http://ansinet.com/itj

ITJ

ISSN 1812-5638

INFORMATION TECHNOLOGY JOURNAL

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Information Technology Journal 9 (7): 1458-1466, 2010
ISSN 1812-5638

A Multi-functional Aquarium Equipped with Automatic Thermal Control/Fodder-Feeding/water Treatment using a Network Remote Control System

Min-Chie Chiu
Department of Automatic Control Engineering, Chungchou Institute of Technology,
Taiwan, Republic of China

Abstract: For the purpose of convenient management and breeding flexibility, a modern farming industry equipped with a remote automatic controlling system via the internet and a web camera is proposed in this study. Here, to fulfill the multiple functions needed for an outdoor pool, a multi-functional aquarium equipped with automatic thermal control/fodder-feeding/water treatment using a network remote control system is established. Besides, A PC-based control system using a VB interface in both sever pc and client PC via the RS232/RS485 protocol is adopted. To avoid excessive usage of underground water, an alternative method using an inner water circulation system in conjunction with an automatic water treatment process for a pool is used. Moreover, in order to conserve manpower while breeding fish, an automatic fish breeding system is installed in an aquaculture farm. To demonstrate an automatic system for breeding fish, a small aquarium model is assessed. Results reveal that the temperature inside the aquarium can be well-controlled within a preset temperature range. The multiple remote controlling abilities in temperature control, fish breeding, image monitoring and water-circulation can be fully achieved. Consequently, the automatic temperature control system can be applied to outdoor pools for fish reproduction.

Key words: Aquarium, water treatment, thermal control system, remote network monitoring, PC-based

INTRODUCTION

Temperature plays an essential role in fish reproduction, particularly in cueing the precise time of gamete maturation and spawning and providing the capacity for reproductive cycles to be locally tuned to shorter terms with less predictable variations in thermal conditions (Pankhurst and King, 2010; Van Der Kraak and Pankhurst, 1996). Moreover, aquatic fish will die if the pond suffers a cold wave during winter (Sarkar *et al*., 2007). To increase the survival rate of aquatic fish in a pond, an online thermal control system using a monitoring remote control technique becomes essential. For aquaculture farmers on an island, the over-load pumping of underground water that is widely used in large outdoor pools (Chang, 2009) results in sinkholes which may ruin the aquaculture farm. For example, ten percent of Taiwan's level land is sinking, some seriously, particularly in Ilan, Changhua, Yunlin, Chiayi and Pingtung Counties because of excessive pumping of underground water. To overcome this drawback, an alternative method using an inner water circulation system in conjunction with an automatic water treatment process for a pool is necessary. In addition, for the sake of improving fish reproduction, a full time online monitoring/breeding system using an automatic fodder-feeding device via the internet and a web camera is required. Research evaluating how temperature effects aquarium animals has been widely addressed (Pankhurst and King, 2010; Van Der Kraak and Pankhurst, 1996; King *et al*., 2007; Dou *et al*., 2008). Ghosh *et al*. (2008) used a solar energy to heat up the temperature of fish pond. Yet, the temperature within the fish pond is still unstable when either the cold wave or a cloudy wave arrives. Currently, a practical design for breeding fish that maintains a stable aquarium temperature by using an inner circulation water treatment is rare. Therefore, interest in promoting techniques for breeding fish using a remote automatic thermal control/fodder-feeding/water treatment system via a network and a web camera is increasing.

In this study, for the purpose of remotely manipulating an automatic system for fish breeding, a PC-based controlling system using a VB interface in both sever PC and client PC via the RS232/RS485 protocol is constructed. Consequently, to demonstrate the automatic fish breeding system, a small aquarium model is assessed.

A PC-BASED TEMPERATURE CONTROL SYSTEM

Automation systems used in various industries to reduce manpower are now prevalent. To demonstrate an automatic system for breeding fish, a small aquarium

Corresponding Author: Min-Chie Chiu, Department of Automatic Control Engineering, Chungchou Institute of Technology 6, Lane 2, Sec. 3, Shanchiao Road, Yuanlin, Changhua 51003, Taiwan, Republic of China

