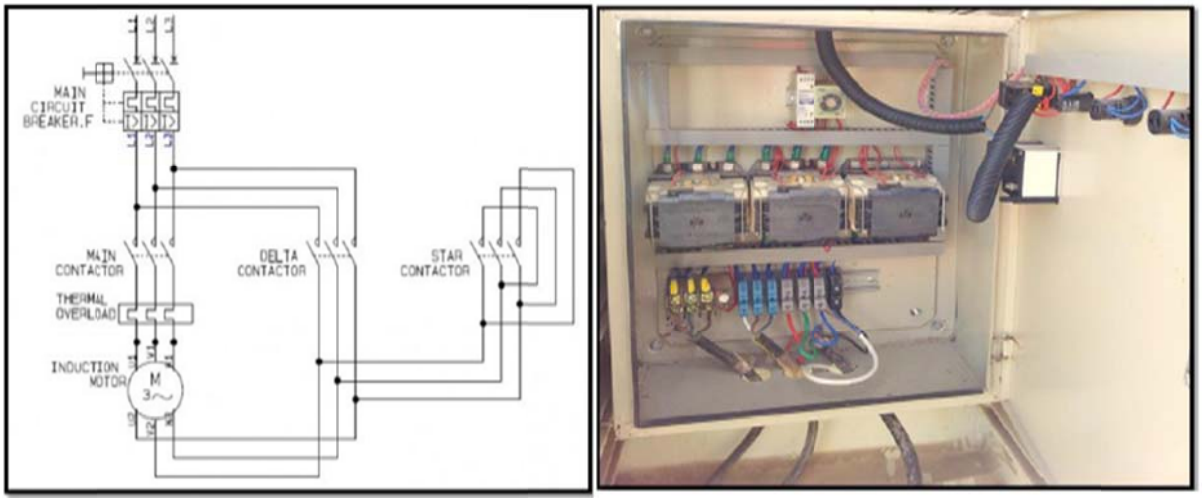


Figure 8 The block diagram and Practical Delta/Star starting circuit

1.2. Processor subsystem

The connection of relays to the MCU is shown in figure 9. The function of each relay is to drive one actuator. Microcontroller at this node makes the interpretation of the command from coordinator to actuators in order to adjusted lake environment conditions. Whereas figure 9 shows practical control node connected to the 3-Phase induction motor.

2. Control node for the fountain pump motor

When the dissolved oxygen in lake water that sensed by high sensitive dissolved oxygen sensor, is decreased blow threshold value (min. point), the coordinator node sends a signal to operate a three-phase heavy load induction motor to raise the lake's water in the air, in the form of a fountain where this process allows mixing between water molecules that is poor - oxygen and air molecules that is rich -oxygen, then the water return back to the lake which is loaded with oxygen, this process is similar to the process of breathing so we called this system " the lake's lung ". Figure 9 shows this lung system

