WEB-BASED INTERACTIVE POSITIONING CONTROL OF AN ELECTRIC FLATCAR VIA WIRELESS NETWORK

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Abstract: A large tank has been used for target strength pattern measurements of fish. It is equipped with an electric flatcar. Further an elevation-rotating unit runs on the rails above it. The probe on the top of its elevation unit is equipped with an attachment for an ultrasonic transducer. The manipulator probe is movable in the four directions of the x, y, z and θ axes. Installation of a remote control switch has been required for the purpose of efficient operation of an electric flatcar. A remote control system using a notebook personal computer has been developed with good cost performance. The PC is equipped with a wireless network interface card. A model of WEB direct-access monitoring has been designed newly on the basis of the concept that an operator can control a mechanical device using a WEB Browser via LAN. Furthermore it performs double exclusive control for access from multi PCs, and has made possible a controller and multiple-monitor system. The mission was performed for the purpose of evaluation of WEB operation. The result has made clear the specifications for motion, and an external interface of the electric flatcar is applicable to the new protocol developed for WEB Browser control.

1 INTRODUCTION

An indoor tank filled with fresh water has been used for target strength pattern measurements of fish (Ishii and Takao, 2000), and its shape is 10(W) x 15(L) x 10(H) m^3. It is equipped with an electric flatcar. Further an elevation-rotating unit runs on the rails above it. The probe on the top of its elevation unit is equipped with an attachment for an ultrasonic transducer as shown in Figure 1 (Ishii et al., 1995). Installation of a remote control switch has been required for the purpose of efficient operation of an electric flatcar. A remote control system by a WEB Browser using a personal computer (PC) has been developed with good cost performance. Generally, WEB Browser displays a page from a web sever responding to a request of a client. A long reply time is not applicable to WEB Browser. But, the reply time of a target mechanical device accessed by a web server varies widely. The issue is development of a protocol for receiving reply messages from a target machine. The communication method of this system is described in detail in this paper.

2 METHOD

The probe can move four-dimensionally. The nominal precision is ± 1 cm along the longitudinal and transverse axes, ± 2 cm along the elevation axis, and ± 0.2 degree around the rotation axis. Resolutions of absolute encoders for positioning are 1 mm and 0.01 degree, respectively. Parameters of velocity are limited between 1 and 20 cm/s along the longitudinal axis, 1 and 10 cm/s along the transverse axis, and 0.2 and 3.0 degree/s around the rotation axis.

The sequencer (PLC, Programmable Logic Controller) directly controls the electric flatcar every 10ms. Interval of communication between the PC and the sequencer is one second using DDE (Dynamic Data Exchange) protocol via P-LINK (Processor Link) (Ishii et al., 1999).

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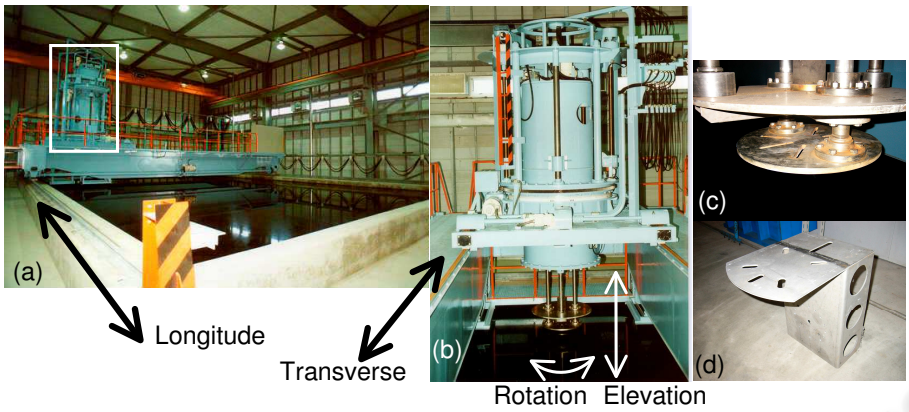

Figure 1: The electric flatcar and its movable directions shown by arrows. (a) The electric flatcar on a large tank. (b) An elevation-rotating unit on it includes a movable probe. Two devices of (c) and (d) are used in the joint mission. (c) An attachment on the top of a probe in the electric flatcar. (d) An adaptor for a transducer.

The function of a remote control switch has been realized by a notebook PC equipped with a wireless network interface card that is implemented more easily than a specified low power radio wave unit. The model of WEB direct-access monitoring has been designed newly on the basis of the concept that multiple users control or monitor a mechanical device using a WEB Browser via LAN (Local Area Network). It consists of a main server program that performs exclusive control for access from multi PCs, and makes possible a controller and multiple-monitor system (Ishii and Sawada, 2005). Figure 2 shows its application to the remote control switch function for an electric flatcar. The driving control command through the main server program does not access the database that holds the values, but accesses the device driver program that operates the instrument instead.