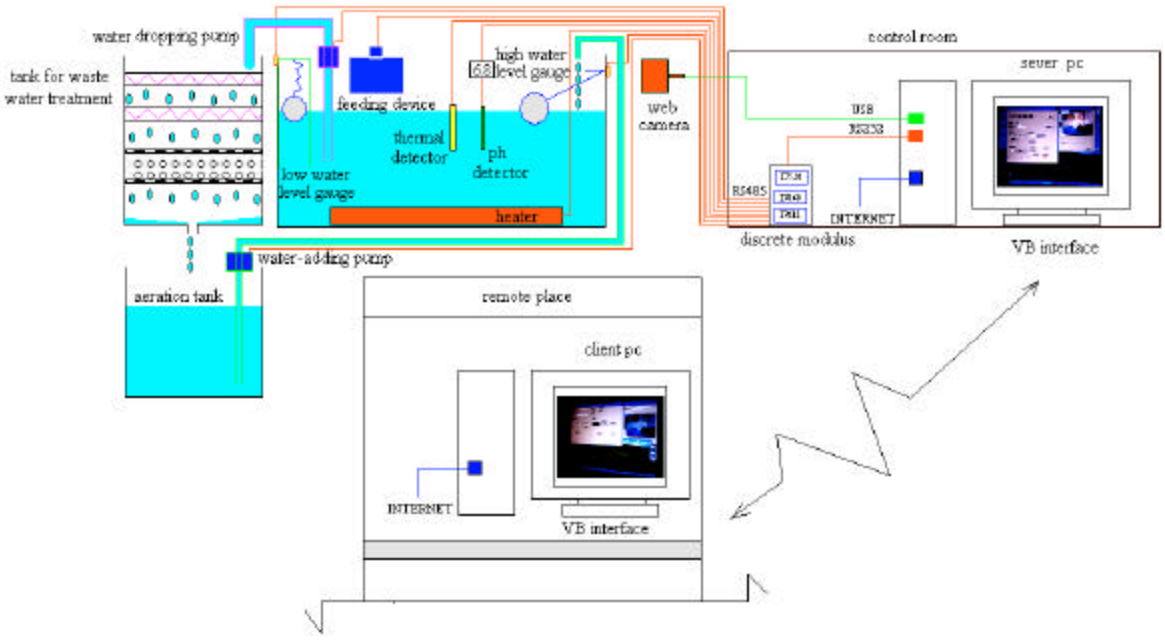

Fig. 1: A remote automatic thermal control/fodder-feeding/water treatment system

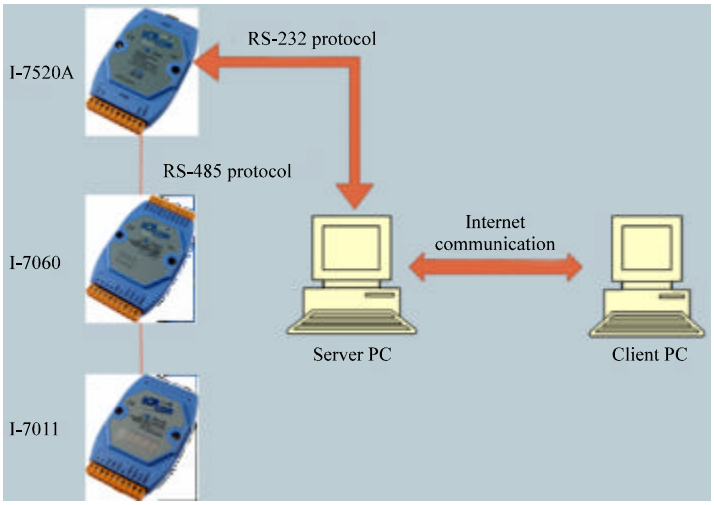

Fig. 2: Three different modulus

model is assessed. As shown in Fig. 1, to improve fish reproduction, a remote automatic thermal control/fodder-feeding/water treatment system using two VB interfaces (one in the sever PC and the other in the client PC) to manipulate aquatic temperature, water quality and breeding via a network and a web camera is established.

As shown in Fig. 2, three system modulus (7060D, 7520 and 7011D) are applied in the remote monitoring/control system. Because of a serious decay in the signal for a RS232 protocol traveling over a distance of fifteen meters, a new protocol (RS485) in which the effect of the signal decay is trivial during long-distance transportation is recommended. Here, the 7520 module is a protocol transfer device from RS232 to RS 485 (Tse and Chan, 2003; Mustafa *et al*., 2007). A command emitted from the sever PC will be sent to other modulus via the RS232/RS485 converter. A thermal detector made of a thermocouple is embedded in the aquarium to detect the temperature of the