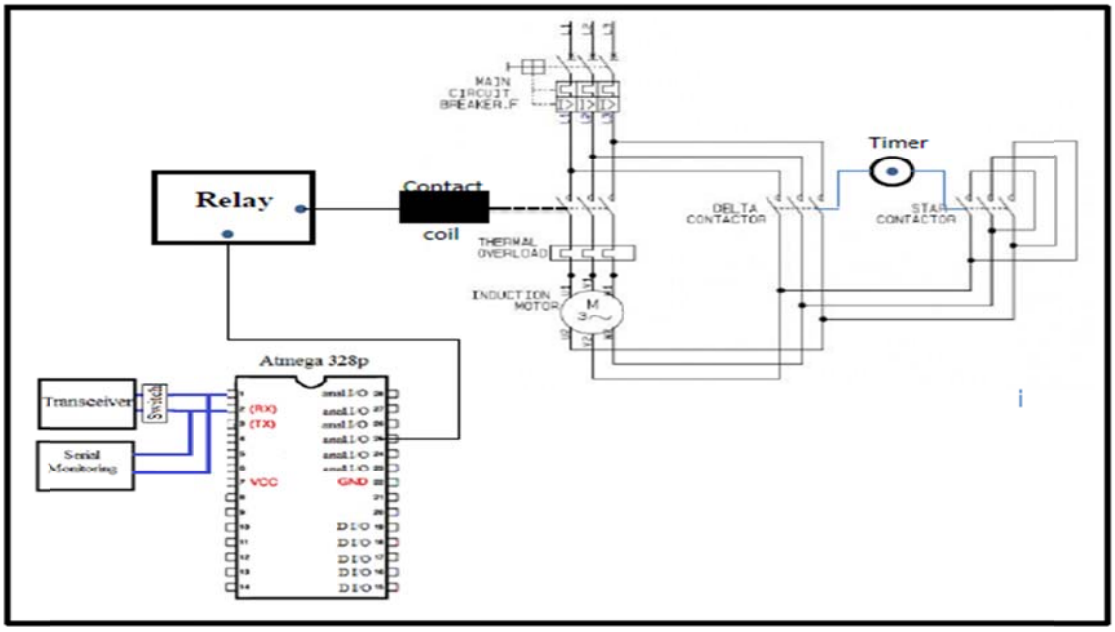


Figure 9 The block diagram connection circuit of the control node with 3-Phase motor

F. Gateway Node (GWN)

The system consists of one gateway node works as bridge to connect ZigBee network with computer. When XBee shield fixed over arduino platform, one drawback with serial connection among the three destinations (XBee module, MCU, and serial to USB adapter) will appear. If the controller tries to send data to computer via USB, a copy of these data will send at same time wirelessly by the wireless module; as a result, we will get undirected data packet over air. From other side, GWN action can be summarize in the following points:

It should receive data packet from coordinator node and pass it to the Graphical User Interface (GUI) in computer to display farm parameters.

It should receive data packet from GUI to modify system parameters such as control upper and lower thresholds, control mode, and total number of sensing node.

It should communicate with coordinator node to deliver GUI information and make coordinator node to update its information.

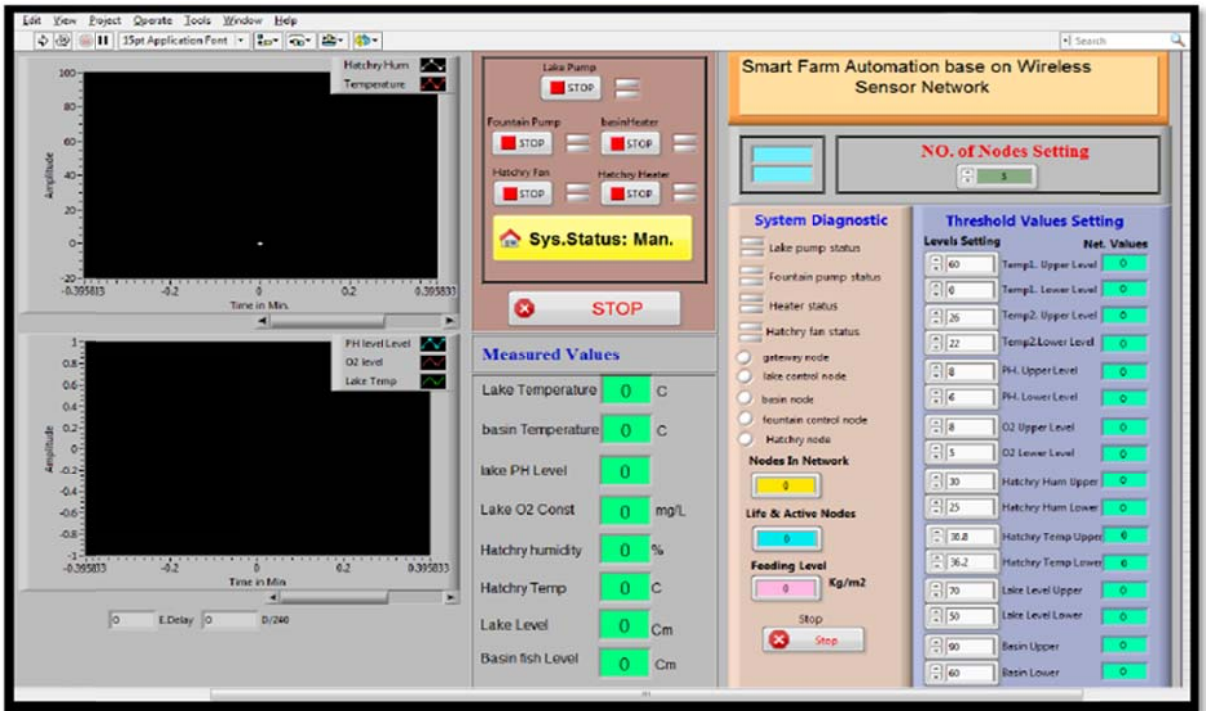
To eliminate the limitation of serial connection, fulfill the above requirements and manage packet traffic safely. An automatic serial selection circuit is designed If the controller needs to receive data from transceiver, it turn relay OFF/ On the other hand, if the microcontroller tends to send its own data to GUI ,it turns the relay ON and starts to send data after that, the controller waits response form GUI to turn relay OFF and start anew cycle. The communication subsystem here is represented by XBee module also. XBee module is configured to work as ZigBee end device. On the other hand, GWN takes power from the computer via (USB) port. XBee module similar to that in sensing node, it works as ZigBee network end device. On the other hand, the operation of GWN can be summarized in the following points:

