Automated Monitoring System for the Fish Farm Aquaculture Environment

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***Abstract*—This panel will establish an automated monitoring system of wireless sensor networks for a fish farm Environment Simulation. This system allows a user with a mobile device to monitor the fish farm Environmental Data with Instant mastery and control over the various environmental data. Temperature, dissolved oxygen, PH value and water level sensing modules are incorporated in this monitoring system. MCU processing is used to capture the physical sensing signal. The ZigBee wireless sensor network brings the data to a central processing core. A WIFI interface transfers the data to the user terminal device. The user can control the entire fish farm environment through the terminal device. Android software was used to design the terminal device user interface. A low power MSP430 series MCU is the core of each sensing terminal and the central terminal. The power supply can be battery-powered, standard electricity supply and/or solar battery powered. UPS makes the whole system more secure with low-cost, low energy consumption, easy operating features with a high degree of freedom for this wireless breeding environment monitoring system.**

Keywords—IOT; Wireless transmission; ZigBee; Automatic fish feeding system.

I. INTRODUCTION

In recent years global climate anomalies, the greenhouse effect, El Nino, anti-El Nino have become increasingly serious. Marine fish production has plummeted, with mankind facing a looming food crisis. The rapid increase in world population, increasing demand for food, over-exploitation of land has led to land resources decrease, desertification and global crop decline for livestock. Aquaculture development of renewable resources has become an effective fish breeding method instead of sea fishing will become the future trend. According to FAO, "2012 State of World Fisheries and Aquaculture", Global annual production of fishery products amount to about 128 million tons. The animal protein intake per person is about 15%, which makes the human dependence on fishery resources increase. Based UN Food and Agriculture (FAO) estimates that the average consumption of fish products in the world in 2030 will be 16.7 kg per year, compared to today's 19 to 20 kg per person per year. We can see that fisheries production, development and future food needs are closely related [1].

Taiwan fishery technology continues to progress. The key technologies in fish farming were developed through international attention and affirmation. High-tech culture fisheries technology is used to achieve high economic and operating efficiency. For the island nation of Taiwan aquaculture is definitely one of the most important economic lifelines. Automated farming systems allow the following benefits: (1) Origin of production close to the market demand (2) Improved environmental control (3) Reduced losses caused by major disasters (4) Reduced management environment (5) Lower production costs (6) Improved aquatic product quality. [2] ◦ In addition, aquaculture development provides affordable animal protein and drives industry economics; such as: feed, farming machinery and transport development, etc., to balance the deficit in international trade. More importantly our superb aquaculture technology promotion favors foreign aid work, enhancing Taiwan’s international status.

II. LITERATURE REVIEW AND RELATED TECHNOLOGIES

Wireless sensors network (WSN) and Wireless personal area network (WPAN) rapid development and popularization, Driven sensing and transmission of information environment has become more fast and convenient. ZigBee short-range wireless transmission technologies, the use of standardized IEEE802.15.4 standard, features include low-power, low-rate, low-cost ... and so on. ZigBee is applied to a considerable number of occasions, Dae-Man Han and Jae-Hyun Lim, (2010) as the main signal transmission using ZigBee technology, Consumers with a variety of physical sensors and home equipment, set up a smart home energy management system to handle a variety of situations that may occur at home [3]. This article applies ZigBee aquaculture systems, when combined sensor and fish farming equipment, and design their own ZigBee transmission path, enabling wireless transfer of information, the information is not easily blocked foreign body, resulting in signal loss.

Physical parameter of water is considerable, Temperature, PH, dissolved oxygen and water microbial activity ... etc. Each fish has a suitable growth environment, The fish farm water is unstable, Survival and growth of aquatic organisms affected the water quality is very large, Water quality is not suitable for short-term, such as oxygen, temperature and salinity of the upheaval, Pathogen infection spread rapidly through the water, are enough to cause biological farming all died within a short time. To achieve high economic efficiency, Except for using a number of sensors to monitor the status of fish farming environment, Also add automatic control systems, solar systems, mobile