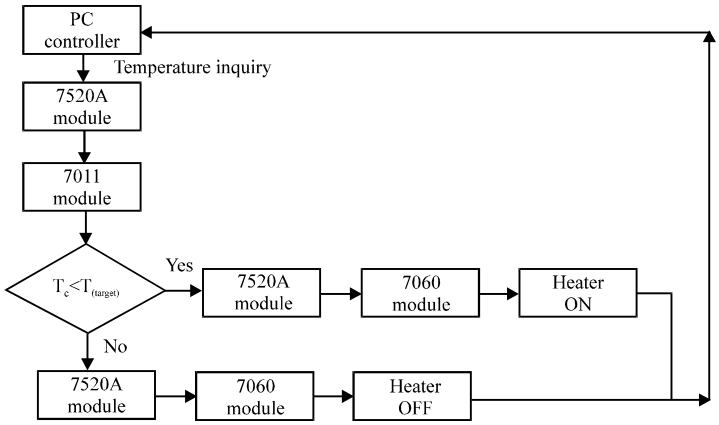

Fig. 3: A temperature-detecting feedback system built into a PC-based controller

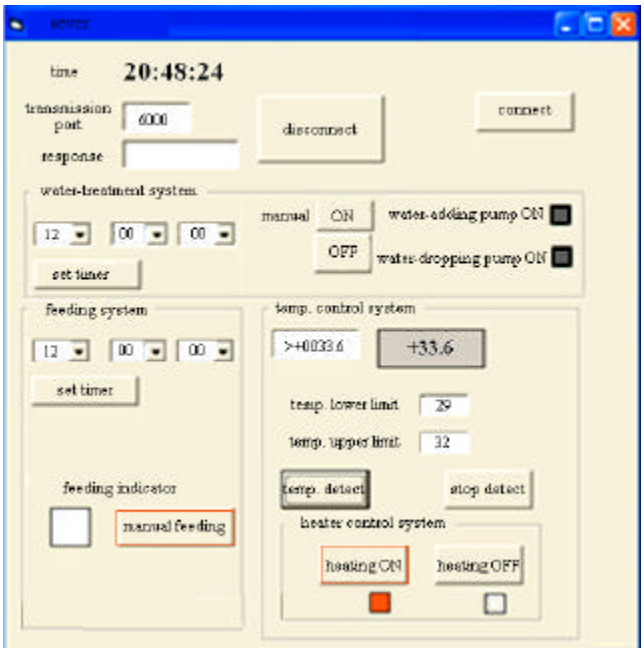

Fig. 4: Manual heating on the VB dialogue (PC sever)

aquarium via a 7011D module in which the analogue signal of the temperature will be transformed to the digital signal of the electrical voltage.

The hardware of the thermal control/fodder-feeding/water treatment system will be actuated by the 7060D and 7011D modulus's DI/O (digital input and output) which is emitted from a sever PC via a 7520A module (a protocol translator from RS232 to RS485). Similarly, the status of the temperature which is online will be sent back from the 7011D module via an A/D converter. As indicated in Fig. 3, to control the aquatic temperature online, a PC-based logic using a temperature-detecting feedback system in conjunction with a heating device is performed. Based on the online inquiry to the 7011D module from the PC controller (server PC), the value of aquatic temperature detected by a thermal couple will be obtained via the 7011D (a A/D converter in RS485 protocol) and the 7520A (the converter of RS485/RS232). The heater will be actuator when the current temperature is lower than the target temperature.

As shown in Fig. 4 and 5, the user can monitor the current temperature of the aquarium online. Manual

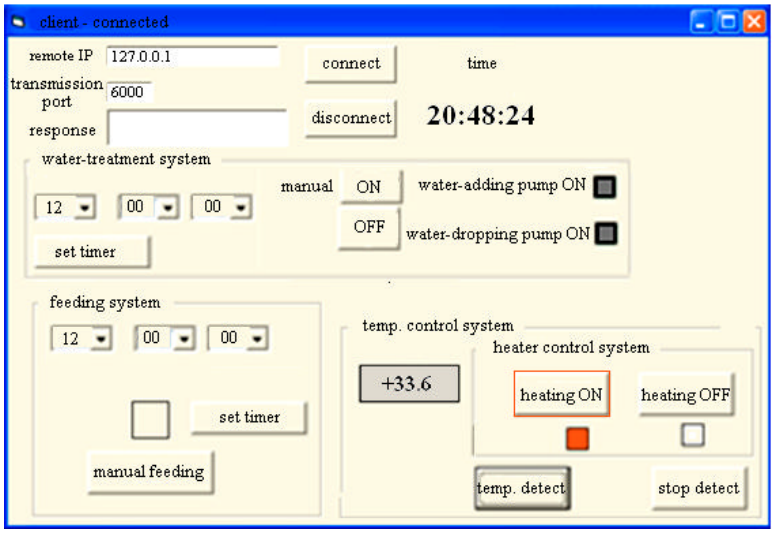

Fig. 5: Manual heating on the VB dialogue (PC client)

heating can also be performed by clicking the heating button to actuate the heater via the VB dialogue on both the PC sever and the PC client.

A PC-BASED FODDER-FEEDING SYSTEM

To reduce the cost in manpower in fodder-feeding, a remote/near automatic feeding system shown in Fig. 6 using a VB dialogue to trigger an electrical motor installed in a fodder-feed via the RS232/RS485 and the TCP/IP protocol is established.

