DESIGN OF AUTOMATIC IRRIGATION WATER DOOR PROTOTYPE FOR PEATLAND FIRE PREVENTION USING MICROCONTROLLER

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Abstract

Forest and land fires always occur every year in Indonesia. Data from the Ministry of Environment and Forestry of the Republic of Indonesia recorded that from January to September 2019, a total of 227,304 ha of fires occurred for peatlands, and peat fires in Borneo with a burned area of 135,991 ha have the biggest impacts in Indonesia, which would increase every year if not handled well. Peatlands that experience drought are one of the reasons why they burn easily. One of the efforts made by the Indonesian government to prevent land fires is by making irrigation gates that function to wet the land (Rewetting), because in normal condition peatlands have to be submerged in water. In this study, a prototype design of an irrigation sluice gate with automatic control using a microcontroller were developed which works by detecting the condition of the peatland ecosystem using sensors of soil moisture and air temperature. The irrigation water gate prototype can move wide open, moderately open, and closed, according to the state of the peatland ecosystem, namely: when it is dry, wet, and the peatland is submerged.

Keywords: *Land Fires, Peatlands, Water Gate, Rewetting, Microcontroller.*

1. INTRODUCTION

Forest and land fires always occur every year in Indonesia. Data from the Ministry of Environment and Forestry of the Republic of Indonesia recorded that from January to September 2019, a total of 227,304 ha of fires occurred for peatlands, and peat fires in Borneo with a burned area of 135,991 ha have the biggest impacts in Indonesia, which would increase every year if not handled well.

One of the efforts made by the Indonesian government to prevent land fires is by making irrigation gates that function to wet the land (Rewetting), because in normal condition peatlands have to be submerged in water.

In this study, a prototype design of an irrigation sluice gate with automatic control using a microcontroller were developed which works by detecting the condition of the peatland ecosystem using sensors of soil moisture and air temperature. The irrigation water gate prototype can move wide open, moderately open, and closed, according to the state of the peatland ecosystem, namely: when it is dry, wet, and the peatland is submerged.

This prototype design will use an air temperature sensor (DHT11) and a soil moisture sensor (FC-28). Using the Arduino Nano microcontroller board, which is built using the C language, so that it will drive the motor through the L298N Motor Module which results in automatic movement of the floodgates that can be wide open, moderately open, and closed according to the conditions of the peatland ecosystem.

Soil humidity and air temperature variables are used as the basis for sensors based on 5 weather factors that influence fire behavior, namely wind, air temperature, moisture content, relative humidity, and rainfall, which are taken from exposure by [1]. Then in research [2] states that air temperature contributes greatly to influencing the state of soil moisture compared to rainfall, so two variables are taken, namely soil moisture and air temperature.

2. RESEARCH METHODOLOGY

2.1 SYSTEM DESIGN

The design of the system prototype is divided into 3, namely: Input in the form of a sensor for air temperature and soil humidity, the Arduino Nano board as a controller, and the output in the form of an LCD and a motor shown in Fig.1.

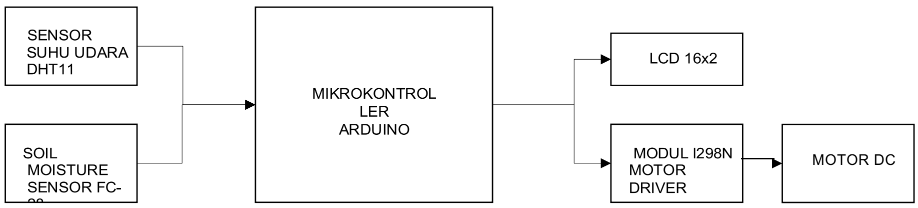

Figure 1 Block Diagram System

The function of each component in Figure 1 is as follows:

a. DHT11 sensor functions as input to detect the air temperature condition of the peatland environment. DHT11 itself has a temperature range of 0^{o} C to 50^{o}C.
b. The FC-28 sensor functions as input to detect the moisture condition of the peat soil. FC-28 itself has a moisture range of 0% to 1000%.
c. The Arduino microcontroller functions as a data processor from the detection results of the DHT11 and FC-28 sensors. The microcontroller used is the Arduino Nano series which will control and function the motor.
d. LCD serves to display data on air temperature and soil humidity on the floodgate prototype.
e. The motor driver functions as a rotation and speed regulator for a DC motor. Because DC motors only understand positive and negative currents, a motor driver is needed that is able to change the electric current received by a DC motor.
   The DC motor serves as the main driving force for the floodgate prototype, so that the door can be opened and closed, according to the state of the peatland ecosystem detected by the sensor.

2.1 Hardware Design

The hardware design consists of three parts, namely the input section, there is an air temperature sensor and a soil moisture sensor, which functions as a detector for the state of the peatland ecosystem. On the controller, there is an Arduino Nano board as a data processor from the sensor detection results to control the water door motor. Then there is an output in the form of an LCD as a display that displays the sensor reading value, as well as a DC motor which is controlled using a motor driver.

