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Integrated Control of River Overflow Based on Microcontroller

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***Abstrak*— This river overflow control is carried out in stages and in an integrated manner. The river water level is detected in real time with four levels, namely normal, alert, standby, and beware. The overflow of river water at each level will flow automatically through three floodgates that work simultaneously, followed by turning on three water pumps which also work simultaneously. The water flowing from the floodgates is channeled into an irrigation area, while the pumped water is flowed into a reservoir. This river overflow control is carried out in an integrated manner between monitoring the river water level, opening and closing the floodgates, working the pump, and detecting the reservoir maximum level. When all the floodgates are fully open and all pumps are running, and the water level in the reservoir has reached the maximum limit, the alarm will sound. Such conditions are stated in a state of over flow or out of control. This control is based on a microcontroller so that it has a fast response with minimal components. The control system is designed and made in a miniature form that runs well and with a fast response time.**

Keywords: floodgate, microcontroller, overflow, pump, reservoir, river, water.

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I. INTRODUCTION

River overflows can occur due to heavy rainfall, not so heavy rain but long enough, or large overflows sent from upstream. Overflow that exceeds the capacity of the river will cause flooding along the watershed. Floods that occur will cause losses to the community, especially those close to watersheds. The overflow of water that exceeds the capacity of the river can be controlled through a water intake gate which will drain water from the river to irrigated land or drains towards the sea and or can also be diverted to a reservoir or dam through a pump. The operation of the floodgates and water pumps to reduce the overflow of water in the river is carried out by observing the water level of the river, the discharge channel from the sluice gate and also monitoring the water level in the dam as a reservoir. Delays in controlling the overflow of river water by opening the sluice gate or responding to turning on the water pump can cause flooding. To overcome this problem, control of river water overflow is carried out which is integrated with the floodgate and water pump so that the overflow of the river water will automatically be responded by opening and closing the floodgate and also the water pump will automatically turn on if the water level in the Tepa river is still overflowing under a watchful condition. . This controller is carried out in an integrated manner between monitoring the level of river water levels, opening and closing the floodgates and the height of the dam as a reservoir, this tool is based on an Arduino microcontroller [2,3].

Overcoming river overflows must be based on the concept that the volume of river overflow will be equal to the sum of the volume of water discharge through the floodgates with the volume of water pumped into the reservoir or in other words that :

$$A = B + C ,$$

Where,

A is the overflow volume of the river (m^3)
B is the volume of water discharged through the floodgate (m^3)
C is the volume of water pumped into the reservoir (m^3)

Ultrasonic sensors are used to detect the water level in rivers and reservoirs. In ultrasonic sensors, ultrasonic waves are generated through a device called a piezoelectric with a certain frequency. This piezoelectric will produce ultrasonic waves (usually 40 kHz frequency) when an oscillator is applied to the object. In general, this tool will shoot ultrasonic waves towards an area or a target. After the wave hits the target surface, the target will reflect the wave back. The reflected wave from the target will be captured by the sensor, then the sensor calculates the difference between the time the wave is sent and the time the reflected wave is received [4].

The control center in this system is used an Arduino uno microcontroller which functions to monitor the height of the river water level and control the opening and closing of the sluice gate and water pump

II. RELATED RESEARCH

Previous research conducted by Muhammad Amin [1] was using a microcontroller to monitor river water levels to control flooding. The update in this research is not only monitoring the river water level but controlling the opening and closing of the floodgate and water pump which is carried out in an integrated manner.

III. METHOD AND DESIGN

This research makes an integrated river overflow controller based on a microcontroller in a miniature form. The object of this research is a miniature of several causes and handling of river overflows, including:

1. River flow
2. Floodgate
3. Reservoir
4. Pump

A. Block Diagram

The concept of the research can be illustrated in Figure 1. in the form of a control system circuit block that will be designed

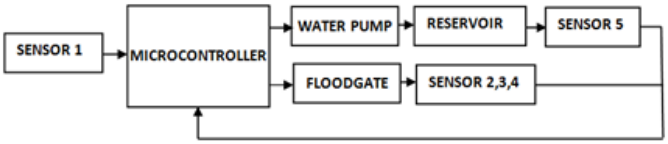


Figure 1. Block Circuit of control system

The river water level will be monitored continuously by placing an ultrasonic sensor that will monitor the river water level continuously. The water level of the river is divided into 4 levels, namely:

