Development of Kamphaengsaen Canal Automation System

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ABSTRACT

Kamphaengsaen canal automation system(KPS CAS) is the tool for real time monitoring and regulating flow of water in the canal irrigation system of Kasetsart University, Kamphaengsaen Campus, Nakhon Pathom province. The irrigation canal system of Kamphaengsaen campus consists of the main storage pond of 0.9 mcm, receiving water from Phanom Tuan irrigation project, the main canal of 3.6 km. long 0.5 m. depth and the lateral canal of 3.25 km. This irrigation canal system can distribute water to irrigate the service area of 700 ha. Robogate 5.0, a low cost embedded system microcontroller, which has been developed by the authors since 2003, was used as the remote terminal unit (RTU) for monitoring and control of flow in the Kamphaengsaen irrigation canal system. Robogate can be programmed to control either the water level for cross regulator or the discharge for the canal offtake. It can perform on both local automatic control and remote automatic control from the master station. Volume control is the logic used for controlling discharge at the offtake while the water level deviation from the target is used for water level control of the cross regulator. There were six RTUs installed in Kamphaengsaen canal irrigation system for monitoring and controlling of water levels and discharges in canal system, monitoring rainfall, air temperature and relative humidity. The master station, installed at the Department of Irrigation Engineering, more than one kilometer from the Kamphaengsaen canal irrigation system, was designed to poll the data from the RTUs every half an hour via VHF radio, CB 245 MHz. The system has been tested during October 2006 - July 2008. The KPS CAS has proven to be quite reliable since the communication between the master station and RTUs are effective more than 88% of the time. The RMSE of water level deviation from target level in automatic control mode were ranging between 0.009 - 0.029 m. while those of manual operation mode were ranging between 0.118 - 0.295 m.

KEYWORDS: canal automation, canal control, water delivery, telemetering
TOPIC: (2) Hydraulic and Water Resources Engineering

Introduction

High-efficient irrigation systems require a flexible (Plusquellec,1988 and Plusquellec *et al.*, 1994) and stable water supply (Clemmens *et al.*, 1998). Canal automation can provide flexible, accurate and reliable control of irrigation water supply. Many low cost canal automation systems have been developed and used in many countries such as Sevier river basin in USA, Jintai irrigation project in China, and Kerian irrigation scheme in Malaysia (Hansen, *et al.*, 2000). There are several methods of flow control in irrigation canals. In this study, the simple but efficient logic has been developed and used in Kamphaengsaen canal automation system. Volume control logic is used for controlling discharge at the offtake and the water level deviation from the target is used for water level control of the cross regulators.

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Description of Kamphaengsaen Canal Automation System

The irrigation canal system of Kasetsart University, Kamphaengsaen campus, consists of the main storage pond, the main canal and one lateral canal which can supply irrigation water to 700 ha cultivation and experimental area of the campus. The main pond has a storage capacity of 0.9 mcm. It was designed to function as a regulating reservoir to re-regulate irrigation water that was supplied from Phanom Tuan irrigation project into the campus main canal. The main canal (MC) with delivering capacity of 1.00 cms and total length of 3.6 km is supplying irrigation water to the cultivation area on both sides of the canal and 1L-MC lateral canal having 3.25 km long. The main crops are sugarcane, paddy, grasses, vegetables and fish-shrimp farms. The diagram of canal irrigation system of Kamphaengsaen campus is shown in Figure 1.