As shown in Fig. 1, the user can monitor the status of the fish via a web camera. As shown in Fig. 7 and 8, manual feeding can be performed by clicking the feeding button of the VB dialogue on the PC sever and the PC client. The fodder-feeding system can also be set on auto mode by a timer.

A PC-BASED WATER-TREATMENT SYSTEM

To monitor the water quality online, a pH-detector is installed inside the aquarium. The image of the pH value will be noted and sent back to the sever PC via a USB protocol and a TCP/IP protocol. According to the pH value, the water treatment system will be actuated online using the VB dialogues in the PC sever and the PC client. Two water-treatment tanks, including a water filtering system and a water aeration treating system, are used. As indicated in Fig. 9, when the water treatment system is triggered, a water-draining process is started up using a water-draining pump in conjunction with a low-water level gauge. The unqualified water will be pumped into the water-filtering system where the filtering devices are allocated. The water-draining process will be stopped when the low-water level is reached. In addition, the filtered water will enter into the water aeration treating system. As indicated in Fig. 14, to assure the quality of filtered water, two layers of porous wools as well as one layer of compact-spall are adopted in the filtering device.

Subsequently, as indicated in Fig. 10, a water-adding process is actuated using a water-adding pump in conjunction with a high-water level gauge. Fresh water will be pumped into the aquarium from a water-aeration tank. The water-adding process will be stopped when the high-water level is reached.

Concerning the oxygencapacity of water in the aquarium, because of the droping from the filtering tank to the aeration tank that will increase the oxygencapacity during the water-treatment process, for the purpose of increasing a sufficient oxygencapacity of water in the aquarium, the interval of automatic water-treatment process can be adjusted.

RESULTS AND DISCUSSION

To prove the performance of the multiple functional aquariums, a prototype of the aquarium equipped with automatic thermal control/fodder-feeding/water treatment using a network remote control system has been accomplished. As shown in Fig. 11 and 12, the remote automatic thermal control/fodder-feeding/water treatment system using two VB interfaces (one in the sever PC and

