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Development of WIA System for Measuring the Water Level of Small-Medium River

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ABSTRACT:The transversal structure of small-medium sized river is relatively poor. In this paper, we developed a system to measure the water level and flow rate in real time by acquiring the surrounding image. The WIA system acquires the images necessary for water level estimation by a non-contact method. As a result, only 15% of the budget for existing automatic water level / flow measurement systems is needed, which can efficiently manage small and medium sized rivers.
KEYWORDS: WIA system, small-medium river, water level, wireless

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I. INTRODUCTION

Repair amount data such as river level and flow rate are used as basic materials for planning and managing river streams in the environment. Therefore, in order to manage the systematic rivers, it is required to secure reliable water quantity repair amount data. Accordingly, in Korea, a water level observatory is installed in many rivers, and real-time water level is measured. However, the measurement of the flow rate is limited to major rivers such as national rivers [1]. Also, there is only a water level and flow rate relationship suitable for the flood discharge at the water level observatory where the flow rate is measured. And reality is only a few reliable observatories. Therefore, it is difficult to reliably estimate the flow rate of the non-flood season using the data from the observatory. So it is a low level of credibility for planning river environment and ecology. Especially, in the case of small and medium river, it is known that there is no place where water level and flow rate relationship are suggested. Flow rate measurement is measured several times in the year in which the river plan is established. So there is no value as a data. In this study, aimed at small and medium sized rivers which are relatively poorly managed compared to large rivers [2]. Small and medium sized river contain many river transverse structure, such as d dammed pool for irrigation and drope [3]. Therefore, it makes the most of the convenience of measuring the flow rate of the transverse structure. In addition, it is developing a system to measure the water level and flow rate of small and medium sized river remotely by applying the rapidly growing image analysis technology and IT to river engineering fields. In this study, low-cost imaging equipment is used to remotely acquire and transmit flow rate measurement image of river.

II. RELATED RESEARCH

The river flow measurement method is the flow rate measurement method using the ADCP and velocity area method in the normal season and low water season [4]. And in the flood season, a method to measure the flow rate using an electromagnetic surface hydrometer or tube float is mainly used [5]. The automatic flow rate measuring equipment is installed at the major points of each water system to measure the flow rate of 24 hours. However, it is very limited in that it is installed only at major points of major rivers, and there is a problem of high cost. Accordingly, new flow rate measurement techniques such as LSPIV and image water level observation are being proposed through various R&D projects [6][7]. However, the utilization rate will be lowered due to reasons such as securing applicability in the field. Table 1 shows the major patents on the flow rate calculation of rivers registered at the inside and outside of the country. The dammed pool for irrigation and drope that can measure river water volume are mainly composed of installing a flow meter in the waterway of the structure. The technology of installing and using the flowmeter or the water gauge in the water does not include damage to measuring machine and the examination method of the unnatural measurement data. Also, no method is prepared to evaluate the water level and the river width on the overflow of the transverse structure. So it has limitations on practicality.

Table -1 Major paten information on domestic and overseas river flow measurement [8]

Registrant	Patent Number	Contents
Lee Hyosang (2015)	101482297 0000	Apparatus for measuring a flow rate with weir
Choi Yongun (2006)	200425372 0000	A flow measurements device for open channels utilizing the theory of inverted siphon
TOSHIBA CORP (2007)	19232745	Weir type flow meter
NIHON HELS INDUSTRY CORP (2002)	14340636	Flow meter for movable overflow weir

The WIA(Wireless Image Acquisition) system, developed in this study, uses contactless methods it image shooting required to determine the water level. So there is less likely to damage the equipment and data is managed in real time. Therefore, immediate response is possible when a problem arise.

III. SYSTEM DESIGN

The H/W of the WIA system developed in this study is organized in as shown in Figure 1.