1. When turn's node ON, the microcontroller set up variables, input/output ports, and serial connection baud rate.
2. Set the initial threshold values of control process.
3. If serial data available, the controller receives them and start to check packet type.
4. If monitoring packet is received, the microcontroller turns serial selection circuit ON, wait one second, then rout received packet to GUI.
5. If setting packet is received, the microcontroller modifies system parameters, wait one second, and turns serial selection circuit OFF.
6. If beacon packet is received, the microcontroller sends setting packet to coordinator node.

G. Graphical User Interface (GUI)

In order to display the obtained result, we used LabView software to create a user-friendly monitor interface program that enables Farm manager to perceive, modify the environment conditions of farm and also monitoring the status of the network. As shown in figure 10 below, GUI includes farm actual parameters display, history chart display, setting upper and lower controlling limits, system control mode, network node number setting, current network values and network diagnostic. "Measured values" zone in GUI program

displays real-time average value of farm temperature, humidity, Dissolved oxygen , pH concentration and lake water level. At the same time, the program draws historical chart of these parameters. The designed software gives an option to the user (Farm Manager) to modify environment parameters of farm as he needs. This feature is represented in "threshold Values Setting" zone. Farm manager can set new parameters control levels from "level setting" and see the current value in the network from "Net.Values" indicators. "System status: Auto. or man." is using to change control mode between automatic and manual. System default mode is automatic but the operator can change it to manual for emergency reasons. This zone is containing button for each actuator to turn it ON/OFF in manual mode. Also, there are two LED indicators to display actuator state. The system supported "self-system diagnostic". It is important issue to Farm manager to know if node is dead, still work put with error or till a life. The system provides the total number of nodes which still life and active. Also, nodes state and motors actuator indicators are presented in our diagnostic design.



We established ZigBee network with star topology. Star topology network supports low network latency. The network consists of one ZigBee coordinator device (Coordinator node) and ZigBee end devices (Sensing nodes, Control nodes, and Gateway node). Each communication subsystem on the end device is configured to inter Cyclic Sleep. Moreover, there is one "parent" to each "child" since the end device can sleep, the parent must be able to buffer or retain incoming data packets destined for the end device until the end device is able to wake and receive the data. Coordinator node has the ability to communicate with one end device node (sensing node, control node or gateway) at any time. It uses 64bit unique address of particular node in the network to send or receive data from it.

H. System operation

We configured all end device node to communicate with coordinator node only by writing coordinator 64bit address in corresponding DL and DH field. On the other hand, coordinator node uses address list stored in SDRAM memory to communicate with each node in the network. The designed system gives an option to Farm Manager to feed all a list of node addresses to coordinator node using removable SDRAM memory.by this way, Farm manager can add, remove or modify node in the network. When the end device is awake, it sends poll request messages to its parent. When the parent receives a poll request, it checks a packet queue to see if it has any buffered messages for the end device. Then send a MAC layer acknowledgment back to the end device that indicates if it has data to send to the end device or not. If the end device receives the acknowledgment and finds that the parent has no data for it, the end device can return to idle mode or sleep. Otherwise, it remains awake to receive the data.