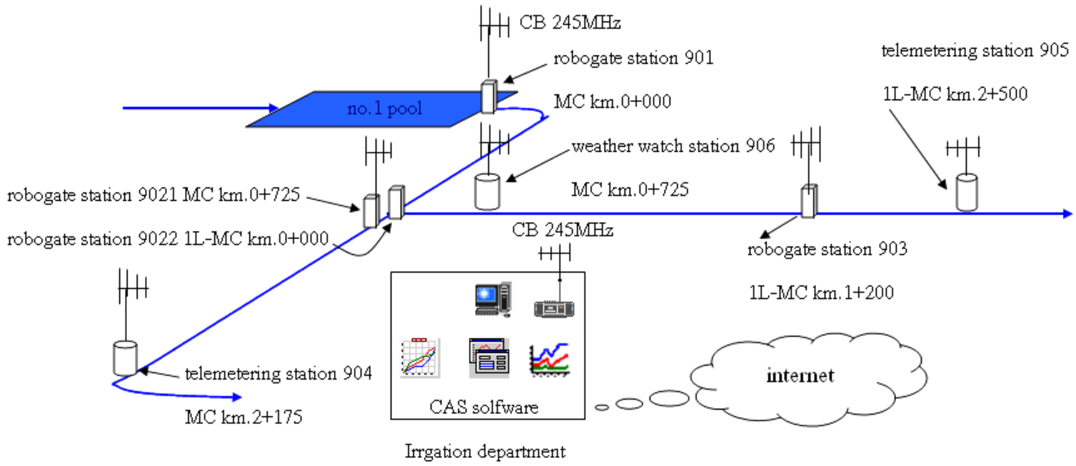

Figure 1: Diagram of Kamphaengsaen canal system

Kamphaengsaen canal automation system (KPS CAS) consists of the master station and six remote terminal units (RTUs) which communicate by VHF radio, CB 245 MHz. The master station consists of PC and the canal automation interface which is installed at Department of Irrigation Engineering, Faculty of Engineering at Kamphaengsaen lacated more than one kilometer from the irrigation canal system. Robogate 5.0, a low cost embedded system microcontroller developed by the authors since 2003, was used as the remote terminal unit (RTU) for monitoring and controlling of water level and flow in the Kamphaengsaen canal irrigation system. Robogate can be programmed to control either the water level for cross regulator or the discharge for the canal offtake. It can perform on both local automatic control and remote automatic control from the master station. Volume control is the logic used for controlling discharge at the offtake while the water level deviation from the target is used for water level control of the cross regulator. The location, function and equipments of the 6 RTUs are given in Table 1.

Table 1: Detail of six RTUs

RTU No.	Equipments	Location	Function
1	Robogate 901, 2 floating type water level sensors, 1 gate positioning sensor and 1 12V-DC gear motor	Head regulator of MC	Monitoring and controlling of discharge to MC
2	Robogate 902, 2 floating type water level sensors, 2 gate positioning sensors and 2 12V-DC gear motors	1L-MC Junction, km 0+800	Monitoring and controlling water level upstream of MC cross regulator and monitoring and control of discharge to 1L-MC head gate
3	Robogate 903, 2 floating type water level sensors, 1 gate positioning sensor and 1 12V-DC gear motor	1L-MC cross regulator at km 1+200	Monitoring and controlling water level upstream of 1L-MC cross regulator, km 1+200
4	Robogate 904 and 2 floating type water level sensors	Tail end of MC, km 2+175	Monitoring of water level at the tail end of MC, km 2+175
5	Robogate 905 and 2 floating type water level sensors	Tail end of 1L-MC, km 2+500	Monitoring of water level at the tail end of 1L-MC, km 2+500
6	Robogate 906, tip bucket rain gage, thermometer and relative humidity sensor	1L-MC Junction, km 0+725, near Robogate 902	Rainfall, air temperature and relative humidity

The master station was programmed to poll the data from the RTUs every half an hour via VHF radio, CB 245 MHz and upload the data to the internet. The master station, RTUs and stilling wells with floating type water level sensors are shown in Figure 2.

Figure 2: Photo of Kamphaengsaen canal automation system

Water Level Control Algorithm

The algorithm for upstream water levels control is shown in figure 3. The gate adjustment is defined as a linear function of the water level deviation from the target (TL-WL) and the previous gate adjustment(Gauto1). If gate adjustment(Gauto) is greater than the tolerance, 0.008 m., Robogate will command the gear motor to adjust the gate up(+) or down(-) accordingly. Robogate will measure water level and determine gate adjustment automatically for every 0.5 seconds. To avoid the gear motor to over-adjust the gate, the previous gate adjustment (Gauto1) will be memorized and used to deduct the next gate adjustment as shown in Figure 3. By trial and error, it is selected that for every 250 rounds of automatic gate adjustment, the Gauto1 will be reset to zero before the new cycle of gate adjustment by this logic is repeated.