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devices, wireless transmission technology ... etc, to make the system more complete, and reduce costs and create a better economic benefits. Water quality monitoring weather is one of the ingredients of success aquaculture, Unlike this article aquaculture systems, M. Garcia, S. Sendra, G. Lloret and J. Lloret (2010) has established a mariculture monitoring system to measure water in terms of physical sensors use the same temperature and humidity and PH quality ... etc., Because the sensors for marine aquaculture increased wave height, wave frequency, displacement and acoustic underwater sensors ... etc. All data were collected mix analysis, Determine the fish's location, scope of activities and activities, and to confirm the extent of hunger, then put in the feed, Thereby can reduce feeding costs[4]，Goulao. M.V. (2010) and other scholars mentioned Statistically, marine aquaculture feed costs for 60% of all costs, including 8.26% of the feed and the loss has not been eating fish, resulting in unnecessary waste [5], We can use this feature to use this system in aquaculture, breeding area of narrow, and unstable factors reduced (eg: ocean currents, waves ...) allows to determine a more accurate, more effective feeding.

Different spectral characteristics, growth is very significant impact on the biological, autumn flowering plants such as chrysanthemum, a way to make use of light treatment daisy bloom all year round. aquaculture fish will be different because of the light, thereby affecting the growth of fish, eating and survival, Correct (lighting control) is also an important key. Li Shan Sheng (2009) use (LED and other seven different lights), Against grouper for feeding, health and survival do the experiment and found that the choice of different fish age appropriate light source, On the high grouper breeding can improve efficiency [7], This system design a variety of lighting situations, Can be adjusted according to different species,
Adapt to the needs of different species habitat.

III. SYSTEM ARCHITECTURE

A.Hardware section：

The system uses the MSP430 series chip as the processing of each sensing node of the core, Wireless sensing network interface using ZigBee as a communications interface. In each of the (sensor) and (control side) are equipped with a ZigBee wireless transceiver and MSP430 microcontrollers, use homemade central processing system controls each sensor and controller, collecting all of the sensed data, Then through the central terminal is equipped with the WIFI transmission module, all the environmental sensing data communicated to the user's terminal equipment. Power supply can be adjusted depending on different user preferences or sensing the environment. This system architecture is as Figure 1.

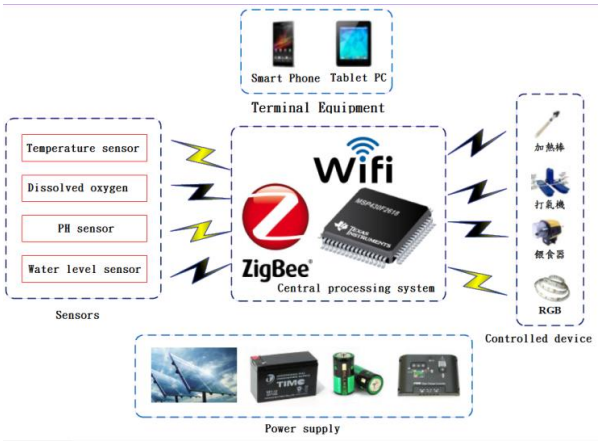

Figure 1. hardware architecture diagram

B. Temperature sensing module：

Temperature sensing module uses the PT100 sensor (Figure 4-2). The element is composed of coiled platinum wire, wound onto an insulating cylinder that is a positive temperature coefficient resistance sensor. The temperature sensor itself is converted into the amount of physical change in resistance. This change is accomplished through a linear circuit and compensation circuit output voltage to eliminate common mode noise. The circuit output travels to the processer, then to the differential amplifier.

Figure 2. PT100

C. Water level sensing module：

The water level sensing module uses an ultrasonic transmitter to emit to an ultrasonic receiver. The sound wave reflection time is converted into the water level. The intensity of the transmitted acoustic wave is affected by distance attenuation. The main reason is because of the energy dissipation from the growing distribution area. Measuring distance based on the time difference as a reference for accurate determination of the echo, the frequency of measurement should be increased to obtain higher resolution so that the distance data is more accurate.

Figure 3. Ultrasonic Sensor

D. PH and the amount of dissolved oxygen sensing module：

After the PH instrument (Figure 4) and dissolved oxygen instrument (Figure 5) signal their measurement data, the signal is converted into transmission through the MAX3232 chip MSP430. After computing the actual value through the chip the value is transmitted through ZigBee

chip central processing systems for integration analysis.