A. Packet Type: Each over air packet in this work is of a certain type. Receiver depends on this field to recognize the coming data packet and how to analysis them. We have five packet types namely:

i. Beacon packet: It sends from coordinator node to each sensing node. This packet is used to make sensing node wake up and preform its tasks. Moreover, gateway node depends on beacon packet to send system setting packet.
ii. Real-time data packet: After sensing node collects environment data, it sends the data to coordinator node using Real-time data packet.
iii. Monitoring packet: This packet is directed from coordinator node to computer software (GUI) through gateway node. It is used for to monitoring the farm and system variables.
iv. Control packet: it is used to hold control command to control node.
v. Setting Packet: It is sent from GUI to coordinator node. It passes through gateway node it is used to set system parameters.
B**. System parameters**: This field consists of all parameters which set by GUI such as farm parameters upper and lower levels, total number of network node and control mode.
C. Control command: Control algorithms output are transferring to control and gateway nodes in this field.
D. Actual data: This field contains farm environment variable values.
E. Packet footer: It contain one of the two following fields:
i. Node existence bit (Sensing node).
ii. Active Node in the network (monitoring packet).
In the following points, system operation is summarized. Starting from sensing physical parameters until reaches to display farm variables and controlling actuators:
a) Sensing node is responsible to collect farm environment data and send them to coordinator node. Sensing nodes must receive permission (beacon packet) from coordinator node to start collecting data and send them.
b) The system starts to collect environment informations when coordinator node turns on. Once the coordinator node is active, it takes few second to establish ZigBee network and joining its child devices.
c) Coordinator node depends on destination addresses stored in SDRAM memory to manage communication with other nodes. The designed system gives Farm Manager the ability to great or modify TXT file which includes node addresses in easy way.
d) Coordinator node starts to load the first address which represents gateway address using AT command. After that, coordinator node sends beacon message to gateway node. Gateway will response to that packet by sending system setting packet which consists Farm Manager defined control threshold values, automatic/manual control mode and network nodes number.
e) When coordinator node receives setting packet, it immediately modifies both the nodes number value in the network and the control threshold values.
f) Then, coordinator node start to send series of beacon messages to different destination addresses to collect information from sensing nodes.
g) While coordinator node receives the response of beacons from each node, it preforms averaging process. The process includes the addition of each measured value from different sensing nodes and divided result by the total number of nodes. Our design support adaptive average value calculation. This mean, when the number of nodes changes for any reason like nodes dead, the average value still correct for active and life node only.
h) After that, coordinator node read O2,pH, temperature and water level sensors voltage, make calculations and then send them to the coordinator.
i) At this moment, all the information is available at the coordinator node to preform control functions. It starts to compare the average value of each parameter with its corresponding upper and lower limits which it has been set by the user. By this method, the coordinator node takes decision to turn actuator ON or OFF.
j) Coordinator node checks control mode of the system.
k) Coordinator node will send monitoring packet to the gateway. Gate way node routs this type of packet to computer directly. GUI will display this information to the Farm Manager.
l) Control node sends control packet to control node to modify actuators status.
m) Finally, coordinator node enters waiting interval. During this interval the network will be inactive.
n) During waiting period, GUI response to monitor packet coming from gateway by sending back packet contains the modified values which they are set by the user. At this point the system will ready to begin new cycle.

I. Diagnostic subsystem

The presented smart farm automation system supported with diagnostic subsystem. As shown in figure 11 below, diagnostic subsystem introduces the following diagnostic cases:
a) Each actuator status. b) Each node state. c) NO. of nodes in the network. d) NO. of active and life in the network. e) Feeding level that must be given to the lake farm. In actuator status, the diagnostic subsystem depends on the beacon comes from the control nodes when the relay is ON or is OFF to recognize actuator status. In designed configuration in each program with each node, the researcher has insert a data package that send logic "1" when the node is ON. The user can set the No. of nodes that he needs, whereas the active nodes can be calculated by sum the one's that coming from each node and shifting them.

Figure 11 Diagnostic subsystems and control Node2 diagnostic LED

Farm Manager can recognize these errors from GUI by making small comparison between actual life and active sensing nodes in the network and total sensing node which set by Farm Manager . Moreover, we designed GUI to give red blinking indicator when error occurs. All nodes have supported by LED's work as indicators , figure 11 shows LED's for control nodes .When red LED is ON that it means node is powered properly. On the other side, if green light appears, this means the node receives information .While we used yellow LED to give indication when node transfer data packet to coordinator. The other two LED's the red and the green ones indicate ON and OFF of the actuator respectively. Whereas in the coordinator node, the latest two LED's is not found, because we didn't have an actuator with this node, instead we support it with error LED this LED is light when there's no node response to the beacon of the coordinator node. Figure 11 above , shows coordinator diagnostic LED's.