The mission was performed for the purpose of evaluation of WEB operation. The mission is achieved by bringing an attachment of a probe close to an adaptor for a transducer shown in Figure 1. In this mission, the speed is one or two cm/s in the transverse direction, one cm/s in the elevation direction, and 0.2 degree/s in the rotation direction (Ishii et al., 2006).

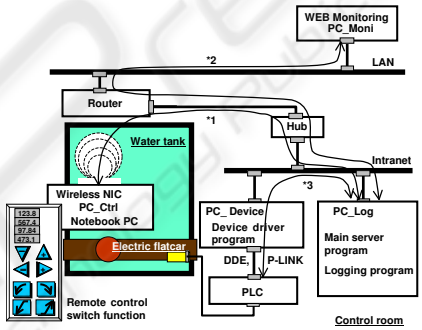

Figure 2: The model of WEB direct access monitoring applied to a remote control switch function. Widely located WEB Browsers post request commands to the main server program respectively via the routes *1 or *2 on a network. The main server program directly accesses, via route *3, a device driver program of an electric flatcar in order of a session.

3 RESULTS

A WEB Browser display of a remote control switch function has dual modes of ”DRIVE” and ”JOG”. Furthermore, each mode consists of two independent frames of ”SUBMIT COMMAND” and ”POLLING”. An example of ”DRIVE” mode is shown in Figure 3. The time chart is the following:

- A negotiation command for priority was submitted from the controller PC at a time of 15:38:38.040, and a transverse driving command was submitted at 15:38:38.056. The left command frame was shifted to Figure 3-(b) from Figure 3-(a).
- During movement, polling is repeated by a monitoring frame.
- After a submission of a STOP command at 15:38:51.415, an end flag of driving was detected at a time of 15:38:52.087.
- By control from a right polling frame, a page of left command frame was renewal to a waiting page of Figure 3-(a) at a time of 15:38:52.368.

Among the mission for evaluation, access of a PLC from a remote control switch and monitor PCs

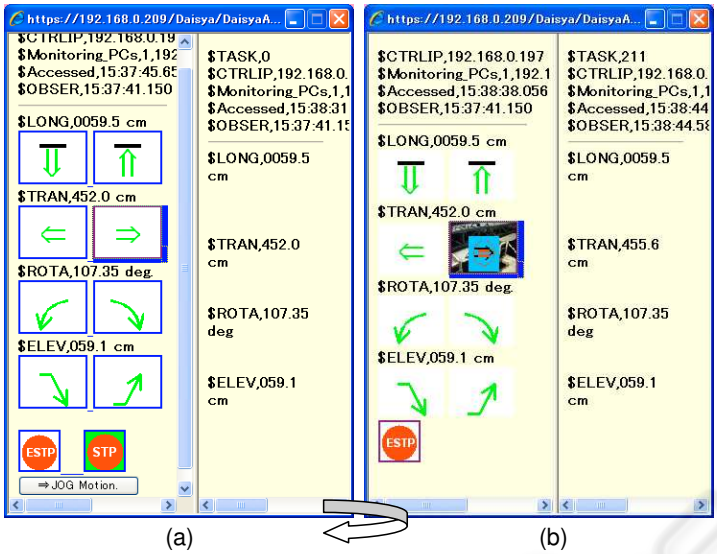

Figure 3: Design of the DRIVE mode with START/STOP. From upper icon, control buttons show the four directions ”longitudinal”, ”transverse”, ”rotation”, and ”elevation”. A driven direction is selected by a tab key or a mouse. The left figure (a) shows a mode of WAITING, and a foreward direction of ”transverse” is focused. The right figure (b) shows a status of driving operation.

was performed via Intranet or LAN as shown in Figure 4 for a typical example. In this figure, the X-axis shows time in seconds. ”PC_Ctrl” of the Y-axis works as a controller with a remote control switch function. A WEB Browser performed polling in intervals of five seconds for the monitoring, or two seconds for the driving. Each access to a main server is classified by a session ID, and is ordered by double exclusive control. A transverse driving command ($DRIVE) was submitted from the controller PC (named PC_Ctrl) at a time of 17:35:38.571, and a stopping command ($STOP) was submitted at 17:35:56.096. Positioning information of the electric flatcar is given per access. On the other hand, a logging PC (named PC_Log) receives renewal data at an interval of about one second linked with changing of values of position. The probe of the electric flatcar moved from 384.6 cm to 370 cm at the minimum velocity of one cm/s along the transverse axis. It has been confirmed that a WEB Browser on the controller PC is available to be performed in repetition of one second. Furthermore, the number of PCs for WEB monitoring has been confirmed normally for Four PCs.

Three kinds of commands such as a negotiation command for priority, driving commands and a stopping command, are submitted sequentially from a command frame of a controller PC. On the other hand, in a monitoring frame, polling is performed for the purpose of acquisition of positioning information. Averaged reply times for drive commands are shown in Table 1 in addition to needed times for acquisition of moved position information.