1. Normal
2. Be alert
3. Standby
4. Beware

The microcontroller reads the condition of the river water level from the ultrasonic sensor (sensor 1) [5]. Each monitored level condition is presented on an indicator light according to its level, when the river water level has reached the alert level, the system will open the floodgate. There are 3 sluice gates provided, the number of sluice gates opened according to the time duration given at the alert level. For example, as a result of the condition of the river water level being at an alert level [6], floodgate 1 will open and if this alert level condition continues for a certain period of time then floodgate 2 will open, and if this alert level condition continues for a certain period of time that has been determined, the floodgate 3 will open. When all the floodgates have been opened and the condition of the water level is still at the alert level, the water pump will turn on to discharge water into the reservoir. The number of water pumps provided is 3 and the number of water pumps that are on according to the given time duration is at the alert level. If the alert level condition continuously occurs within a certain period of time, the number of running water pumps will increase. When the reservoir is at a high level (high), the alarm will fire stating that the condition has been in an over-out of control (out of control) state.

This control system is designed by using electronic components and mechanical components. The electronic components used are:

1. Ultrasonic Sensor
   This sensors are used to detect the height of the river water level (sensor 1) and detect the height of the water level in the reservoir (sensor 5)
2. Infra red sensor or mechanical sensor (sensor 2,3,4) [7]. This sensor functions to stop the movement of the sluice gate at the lower limit (closed door) and upper limit (open door).
3. DPDT Relay, Motor, Driver
   These components function to open and close the floodgate
4. Water pump
   The water pump is used for filling water to the reservoir
5. Displays and Alarms

The display used is in the form of blue, green, yellow, and red lights or LEDs. This light indicator is used to indicate the river water level is normal, alert, alert, or alert, the same other indicators are also used to indicate the floodgates are open 1 door, 2 doors, or 3 doors. Likewise other indicators that state 1 pump, 2 pumps, or 3 pumps are on. For the condition of the water level in the reservoir, 3 lights are also used which indicate low, medium, or high conditions.

B. Design

The block image of illustration of the system designed is depicted in Figure 2. which consists of 5 main parts, namely river water level detector, microcontroller, indicator light display, sluice gate, water pump and reservoir.

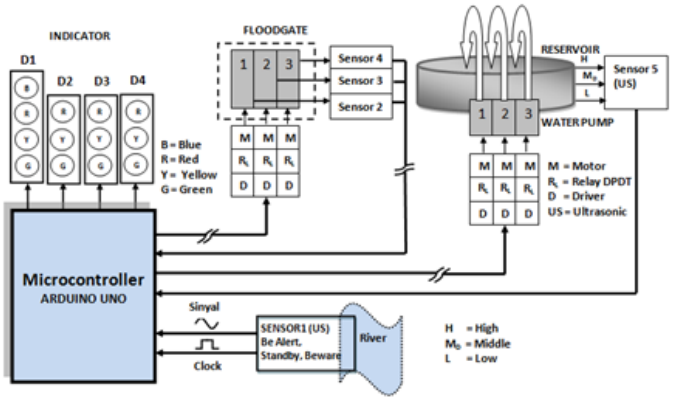


Figure 2. Illustration of the system designed

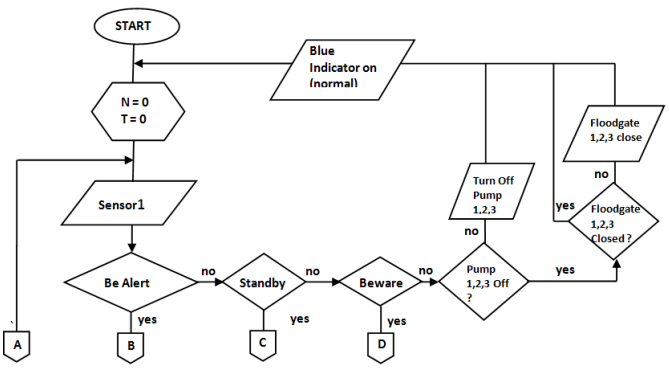
The blue D1 indicator indicates the condition of the river water level is in normal condition, the green color indicates the condition of the river water level is in a state of alert, the yellow color indicates the condition of the river water level is in a state of alert, and the red color indicates the condition of the river water level is in a state of alert. . The green D2 indicator indicates that the floodgate 1 is open, the yellow color indicates that the floodgate 2 is open (sluice gates 1 and 2 are open), and the red color indicates that the floodgate 3 is open (the floodgates 1, 2, and 3 are open). . The green D3 indicator indicates that the water pump 1 is on, the yellow color indicates that the water pump 2 is on (water pumps 1 and 2 are on), and red indicates that the water pump 3 is on (water pumps 1, 2, and 3 are on).). The green D4 indicator indicates the reservoir is at a low level, the yellow color indicates the reservoir is at a medium level, and red indicates the reservoir is at a high level where in this condition the microcontroller turns on the danger alarm. All of these conditions are described in Table 1.