J. surveillance and security system

With the control system mentioned above, side by side, we have been proposed surveillance and security system according to the Farm Manager demand, this system aims to secure the entrance gate of the farm and monitoring and surveillance high-value animals like an tostriches and hinds or deers. For this proposed system, we have been used an IP cams and each IP cam to the nano station antenna to transmit the captured video wirelessly to another nano station antenna configured in its software program as a receiver antenna. Then, the two received signal that came from the two IP cameras and an Ethernet cable came from the desktop computer are collected by a hob device and then the IP cams display on the computer's monitor after installing the software program of the IP cams in desktop computer. This is an important application because fighting between high-value animals such as ostriches and deers during breeding seasons causes significant financial loss to producer. As a result of continuous imaging and monitoring we can now see real-time ostrich breeding and egg-laying time and quantities and to study the behavior of the bird with the rest of the ostrich birds in the same barn and develop solutions to the problems that may arise in this corrals.

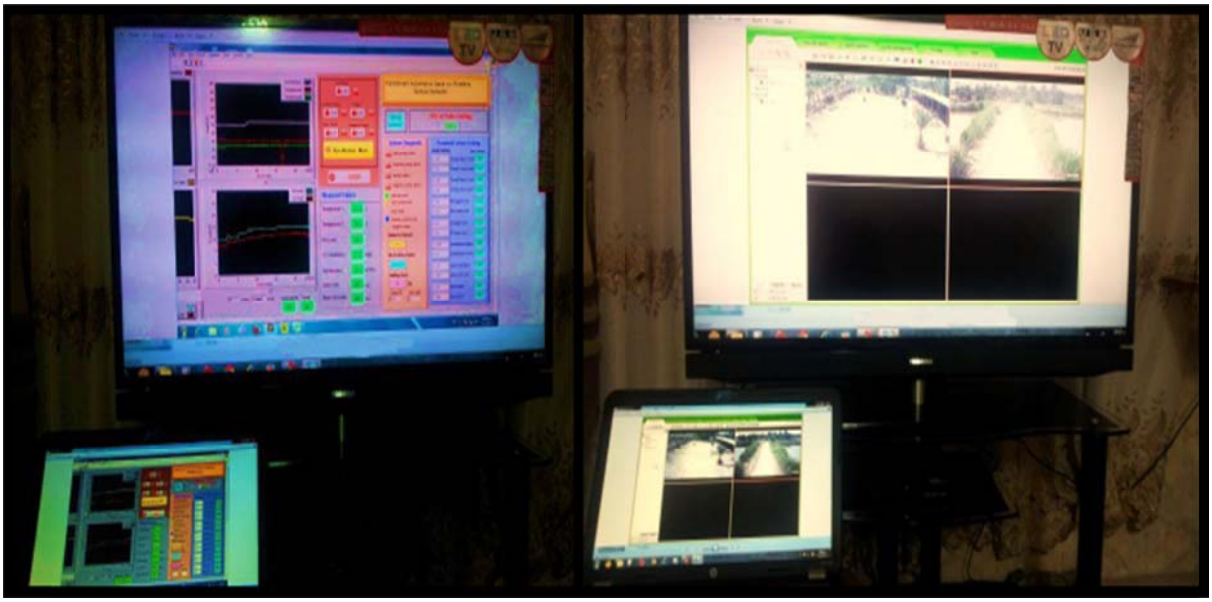
K. Communication Towers Installation Process

One of the problems that faced the Farm Manager, that his home was relatively remote from his farm (about 10 Km distance), and it's become inaccessible in some days of the year for the difficult climatic conditions such as high heat in summer and rainfall in the winter where the roads being blocked because these roads unpaved as shown in figure 12.