Figure 4. PH meter

Figure 5. dissolved oxygen meter

IV. WIRELESS SENSOR NETWORKS

The ZIGBEE wireless transmission has the advantage of high reliability, low cost, low power, transmission speed, network infrastructure and support diversity to improve encrypted data security. Its actual transmission distance is 150 to 200 meters, with a data rate from 20Kbps to 250Kbps. The network layer side also supports Star, Cluster Tree and Mesh three network architectures (Figure 6). Comparative wireless transmission interface (Figure7).

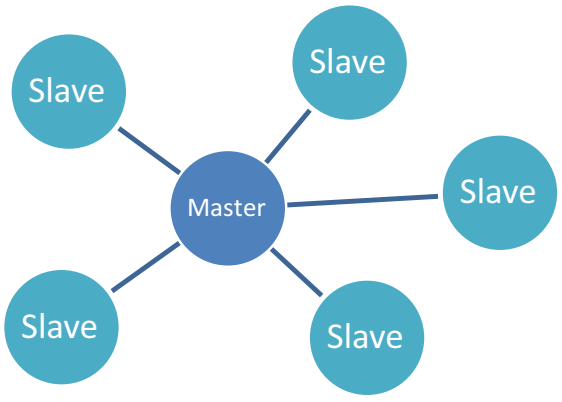

Figure 6 Star network architecture

Name / Item	Bluetooth	UWB	WiFi	ZigBee	IrDA
Use of the frequency band	2.4GHz	2.4GHz	2.4GHz	2.4GHz	
Transmission rate	1Mbit/s	480Mbit/s	54Mbit/s	250kbit/s	4Mbit/s
Transmission distance	10~100m	2~10m	2~100m	10~150m	1m
Transmit power	1mW	≦1mW	100mW	≦1mW	≦1mW
Network node	7		32	6500	

Figure 7. wireless transmission interface comparison chart

The MSP430 chip uses two serial communication ports connected to ZigBee and WIFI. The wireless sensor network architecture Master collects all of the data for meta-analysis. And the Master performs automatic environmental parameter monitoring and transmits the information to the user terminal device through WIFI. The user can use the terminal equipment for environmental control parameter adjustment for fish growth control and maintaining stable environment control.

LOAD CONTROL

A. RBG light modulation system：

The system uses the PWM pulse width modulation technology through a terminal control device to adjust the brightness of the lights in three primary colors. Delicate multicolor light is varied to adjust the light color fish need for growth, as shown in Figure 8.

Figure 8. RGB Light

B. Heaters：

When the temperature is below the range set by the user, the central processing system will automatically send signals to turn on the switch to increase the water temperature by increasing the (Figure 9) heating rod load.

Figure 9. Heater

C. Inflator：

When the dissolved oxygen value falls below the range set by the user the central processing system will automatically send a signal to start the load to improve the amount of dissolved oxygen in the water, see (Figure 10).

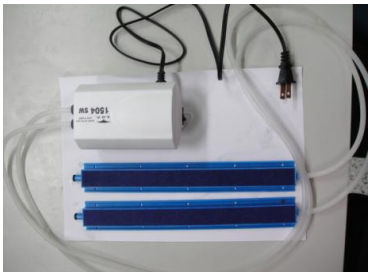

Figure 10. Inflator

D. Feeder：

The fish feeder can be set through terminal device. Figure 11 shows our feeders.

Figure 11. Feeder Load

E. Power supply：

This system is designed for low-power sensors. The power supply can be battery-powered to follow the current sensing environment or the user can switch to electricity or solar power.

The central processing terminal is an important core of the wireless sensor networks. The power supply will be used as a stable electricity supply mode with uninterruptible power systems for the auxiliary battery. This greatly reduces the instability caused by power outage or drained batteries increasing the reliability of the entire system.

V. SOFTWARE DESIGN

The terminal (mobile devices) uses the Android operating system to do the monitoring. The software provides a Windows program design with a graphical user interface tool and program development tools. Just pull out the desired graphical tools to see most of the program implementation tools with the same look as the Windows programming process, saving development time by writing applications, accelerate the speed of application development.

Click the app will enter the login screen as (Figure 11) shows; enter the account password to enter the monitoring page (Figure 12).

Figure 11. login screen

Figure 12. Monitoring page

Enter the monitoring page, open the upper right corner of the MENU button, click on the connection options will pop IP position setting box (Figure 13). Enter the corresponding IP address to connect to the monitoring equipment; monitoring data with the data on the screen will be issued by the central processing system, and timely updates.