4 DISCUSSIONS

Dual modes of motion operation are available to be changed to the other interactively. The DRIVE mode with START/STOP is used for driving of long distance. The JOG mode is useful for short range driving, about one cm. And Driving of a fixed distance such as JOG mode is needed for safety of operations.

In Figure 4-(b), it is shown that access timing of multiple PCs (PC_Moni and PC_Ctrl) was successfully ordered by double exclusive control of a main server program.

In Table 1, it takes several seconds for acquisition of first positioning data owing to lower initial speed. After second positioning data, it takes about one second. It takes about six ms for negotiation of priority. Positioning data is obtained at the same time of negotiation of priority. And in the monitoring frame of a WEB Browser, a negotiation command also works as a polling command for receiving a reply message from the mechanical device (PLC). A reply to a monitoring command is performed immediately. The return time of driving commands is about 30ms.

Furthermore, submission of a driving command hardly coincides with the renewal of a WEB page for polling, because of the two independent frame

Table 1: Reply times for commands and needed times for position information.

Drive axis	Priority ms	$DRIVE ms	First position sec.	Priority ms	$STOP ms	Last position sec.
Transverse	6	32	2.5	6	31	1.6
Elevation	6	28	1.5	7	28	1.0
Rotation	7	30	3.2	7	27	1.2

architecture. Therefore retry of the selection is not required. Consequently remote control by a WEB Browser has been working well.

Residual issues are the following:

- A notebook PC lacks solidity.
- It takes longer time in a FORCED STOP operation on a wireless PC than in an operation by an EMERGENCY STOP button on an operation desk.

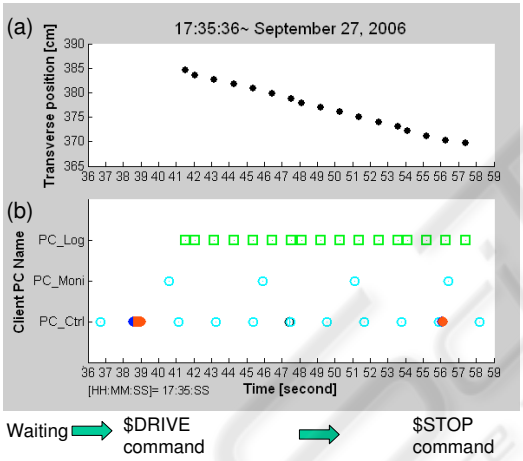

Figure 4: Ordered accesses by three PCs to a main server PC via LAN. The lower figure (b) shows access timing from multi PCs. PC_Mon and PC_Ctrl use WEB Brower with an interval time of two or five seconds. PC_Log uses an exclusive application program for logging positioning data with an interval time of about one second. The upper figure (a) shows positioning information acquisitioned by PC_Log. In the lowest row, a transition of motion modes about PC_Ctrl is shown.

5 CONCLUSION

The development of a remote operation system via a wireless PC didn't require editing of a complex sequencer program in the electric flatcar, so that this system starts working well as soon as possible. Using a function of PRESET DRIVE and a simple communication protocol that are implemented in the electric flatcar, the server program for WEB pages that are available for control and monitoring of a machine has developed in a sever PC. Usage of a WEB browser makes possible a flexible constitution of the remote terminal system. Then it has a merit of a smaller task to a terminal PC.

This system has been developed on the basis of two contents such as a WEB direct-access model, and a controller / multi-monitor system model. It was clear by the above-described mission that the communication speed of the electric flatcar is applicable to the model of WEB direct-access control and monitoring, in the case of attainability of the electric flatcar.

An attachment of a probe is also available for installation of underwater cameras. The optical calibration of an underwater observation bench is scheduled using an electric flatcar. It is hopeful that the wireless operation on the spot instead of a push button operation on an operation desk is effective.

REFERENCES

Ishii, K., Abe, K., and Takao, Y. (2006). Positioning control of the electric flatcar using web browser via wireless lan. In *Abstracts of 2006FY Autumn Annual Meeting*. AMSTEC.

Ishii, K. and Sawada, K. (2005). Network-integrated control program for a transducer-rotating mechanism to measure target strength (ts) pattern of squid. In *Journal of Advanced Marine Science and Technology Society*. AMSTEC.

Ishii, K., Sawada, K., and Miyanohana, Y. (1999). Design of transducer-positioning system scanning around an aquatic target in a tank. In *Collected Papers of FORUM ACUSTICUM BERLIN 99*. ASA and DEGA.

Ishii, K., Sawada, K., Takao, Y., Miyanohana, Y., and Okumura, T. (1995). Control system of electric flat-car equipped above an acoustic tank. In *Proceeding of the Annual Meeting*. the Marine Acoustics Society of Japan.

Ishii, K. and Takao, Y. (2000). Evaluation of transducer-positioning system scanning around an aquatic target in a tank. In *Abstracts of 2000FY Spring Annual Meeting*. Advanced Marine Science and Technology Society.