So, the researcher has proposed an efficient long range powerful PtP Link (point to point link), by using towers on a high (24m) with an efficient antenna. In general, the researcher used parabolic dish 30dBi dual-pol AirMax 2x2 PtP bridge dish antenna for this purpose. Before, the researcher used the link, he has made a test to check the bandwidth channel to knowledge the real b/s rate for more efficient and reliable system. After this test ,the researcher got 171.1 Mbps bandwidth channel which is so good rate

L. Remote Access and control

Firstly, as the researcher mentioned he connected the desktop computer "that placed in the "Central Unit Room", IP cams and the parabolic antenna of the tower to the hub device in order to collect the data and transmit it via our link.On the other hand, the researcher used and developed an advance program named: TeamVeiwer that allows the Farm Manager to access the desktop computer that placed in "Central Unit Room" inside the farm, remotely from his home. TeamViewer host is running as a system service and is used for 24/7 access to remote computers, including login/logout and remote reboot - optimized for home-office access. TeamViewer is universally acknowledged tool of the remote control, remote assistance. Instant connection to various types of far-off desktops is the goal of this application. What's more, it demands no technical skills from its user what makes it incredibly convenient in use. Each time you run TeamViewer you get your unique session number and a password which you can use to get access to the remote computer. By using TeamViewer it's become possible to operate the desktop computer at remote distance on the Internet from any a place and watch the variations in the system and controlling them by the Farm Manager . It provides him file exchange ability, gives him a special chat to communicate with any person if there. Already, the researcher installed this program in both desktop computer inside the farm and in PC computer for the Farm Manager that found inside his home. At the end of our work, the researcher has connected LCD to the PC computer by using HDMI cable, inside the Farm Manager's home to display our system with its environment variations and imaging video as shown in figure 13 below.



V. RESULTS AND DISCUSSIONS

In order to measure and control the farm environment parameters, dissolved oxygen, pH concentration water level and temperature, humidity and water level as well as according to the obtained results, the designed system presented in this paper gives an excellent results and the farm control operation is very efficient. The system monitored temperature, humidity, and dissolved oxygen, pH concentration inside farm lake and water level successfully as shown in figure 14. After implementation and testing the designed system, we show that it was stable; no error detected. Figure 15 illustrates farm parameters monitoring with GUI.