Figure 13. position input box

Click the button on the lower left corner of the environment setting environment settings box will pop up. Users can freely set the required environmental monitoring data (Figure 14).

Figure 14. Environment Settings box

Users can set the state of the environment in addition to the value, but also to control lighting, Inflator, Heater and feeders.

Monitoring interface is set to the right block for our RGB lights with buttons one to six. Status values are displayed below it. The user also can change the default color of each button lights according to their own personal desire, such as (Figure 15) is set to block the light.

Figure 15. light toned box

Click the Preview button to see the current set of colors. Texas Instruments MSP430 family of chips, is 16bit, with RISC, ultra-low power Mixed Signal Processor. It is powerful power-saving features and built-in memory for each MSP430 different sizes and peripherals. The user can select the desired model, effectively reduce the overall system cost and board space. Complete development environment and online programming; accelerate the speed of development for users.

Android is a Linux kernel constructed on top of the smartphone operating system. Developers can write for free download to install Android SDK to develop applications. Most programmers are familiar with the Java programming language app，Android has been designed with versatility to define it as a programming language. Its powerful performance and widely covered the database, communications, Internet and most other functions, Android has provided a very comprehensive functionality. So the topic of the terminal (mobile devices) using the Android operating system to do the monitoring. Windows programming software provides a graphical interface with tools and program development tools. You can see that most of the program is implemented with the same appearance as the Windows programming process.