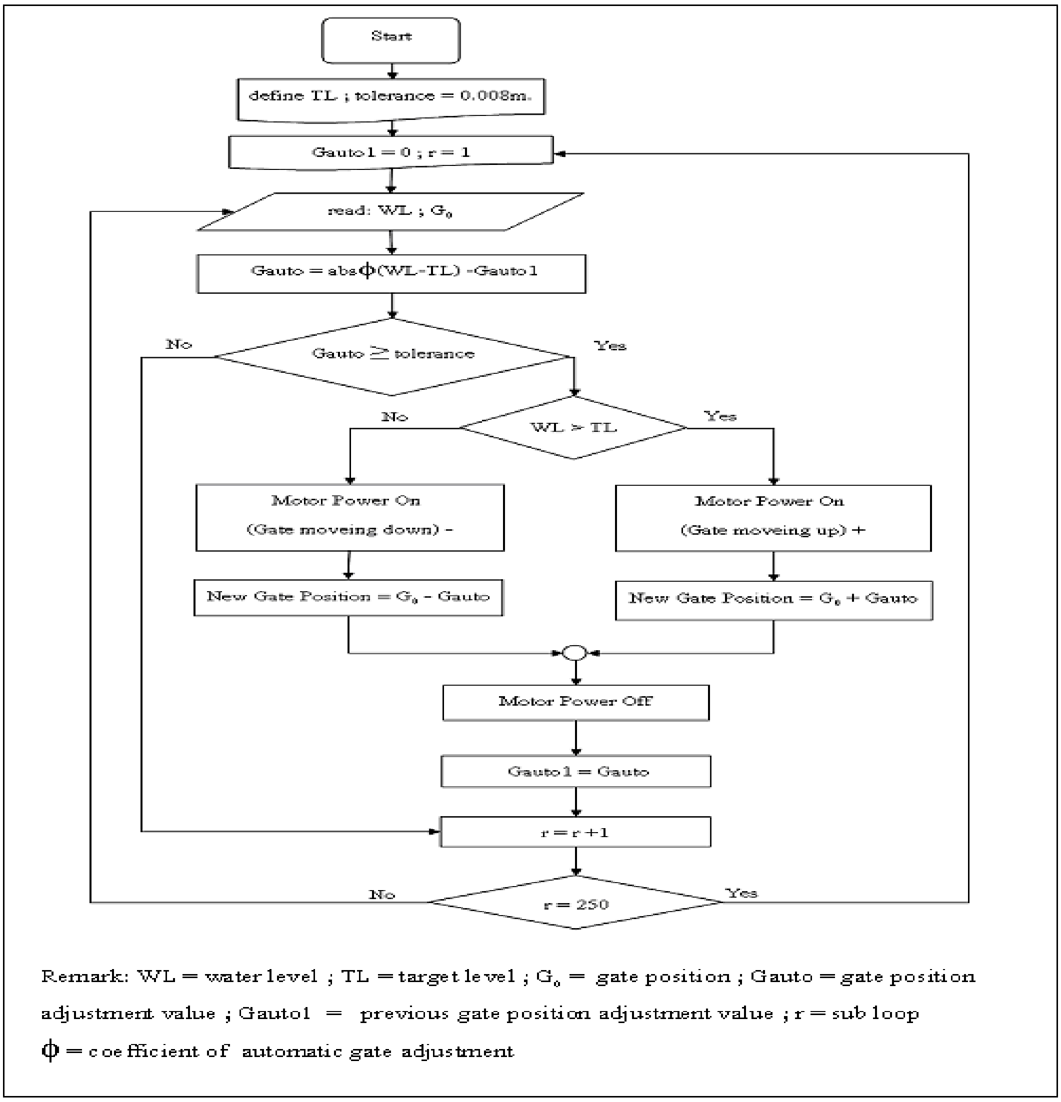

Figure 3: Water level control algorithm of Robogate

Test of Kamphaengsaen Canal Automation System

The Kamphaengsaen canal automation system was tested in manual operation control mode during 10 October 2006 - 3 January 2008 and in automatic control mode during 4 January- 1 June 2008. The water levels, gate openings and discharges were recorded every half an hour were plotted in Figure 4.

Conclusions

The reliability in water measurement and data transmission from RTUs to the master station every half an hour during test run 625 days was 88.7 % which showed reliability of Robogate and radio system. The test during 10 October 2006 to 1 June 2008 showed that the RMSE of water level deviation from target level in automatic control mode were ranging between 0.009 - 0.029 m. while those of manual operation mode were ranging between 0.118 - 0.295 m. It showed considerable improvement in water level control by automatic control mode.