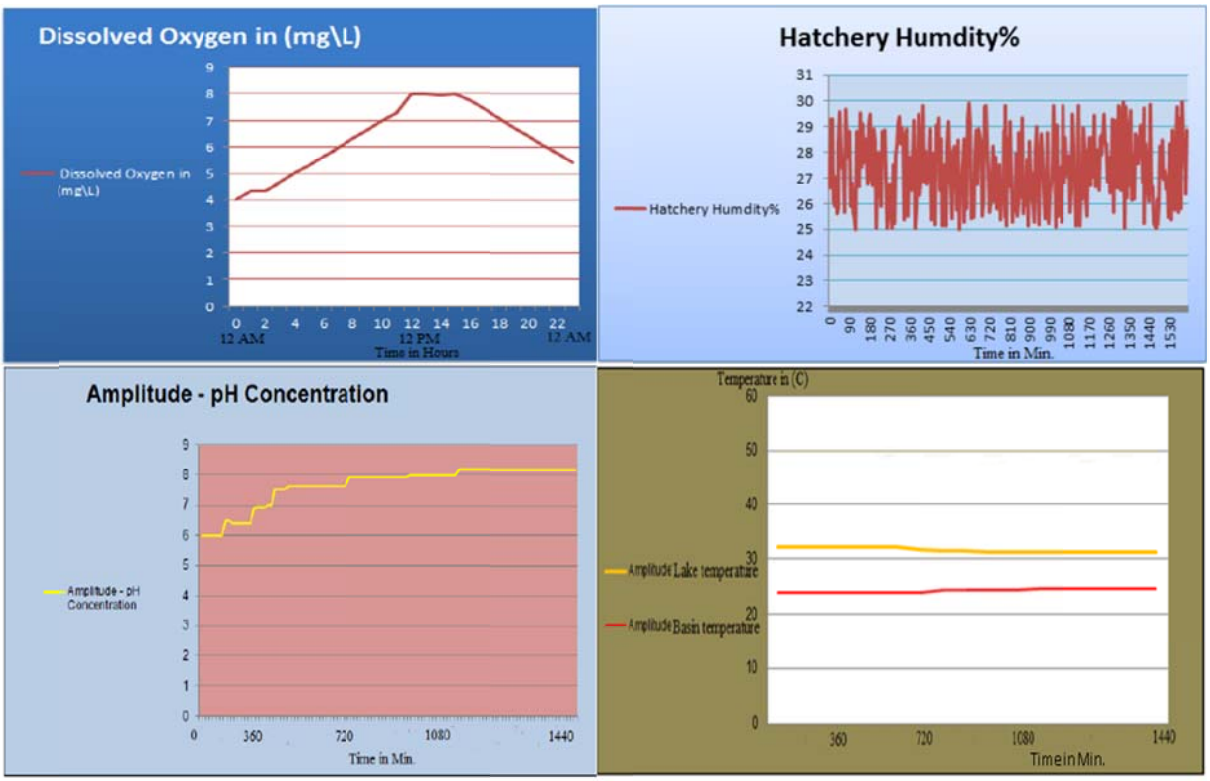
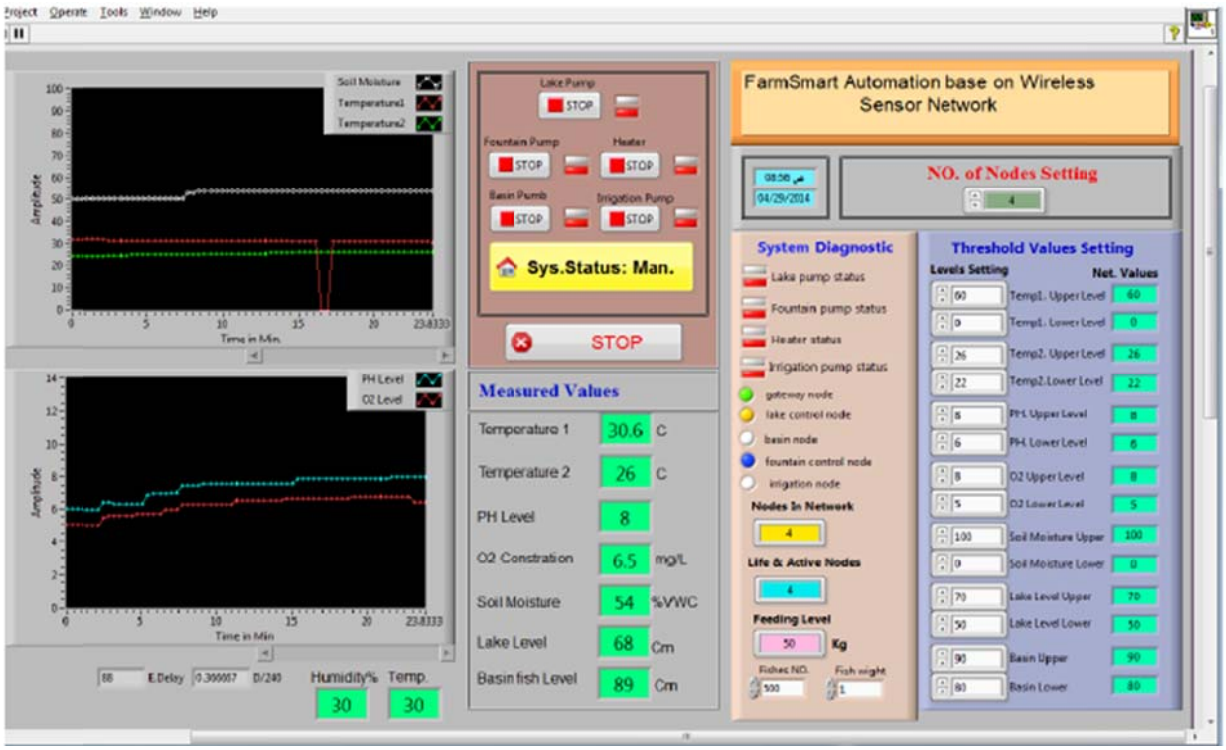