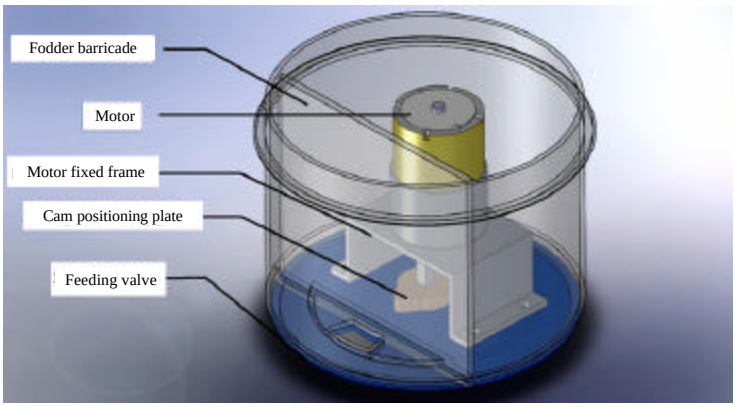

Fig. 6: An automatic feeding system

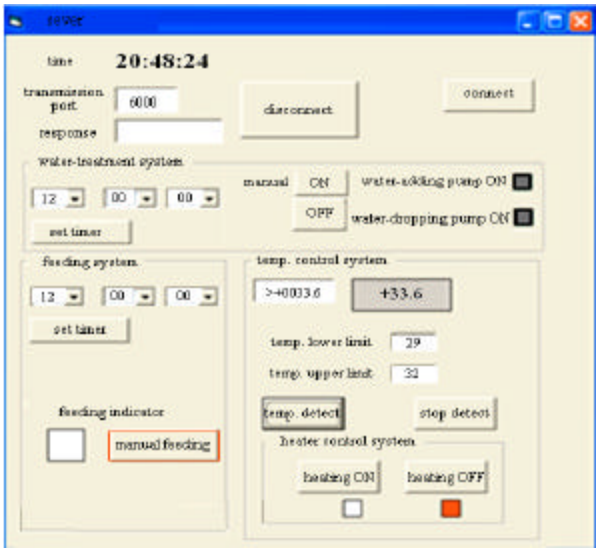

Fig. 7: Manual feeding of the VB dialogue on a PC sever

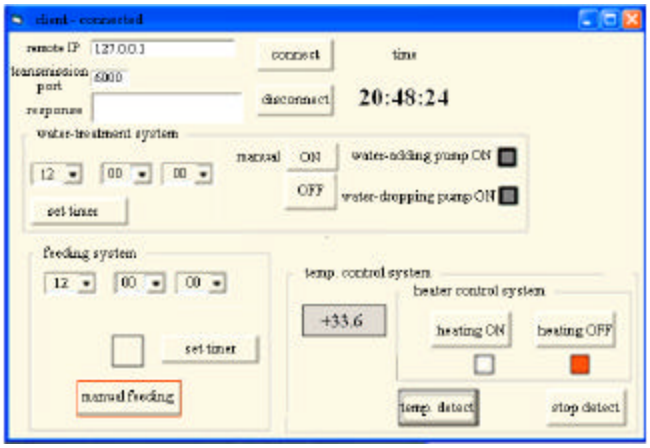

Fig. 8: Manual feeding of the VB dialogue on a PC client

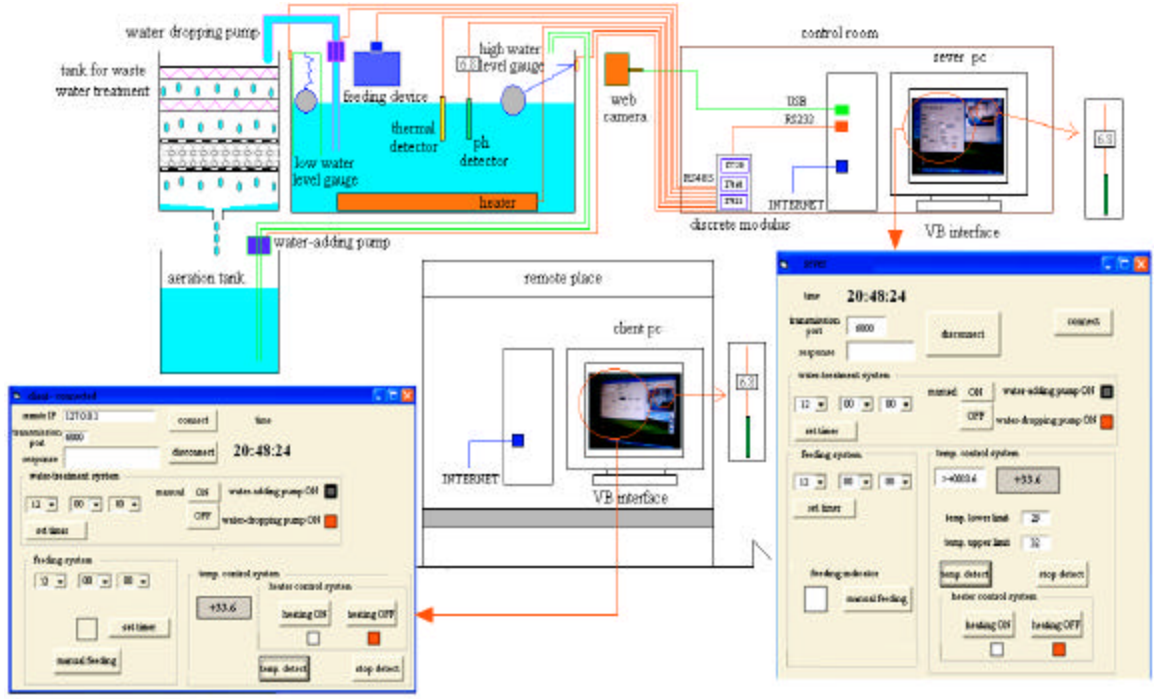

Fig. 9: The water-draining process

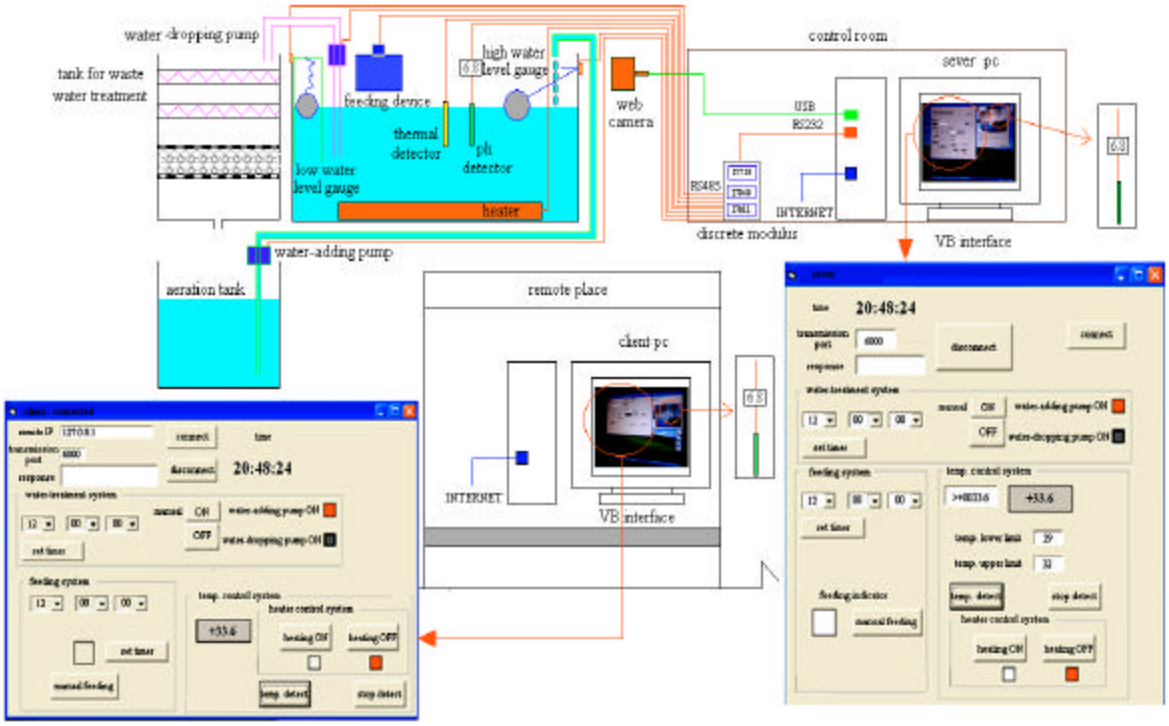

Fig. 10: The water-adding process

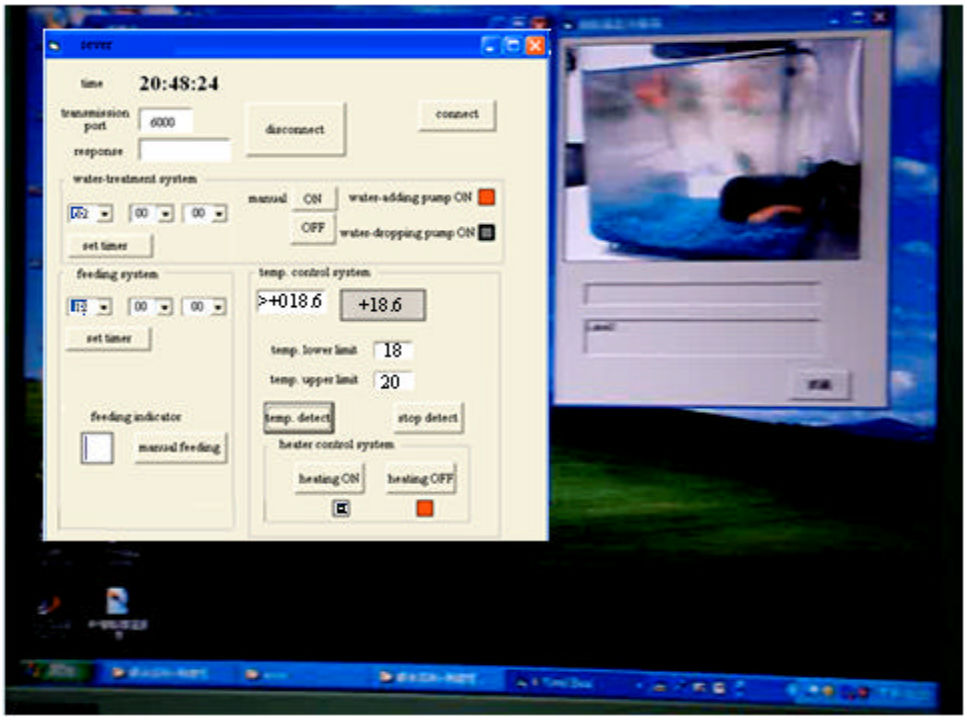

Fig. 11: VB dialogue in a PC sever

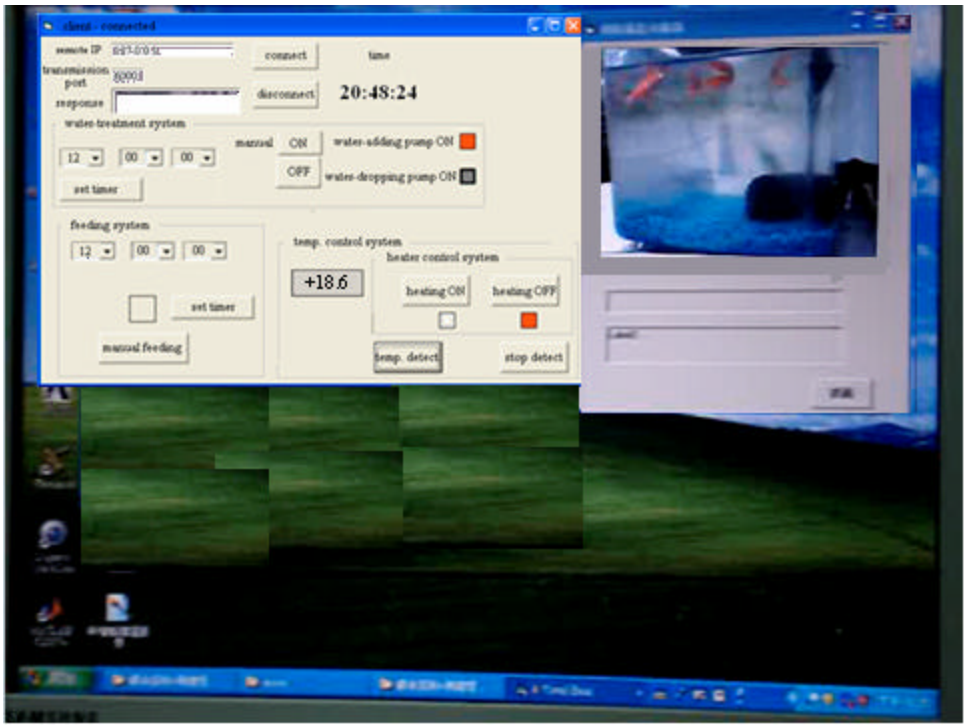

Fig. 12: VB dialogue in a PC client