Table 1. Meaning of color on indikator

Indicator	Colour	Description
D1	Blue	River Water at Normal Level
	Green	River Water at Be Alert Level
	Yellow	River Water at Stanby Level
	Red	River Water at Beware Level
D2	Green	Floodgate 1 Open
	Yellow	Floodgate 2 Open
	Red	Floodgate 3 Open
D3	Green	Water Pump 1 ON
	Yellow	Water Pump 2 ON
	Red	Water Pump 3 ON

C. Flowchart

The signal from sensor 1 which describes the level of the overflow of the river is received by the Arduino microcontroller. The river water level will be shown on the D1 indicator. If the river water level is at the alert level, the microcontroller will order to open the floodgate 1 (indicator D2 lights up green), if in this condition after a period of t minutes the river overflow is still at the alert level then the floodgate 2 is opened (indicator D2 lights up yellow) so that there are 2 floodgates that are open, namely sluice 1 and sluice 2. After sluice 2 opens, it turns out that the river water level is still in a state of alert after a period of t minutes, sluice 3 is opened (indicator D2 lights up red).) so that all 3 floodgates open. If after a period of t minutes the water level is still in a state of alert, then the microcontroller will command to turn on the water pump 1 (the D3 indicator lights up green) and after a period of t minutes the river water level is still at the alert level, the microcontroller will turn on the water pump 2 (the D3 indicator lights up amber). If the river water level is still at the alert level, the microcontroller turns on water pump 3 (the D3 indicator lights up red) so that all 3 water pumps turn on, and in this situation the microcontroller receives a signal from sensor 5 which states that the reservoir is full so that the microcontroller turns on the alarm [8]. danger and declared in a state of over out of control (out of control).



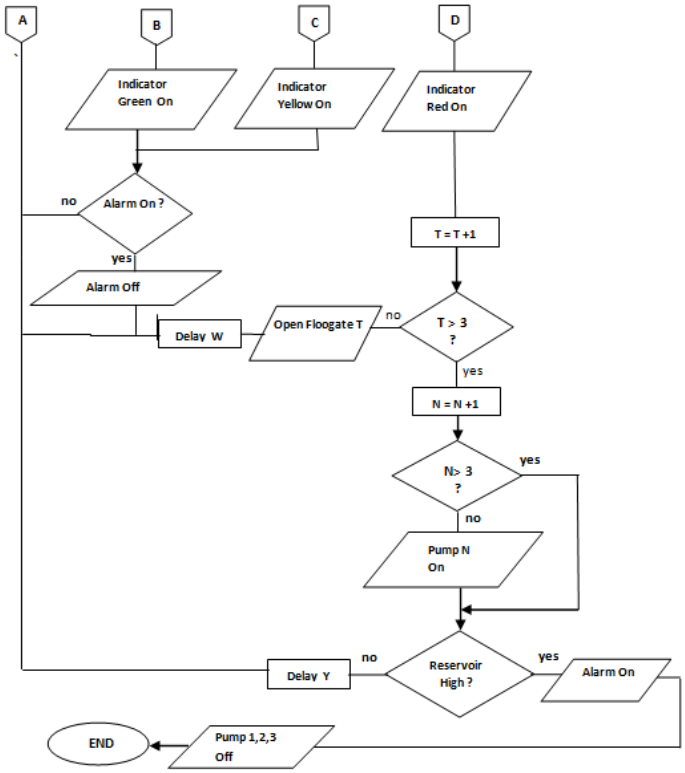


Figure 3. Flowchart of river overflow control system

IV. Result and Discussion

Here is the Control device designed in miniature,

Figure 4. Control device designed in miniature

The system specifications in the design of this automatic floodgate and water pump are:

1. Arduino Uno R3 microcontroller whose functions are:
   a. Receives input from the ultrasonic sensor to determine the water level limit (normal, be alert, standby, beware).
   b. Turn on the relay to close/open the flood gates 1, 2, and 3.
   c. Detect closed/open floodgates 1,2, and 3.
   d. Turn on Indicators D1, D2, D3, and D4

e. Turn on the Relay to turn on/off the 1, 2, and 3 pumps
f. Knowing the water level in the reservoir (low, middle, high)

2. Ultrasonic sensor HC-SR04 which functions to detect river water level and water level in reservoir
3. Servo motor which functions to open/close floodgates 1,2, and 3
4. Water pump that functions to pump water to the reservoir

The block diagram of the arduino uno-based automatic water gate and water pump system is shown as shown in the figure 3. The results of the design trials that have been carried out are as shown in Table 2.

Table 2. Design trial results

Water Level (cm)	Floodgate			Pump			Alarm
	1	2	3	1	2	3	
1	Close	Close	Close	Off	Off	Off	Off
3	Open	Close	Close	Off	Off	Off	Off
6	Open	Open	Close	Off	Off	Off	Off
9	Open	Open	Open	Off	Off	Off	Off
12	Open	Open	Open	On	Off	Off	Off
15	Open	Open	Open	On	On	Off	Off
18	Open	Open	Open	On	On	On	Off
21	Open	Open	Open	Off	Off	Off	On

Table 3 is the stage of the control system process based on the time sequence from normal to alert state

Table 3. Stages of the control process based on time sequence

TIME	RIVER LEVEL	FLOODGATE			SENSOR								RESERVOIR				SENSOR
					1	2		3		4		5	WATER PUMP			LEVEL	5
		1	2	3		Top	Down	Top	Down	Top	Down		1	2	3	HIGH ?	
T1	Normal	Close	Close	Close	On	Off	On	Off	On	Off	On	On	Off	Off	Off	No	On
T2	Be-Alert	Close	Close	Close	On	Off	On	Off	On	Off	On	On	Off	Off	Off	No	On
T3	Standby	Close	Close	Close	On	Off	On	Off	On	Off	On	On	Off	Off	Off	No	On
T4	Beware	Open	Close	Close	On	On	On	Off	On	Off	On	On	Off	Off	Off	No	On
T5	Beware	Open	Open	Close	On	On	On	On	Off	Off	On	On	Off	Off	Off	No	On
T6	Beware	Open	Open	Open	On	On	On	On	Off	On	Off	On	Off	Off	Off	No	On
T7	Beware	Open	Open	Open	On	On	On	On	Off	On	Off	On	On	Off	Off	No	On
T8	Beware	Open	Open	Open	On	On	On	On	Off	On	Off	On	On	On	Off	No	On
T9	Beware	Open	Open	Open	On	On	On	On	Off	On	Off	On	On	On	On	No	On
T10	Beware	Open	Open	Open	On	On	On	On	Off	On	Off	On	On	On	On	Yes	On
T11	Beware	ALARM ON															

This river overflow controller can function if the water discharged through the sluice is added to the water pumped into the reservoir not less than the amount of the river overflow, in simple mathematical terms it can be written as follows:

$Dmax \leq (A + B)$ or
$Dmax - (A+B) \geq 0$

where,
Dmax = River overflow volume (m^3)
A = The volume of water discharged through the floodgate (m^3)
B = Volume of water pumped through the water pump to the reservoir (m^3)

V. Conclusion

Overall this control system can work with a good response, both at the beginning of detecting overflowing river water levels (normal, alert, standby, and alert), opening and closing 3 floodgates simultaneously, and turning on 3 water pumps which also work simultaneously. The response time for each stage starting from the river overflow level sensor until the water pump turns on is very fast because it uses a microcontroller response time. This controller is very good to be implemented directly in the field because it works in an integrated manner.

Ucapan Terima Kasih

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