Figure 14 Farm environment parameters monitoring



Practical test for all control functions in the designed system was done. We have connected control node to the heavy actuators of farm like 3-Phase motors pump. At the beginning, the two control thresholds (MAX and MIN) set for each parameter by expert Farm Manager form the Central Unit Room (CUR). Then the system continuously keeps each measured value between these thresholds. The system shows a good stability, fast response, and high efficiency. The obtained results are:

i. Motor pump level excellent control can be performed for lake water level between 100cm for upper limit and 50cm lower limit. We obtain good actuator pump stability by selecting this upper and lower range. Figure 14 shows the obtained results. Another control for dissolved oxygen is done by fountain motor.
ii. Basin hatchery fish temperature control The network perfectly controls the basin fish hatchery temperature value between 27 Celsius for upper limit and 22 Celsius lower limit. Figure 14 shows the obtained results.
iii. Ostrich hatchery humidity control. The system perfectly kept in hatcher relative humidity value between 30%RH for upper limit and 25%RH lower limit as shown in figure 14 above.
iv. Dissolved Oxygen control: Farm Manager set dissolved oxygen water levels between 5 mg/L and 8 mg/L. The system controlled the amount of dissolved water depending on the average value of sensing node measured value. Figure5.9 shows the practical result of dissolved oxygen in water control.
v. pH concentration control: The upper and lower pH threshold have been set to 5 and 10 respectively.
vi. Temperature control for basin fish hatchery and the display for lake temperature.
The most important factor in aquaculture is the temperature for the reasons mentioned previously. So, in basin fish hatchery we have controlled the temperature in between 22C as MIN. and 27C as MAX. for successful hatching. Whereas in the lake the temperature is displayed for knowing the amount of feed that must be given to the fishes. Figure 5.13 shows temperature results for both the basin and the lake. The deigned system has been well tested practically. The obtained results were excellent and trusted. The system delivered the actual measured values (dissolved oxygen in water, pH concentration in water, lake water level and temperature, relative humidity for basin hatchery fish) to Farm Manager with efficiency and without any error or latency. A Occasionally, we got zero reading in GUI chart for one or all measured values for one sample. This happened due to incompatibility between Arduino platform and LabView software as shown in figure 15. And RHT03 digital output sensor has good accuracy and resolution. it is an efficient way to measure relative humidity and temperature far from the complexity of this type of measurements. And in relation to the system control, two points are depicted: 1-The designed system shows high stability to control actuators. 2- ON/OFF actuator control methods were efficient to adjust farm environmental conditions. And when we talking about the diagnostic subsystem, the designed system was tested in different operation conditions to detect all error types (network topology changing or node status). The designed system worked with high efficiency

VI. CONCLUSIONS

In both sides this work, the design and implementation aspect, it need a lot of experience in different fields like communications, electronics, control, and measurements. Moreover, it can be concluded that designed system has the ability of monitoring and controlling the designed environmental conditions like (dissolved oxygen, pH values, temperature, the water level and humidity) to obtain maximum crop growth in the farm. And WSN technology has good features such as small size devices, low power consumption, scalability, and low cost with respect to instillation or maintenance. WSN is a best way to collect, process, control, and monitor scattered information wirelessly over large area. Also WSN application includes health care monitoring, building automation, objects tracking, fire alarm system, and greenhouse automation. And ZigBee protocol supports low cost, low data rate, low power consumption, communication range about (200m), self-organize, and self-healing. And the quality of product of animals inside the farm specially the fishes in the lake are highly dependent on the management quality. Therefore, continues monitoring and adjustment of environment conditions will allow for maximum crop yield as much as possible. Also because of the system depends on high accuracy and short time response sensors to collect environment data so that the life time of the system will be extend. And the designed system supports multi-sensing nodes so that increase system reliability. Also the farm manager can set or modify the total number of sensing nodes through GUI program. The design also supported the error diagnostic subsystem and can adapt to any change in network topology at the same time farm manager can monitor active sensing nodes number in the network, this was made because of using LabView program to develop easy to use Graphical User Interface (GUI) to make the front panel parameters friendly and easy as possible. Also the system can save the history chart of environment variables so one can analysis and study system and environment behavior. The designed system includes two control modes automatic and manual. System default mode is automatic but for emergency cases, farm manager can control actuators directly by manual mode. Also the control function is progressive in network. This gives us a freedom to remove the computer from the network while a network control function still operates. Finally the presented system design has the flexibility Finally, and what is the best designer in the system could be monitoring and control all the variables of the lake and the fish hatchery fish eggs and incubator ostrich eggs from anywhere in the world through the Internet.

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