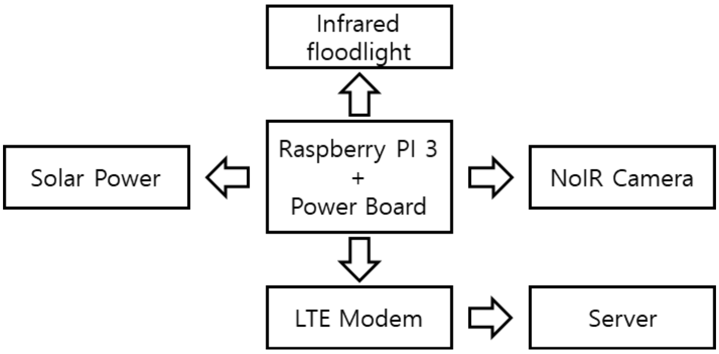


Figure 1. WIA system some hardware configuration diagram

For the micro sized PC, which is the core of the WIA system, it chose Raspberry Pi 3 with its Linux based OS running at a low power of 1.2GHz. It is suitable for building the system on a credit card sized board and at a low cost. Also since the USB socket type cam camera consumes a lot of power, it uses a camera exclusive to Raspberry Pi 3. There are two types of exclusive cameras, and we chose the NoIR camera which removed the infrared filter in order to shoot at night. Using the Son IMX219 image sensor with up to 8 megapixels, the WIA system now save image at 640X480 resolution in consideration of image quality and communication conditions. Also an infrared floodlights was used to secure the light source necessary for night. The infrared floodlights is always in operation when the surroundings are dark. However, to reduce unnecessary power consumption, the board was designed to be controlled from Raspberry Pi 3 by designing its own power board to work only during shooting at night. The Power Board supplies power to the 12V(Infrared floodlight), 5V(Raspberry Pi 3) when it enters 24V. Also a voltage measurement function was added to confirm the current output voltage of the solar power, and it was responsibility to be On/Off role of the infrared floodlight. Also small and medium sized river may be environmentally poor, so communication and power sources should be self resolved. We used a USB-type modem equipped with LTE Usim chip to use the communications used to transmit the recorded images to the server. A solar power system has been adopted to power all of these devices.

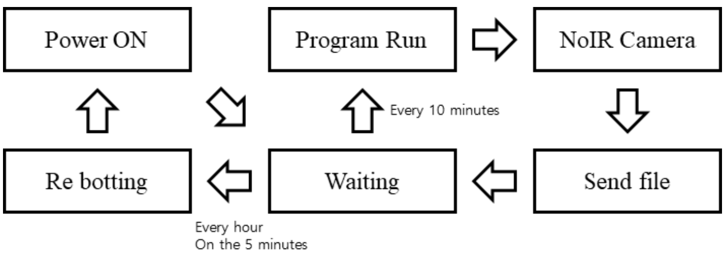


Figure 2. WIA system H/W operation method

The WIA system is run a program every 10 minutes and capture 10 seconds of images and transmit them to a designated server, and then programmed it to work as shown in Figure 2. Also to prevent a memory leak in Raspberry Pi 3, we rebooted every hour on the 5 minutes to reduce errors. The solar power generation system initially used four 100A batteries in three 190W panels, as we continue to reliably upgrade our features, we have now shrunk to the point where we only use two 50W panels and two 18A batteries. The solar power systems have been configured to record for three days in spite of bad weather. In fact, as a result of measuring the current consumed using the power measuring equipment, it is consumed at less than 100W per day, which operates at a low power rate of less than 3kW per month.

Table -2 WIA system Main hardware components

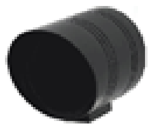
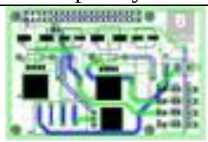
 ① Raspberry Pi3	 ② Camera module	 ③ IR floodlight
 ④ Power Board	 ⑤ LTE modem	 ⑥ Solar Power

Figure 3 is the inside of the WIA system, which is about the size of two credit cards, and is mounted on a dummy camera.

Figure 3. WIA system internal state

IV. WIA SYSTEM OPERATION

Before applying the WIA system developed to date to the actual river, we installed the test bed in a real scale river test site and reviewed the applicability in the field.

WIA System front view	Night shooting front view

Figure 4. WIA System on the test bed

①upper stream | ②a dammed pool for irrigation | ③downstream

Figure 5. A picture taken in each direction

Accordingly, two WIA system were installed in the waterway of the KOREA INSTITUTE of CIVIL ENGINEERING and BUILDING TECHNOLOGY's river test center. Solar panels were installed and power was supplied through this power generation system. And after installing the WIA system 3 Set(upstream) + 1 Set(downstream) equipped with infrared floodlight, it is under test operation. Figure 4 shows the WIA system installed in the river sites center of KOREA INSTITUTE of CIVIL ENGINEERING and BUILDING TECHNOLOGY, a real-scale river site. Figure 5 shows the images taken in the same time frame for each direction of the WIA system installed in the river testing center.

①upper stream A in Gimhae | ②downstream A in Gimhae | ③ upper stream B in Gimhae

Figure 6. WIA system operating in Daecheong Stream, Gimhae

Figure 6 shows the WIA system installed in the actual Gimhae Daecheon Stream based on the supplemented contents. WIA system 2 Set(upstream A) + 2 Set(upstream B) + 2 Set(downstream A) was built and installed, and it is continuously tested and supplemented. We plan to install additional WIA system 2 Set(downstream B) will be additionally installed.

V. CONCLUSION

In this study, we have developed a WIA system that acquires real time information of a long river section through real time image shooting and analysis of the transverse structure installation point of small and medium sized river. This system can manage small and medium sized river economically because it takes only about 15% of the budget for existing automatic water level /flow measurement system. Also, there is no fear of break away from the equipment by using the contactless method through image filming. At the point where the WIA system is installed, the image data is periodically secured, so that the real-time river monitoring function can be performed in parallel.

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