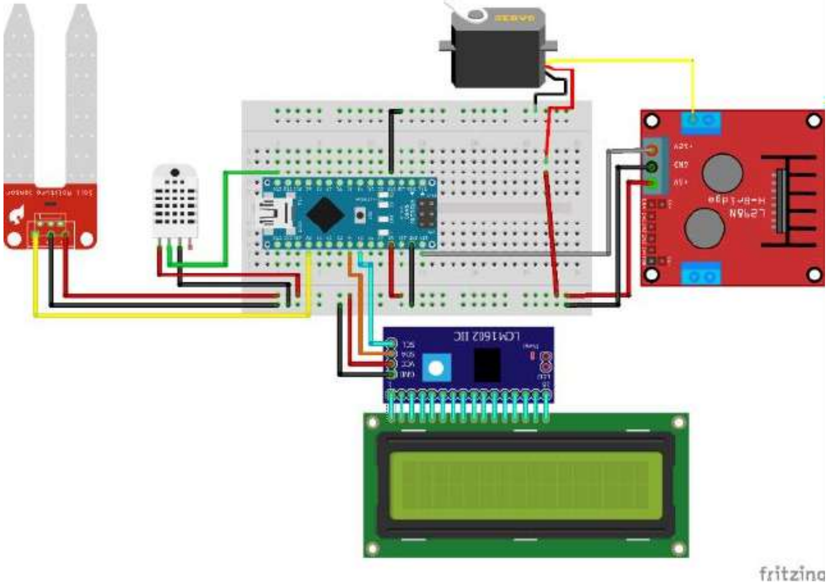

Figure 2 Hardware Design

2.2 SOFTWARE DESIGN

Hardware will not be able to run without being accompanied by a software design that is designed to control the prototype system algorithm automatically, and which regulates the steps that must be carried out by the microcontroller for the entire system. This software is built using the C language which is compiled using the Arduino IDE.

The program made for this prototype has a basic working system, when the soil moisture sensor detects dry soil moisture that is <100%, and the air temperature is hot>36° C, the motor will move to open with a delay of 160, positive current. Then when the peatlands are in a wet state, which is between 100% -600%, and the air temperature is normal, which is 28° C – 36° C, the door will move to open moderately with a delay of 80. Conversely, when peatlands are detected in normal condition is submerged, which is> 600%, and cold air temperature <28° C , the door will move to close with a delay of 160 negative currents. The current movement will be regulated using the L298N motor driver. Taking the range delay is based on the height of the water door.

3. IMPLEMENTATION

The system, as well as software and hardware that have been designed beforehand, are then implemented in the implementation of the design of automatic irrigation gates to prevent peatland fires. The installation uses the Arduino IDE 1.8.12 software, the prototype is built using mica, and simple materials. After installation, testing is also carried out using the Blackbox method.

3.1 Hardware Installation

The hardware circuit in Figure 2 then assembled. The water door prototype can be seen in Figure 3 and Figure 4.

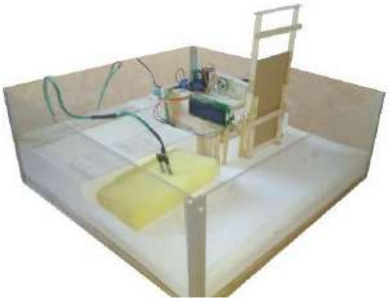

Figure 3 Water Door Prototype View

In Figure 4 there are core components consisting of (1) Arduino Nano as a microcontroller, (2) FC-28 as a soil moisture sensor, (3) DHT11 as an air temperature sensor, and (4) L928N as a motor driver to control a DC motor.

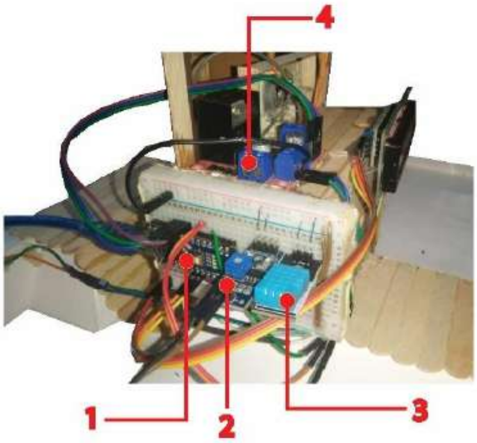

Figure 4 Core Components of Prototype

In Figure 5, there is a display component that functions to display the state of the door, consisting of (5) 16x2 LCD to display the received sensor value, and the Defuzzyfication results, and (6) LED indicators to indicate the state of the sluice, consisting of 3 colors, namely Red (Wide open), Yellow (Medium open), Green (Closed).