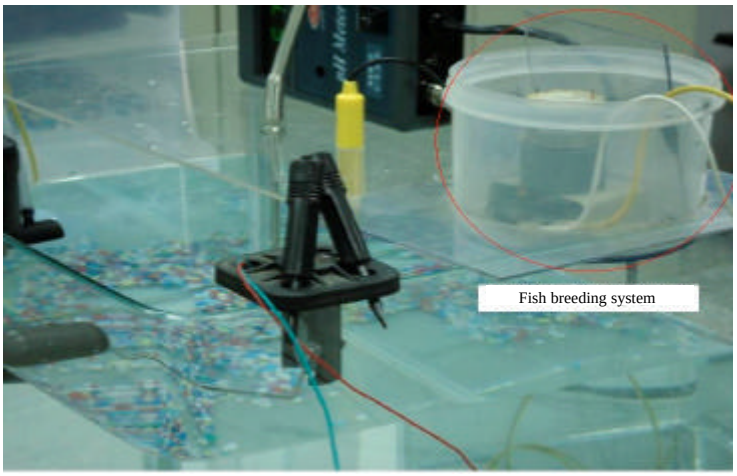

Fig. 13: The fish breeding system

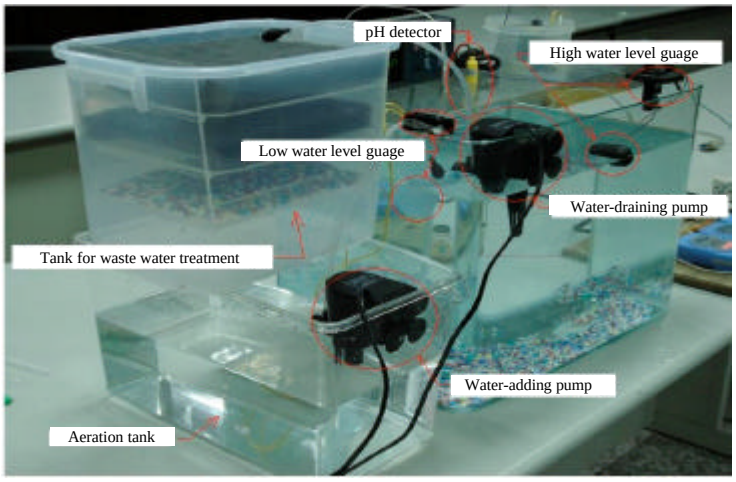

Fig. 14: The inner water circulation/treatment system

the other in the client PC) to manipulate the aquatic temperature, water quality and breeding via a network and a web camera has been established. Before the client PC can be manipulated, based on the TCP/IP protocol, the sever PC shall be connected by inputting the IP address and transport number in the client's PC dialogue.

As it can be seen in Fig. 11 (the dialog of the sever PC), the preset temperature range is 18-20, the current temperature of the aquarium reaches 18.6°C which is within the targeted temperature range using an automatic thermal detecting and heating system. The value of temperature will be transmitted to the client PC shown in Fig. 12 immediately. Subsequently, the aquatic temperature can be satisfactorily controlled within the targeted ranges of 18-20°C.

Moreover, for the purpose of automatic fish breeding, the fish breeding system shown in Fig. 13 can be actuated by clicking the manual feeding buttons in both the dialogs of sever PC and client PC shown in Fig. 11 and 12.