VI. ACHIEVEMENTS PICTURE

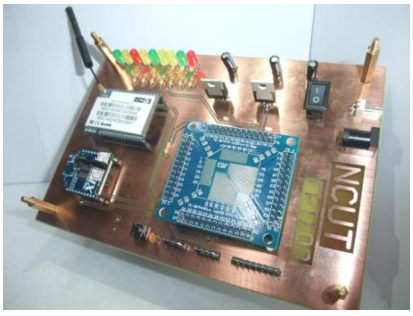

Figure 16. Wireless central control terminal board

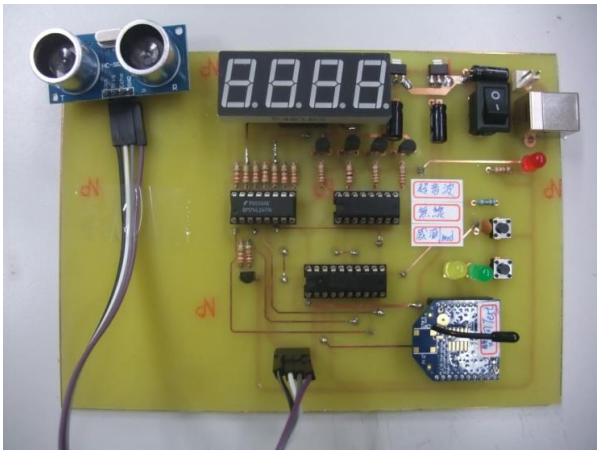

Figure 17. wireless ultrasonic sensing circuit board

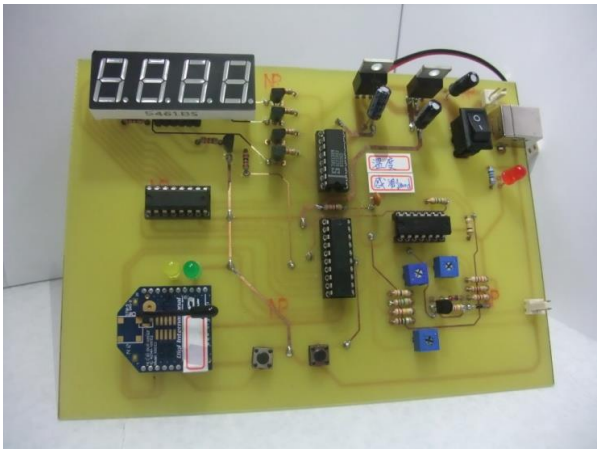

Figure 18. Wireless PT100 temperature sensing circuit board

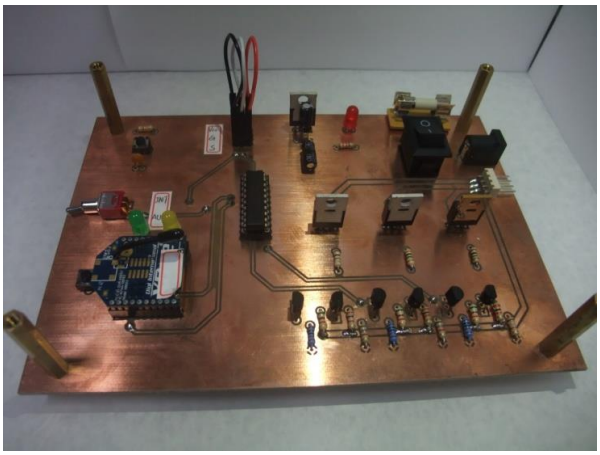

Figure 19. Wireless RGB PWM light modulation control circuit board

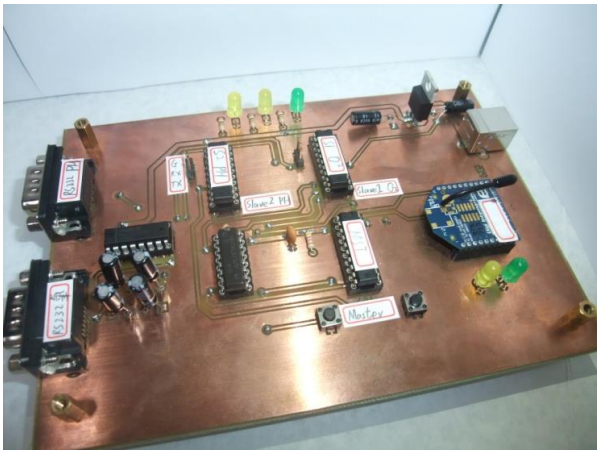

Figure 20. Wireless PH meter dissolved oxygen meter data processing circuit board

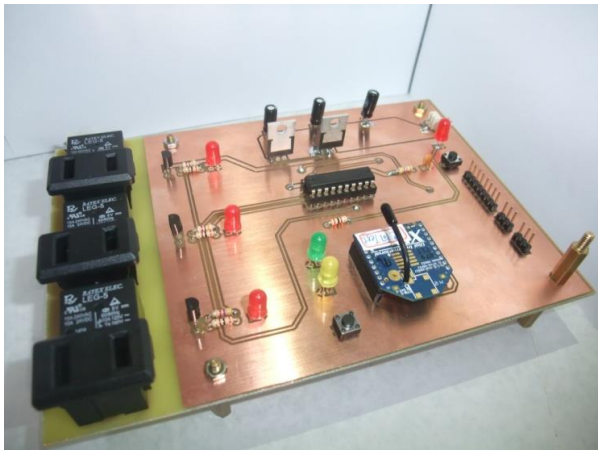

Figure 21. Wireless Load Control Board

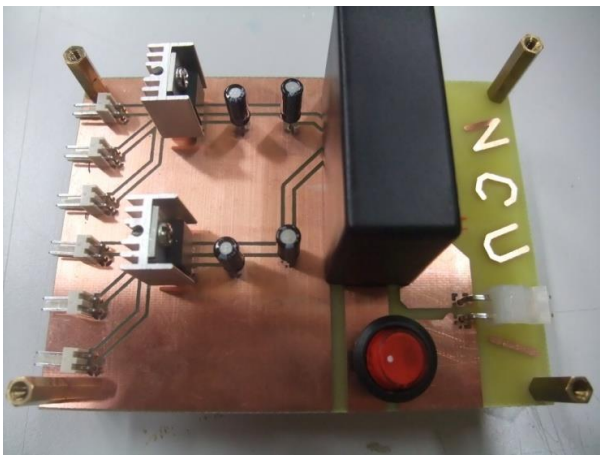

Figure 22. Power board

VII. Conclusions and Future Prospects

This topic is an aquaculture based environmental monitoring system. ZigBee wireless transmission and MSP430 chip are applied as the spindle hardware system for building a small wireless sensor network. The energy saving is very significant. The central system is equipped with a WIFI transmission module that can be used with most popular Android mobile devices connected directly to increase the overall system convenience and timeliness.

In the future this system can be widely used in a variety of environmental monitoring settings, such as plant care systems, environmental monitoring home security systems ... etc. Combined with the Internet of Things, Regardless of where the user is located, the user can receive the instant messaging environment, taking real-time monitoring technology to the next level.

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