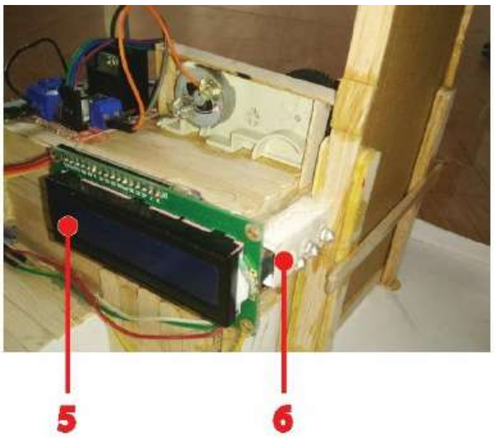

Figure 5 Display Components of Prototype.

Figure 6 shows a door component consisting of (7) Plate Gate or a door that functions to control water discharge, (8) Gear or gears that connect the motor to the door. (9) There is a motor using a DC dynamo, which is controlled by the Motor driver module L928N. And (10) Power Cables as a power supply for components.

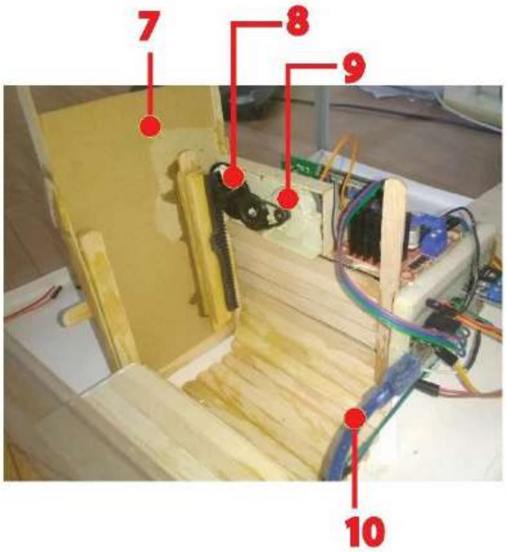

Figure 6 Door Components of Prototype

3.2 *Blackbox Testing*

Testing with the blackbox method aims to determine whether the prototype tool designed is in accordance with the expected results. This test is useful for knowing the performance and function of the tool, and in order to find out errors in system performance. To obtain suitable and efficient conditions of air temperature and soil moisture in terms of simulation time, sponges are used as an alternative to peat soil. In addition to making it easy to regulate soil moisture conditions, the use of sponges is also based on the state of the peat soil, which is based on statement [3], peat has sponge-like properties that easily absorb and store large amounts of water. The humidity sensor is controlled by adding water and squeezing the sponge so that the water is reduced. As for the condition of air temperature, the way to do this is to use a heater in the form of a hair dryer as the simulation was carried out in the study by [4]. With normal air temperature conditions the room is 30 ° C, then by using a heater the air temperature can be set to 50 ° C. From the simulations that have been carried out, it can be seen in table 1

Tabel 1 *Blackbox testing*

NO	Procedure	Expected Results	Validation
1	Dry soil moisture, and hot temperatures	The water door moves from closed to wide open, with a delay of 160	Valid
2	Wet soil moisture, and normal air temperature	The water door moves either from closed or open, to half-open, with a delay of 80	Valid
3	Submerged soil moisture, and cold temperatures	The water door closes. If it is open, the water door will move to close with a delay of 160 or 80	Valid

4	The state of the sensor is arbitrary	LCD displays sensor value changes quickly and precisely	Valid

The results of the experiment can be seen in Figure 7 for closed door conditions, Figure 8 for medium open door conditions, Figure 9 for conditions of wide open doors.


Figure 7 Closed door conditions


Figure 8 Medium Open Door Conditions

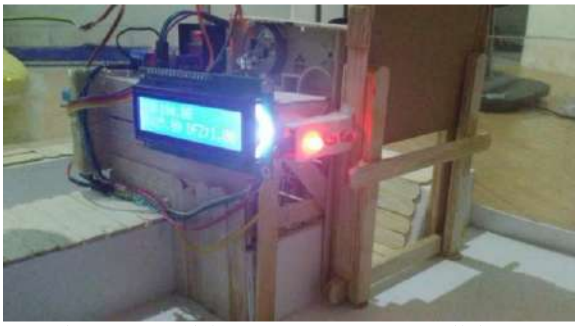
Figure 9 Wide Open Door Conditions

4. CONCLUSION

Based on the results of the discussion and testing that has been carried out on the design of the prototype automatic floodgate to prevent peatland fires, the following conclusions can be drawn:

a. The water door prototype can work in accordance with the conditions of soil humidity and air temperature detected by the sensor.
b. This prototype can be used as the basis for the construction of an automatic water door that can be implemented in peatland areas.
c. Water gates can be used as a means of rewetting the land, to prevent the occurrence of dryness on the land and thereby reduce the chance of forest fires.

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