Consequently, as shown in Fig. 14, the inner water circulation/treatment system will be actuated by clicking the manual buttons in both the dialogs of sever PC and client PC shown in Fig. 11 and 12 upon the pH value.

A user can manipulate the thermal control, water-treating process and fodder-feeding in both the PC sever and the PC client. The status of the PC sever (the water pumps, the heater, the feeding motor and the water-level switches) will be transmitted to the PC client via a TCP/IP protocol. The command given in the PC client will be also transmitted to the PC sever to actuate

the related devices. Moreover, an image of the aquarium will be caught and sent to the PC sever using the USB protocol. The image will be then transmitted from the PC sever to the PC client via the TCP/IP.

Consequently, the appropriate aquarium temperature, which plays an essential role in fish reproduction, particularly in cueing the precise time of the fishes and providing the capacity for reproductive cycles (Pankhurst and King, 2010; Van Der Kraak and Pankhurst, 1996), will be preset. Moreover, compared to a solar heating system in which the temperature of a fish pond is still unstable, the aquarium equipped with automatic thermal control/ fodder-feeding/water treatment has an excellent performance in maintaining and monitoring the temperature of a fish pond online remotely. Furthermore, water quality will also be assured.

CONCLUSIONS

It has been shown that a multiple remote control system for dealing with thermal control, water treatment and fodder-feeding is efficient for improving fish reproduction. To prevent sinkholes problems from occurring on island, an inner water circulating system is necessary. In addition, a pH-detector in conjunction with two water treatment tanks (one, a water filtering system and, the other, a water aeration treatment system) are equipped and monitored via a web camera. Concerning a stable temperature in an aquarium, a PC-based logic using a temperature-detecting feedback system in conjunction with a heating device is performed. For the purpose of saving manpower and to lower the cost of manpower in fodder-feeding, an automatic feeding system in conjunction with visual monitoring using a VB dialogue to schematically trigger an electrical motor installed in a fodder-feed via the RS232/RS485 and the USB protocol is established. Moreover, the remote automatic thermal control/fodder-feeding /water treatment system using two VB interfaces (one in the sever PC and the other in the client PC) to manipulate the aquatic temperature, water quality and breeding via a network and a web camera has been established using a TCP/IP protocol. Furthermore, there is a great advantage for the remote online discrete monitoring/control system used in handling multiple aquarium systems simultaneously by having a login to the sever PCS via a client PC.

Consequently, the remote automatic thermal control/fodder-feeding /water treatment system is indeed efficient in solving the fish reproduction problem. Moreover, it saves manpower. Also, the system protects the underground water and prevents sinkholes on the island.

ACKNOWLEDGMENTS

The author acknowledges the financial support of the Project (CCUT-AI-98-AC03) from TOPSTECH company during July 1, 2009 to February 28, 2010 in Taiwan.

REFERENCES

Chang, M., 2009. Appetite for eel sees local industry stage fightback. Taiwan J., 26: 1-3.

Dou, S.Z., Y. Yamada, A. Okamura, A. Shinoda, S. Tanaka and K. Tsukamoto, 2008. Temperature influence on the spawninig performance of artificially-matured Japanese eel, *Anguilla japonica*, in captivity. Environ. Biol. Fishes, 82: 151-164.

Ghosh, L., G.N. Tiwari, D. Tribeni and S. Bikash, 2008. Modeling the thermal performance of solar heated fish pond: An experimental validation. Asian J. Scientific Res., 1: 338-350.

King, H.R., N.W. Pankhurst and M. Watts, 2007. Reproductive sensitivity to elevated water temperatures in female Altantic salmon is heightened at certain stages of vitellogenesis. J. Fish Biol., 70: 190-205.

Mustafa, G., A.A. Shah, K.H. Asif and A. Ali, 2007. A strategy for testing of web based software. Inform. Technol. J., 6: 74-81.

Pankhurst, N.W. and H.R. King, 2010. Temperayure and salmonid reproduction: Implications for aquaculture. J. Fish Biol., 76: 69-85.

Sarkar, B., B.C. Mohapatra, S.K. Singh, D. Majhi, N. Sarangi and G.N. Tiwari, 2007. Impact on energy consumption in greenhouse fish production. Asian J. Agric. Res., 1: 74-79.

Tse, W.L. and W.L. Chan, 2003. A low cost web-based supply voltage quality monitoring system. Inform. Technol. J., 2: 256-264.

Van Der Kraak, G. and N.W. Pankhurst, 1996. Temperature Effects on the Reproductive Performance of Fish. In: Global Warming Implications for Freshwater and Marine Fish, Wood, C.M. and D.G. McDonald (Eds.) Cambridge University Press, Cambridge, pp: 159-176.