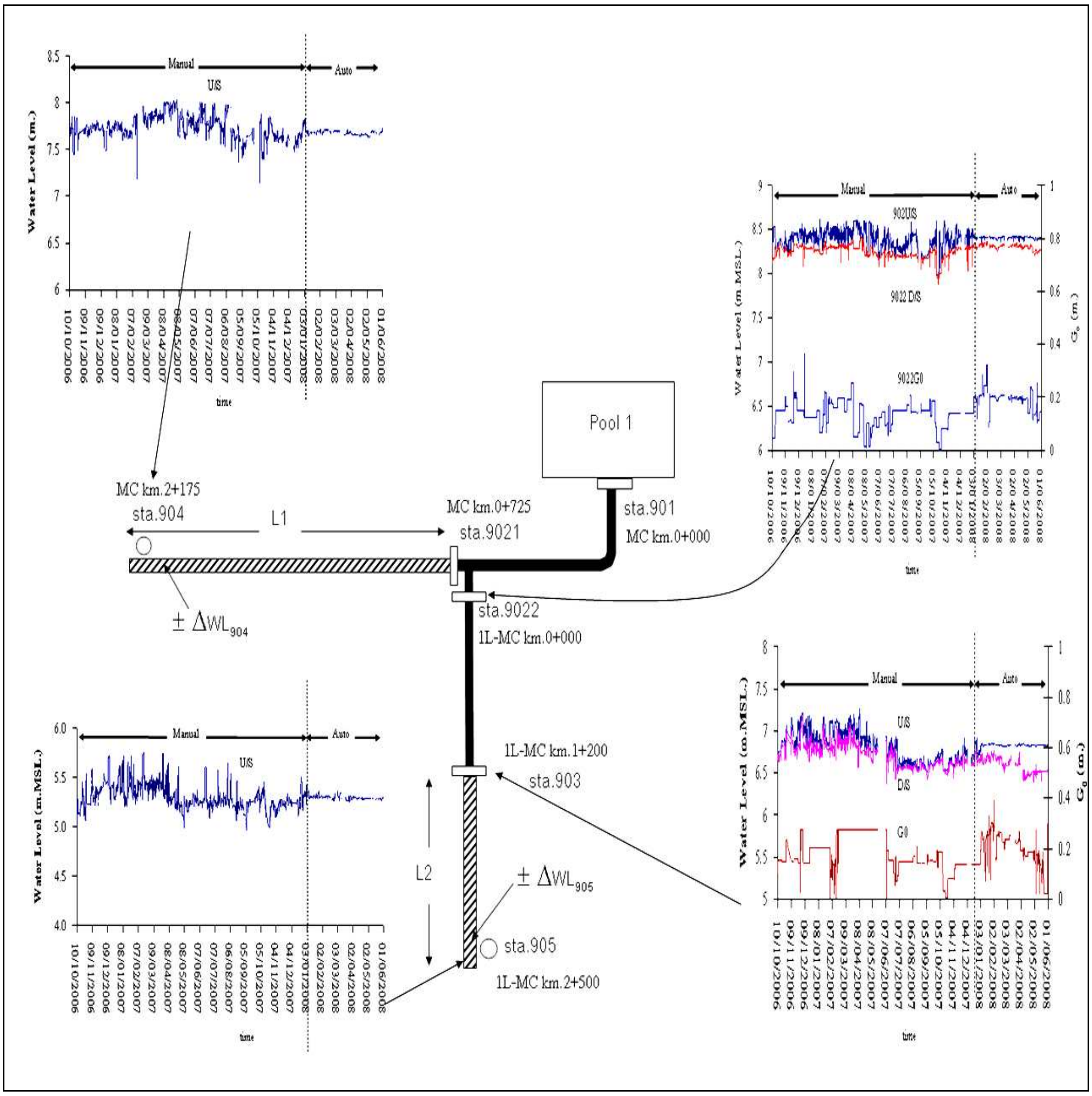

Figure 4: Test run of KPS CAS on telemetering mode during 10 Oct 2006–3 Jan 2008 comparing to the automatic mode during 4 Jan 2008 - 1 Jun 2008.

Ackowledgements

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