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Application Of Photodiodes As Sensors In Arduino-Based Automatic River Garbage Cleaner

Mohammad Ibrahim Ashari[1], Alfarid Hendro Yuwono [2]

Department of Electrical Engineering, Faculty of Industrial Technology, ITN Malang, Jl. Karanglo – Karangploso km 2, , Kec. Lowokwaru, Malang and 65152, Indonesia
[1]ibrahim_ashari@lecturer.itn.ac.id; [2] alfaridhendroyuwono@lecturer.itn.ac.id

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ABSTRACT

The river cleaning system is very concerning because of the amount of garbage that accumulates in the river, causing odor, dirt and flooding. In this regard, the idea arose to create a miniature river cleaning tool that is placed in the river or sluice channel.

The way it works is that the tool is installed in the river or sluice channel, the tool is like an iron spoke. Then a sensor is installed in front of the iron spoke and there is also a stepper motor that is tasked with rotating the iron spoke. If there is garbage that blocks the sensor, the sensor gives a signal to the Arduino, then the Arduino gives a command to the motor and the motor rotates the iron spoke to lift the garbage from the river and throw it into the trash can that has been provided.

Based on the test results, if the laser beam is blocked by garbage for 5 seconds, the stepper motor rotates 180^0 considering that the garbage is ready to be lifted. The stepper motor stops after rotating 180^0. The required stepper motor rotation is 180^0 up with a step count of 1011. The maximum garbage sensor test is only 10 cm according to the width of the tool box.

1. Introduction

The rapid development of technology today has been able to touch all aspects of people's lives, from urban to rural areas. Various programs have been implemented by the government to bring people to this condition, one of which is encouraging the development of appropriate technology in various fields, such as the provision of facilities and infrastructure for the benefit of the community and for the creation of a clean environment.

One of the sources of water that is currently very polluted is rivers. Most of the rivers in Indonesia are unhealthy even though the function of rivers for humans is very much. Not only that, but the function of rivers is also very much for the ecosystem in the river. The river cleaning system is very concerning, the amount of garbage that accumulates in rivers causes water flow to stagnate and floods to occur [1].

Garbage is a material that is wasted or thrown away from sources of human activity or natural processes. Garbage is a problem in all countries in the world, some garbage is easily decomposed, some are difficult to decompose so that it has the potential to cause soil and water pollution, which of course will be problematic for the health of the surrounding environment. However, the big problem here is that rivers as the lifeblood of the environment that should be well maintained, are sometimes used as shared trash bins by people who live around the river. This can cause polemics of flooding and various diseases, so it needs serious attention to clean it up.

In connection with this, an idea arose to create a miniature River Garbage Cleaning tool that is placed in the river or sluice channel. This tool will automatically transport waste in the river to the garbage collection tank that has been provided.

2. The Proposed Method/Algorithm

2.1. Arduino Uno R3

Arduino Uno is one of the Arduino that is cheap, easy to get, and often used. Arduino Uno version R3 is the latest type equipped with ATMEGA328P microcontroller so that it can work optimally [2]. Arduino is the name of a family of microcontroller boards that were originally created by the company smart projects. One of the creators is Massimo Banzi. This board is hardware that is "open source" so that anyone can make it. Arduino was created with the aim of facilitating experiments or the realization of various microcontroller-based equipment [3]. Arduino Uno is a microcontroller board based on ATmega328P, this microcontroller has 14 digital input/output pins (where 6 can be used as PWM outputs), 6 analog inputs, 16 MHz quartz crystal, USB connection, power jack, an ICSP header and reset button [4].

2.2. Photodiode

Photodiode consists of a thin layer of N-type semiconductor that has many electrons and a thick layer of P-type semiconductor that has most holes. The N-type semiconductor layer is the Cathode while the P-type semiconductor layer is the Anode [5]. The photodiode sensor is one of the photoconductive light sensors where when exposed to light, its resistance will change. The photodiode sensor can respond to stimuli in the form of visible or invisible light and convert the intensity of the detected light into current [6]. The working principle of the photodiode when exposed to light, it will act as a voltage source and its resistance value will be small. Conversely, if the photodiode is not exposed to light, its resistance value will increase or can be configured up to. The amount of voltage or electric current produced by the photodiode depends on the amount of radiation emitted by the light source [7].

2.3. Motor Stepper

The accuracy of stepper motor motion control is mainly influenced by the number of steps per rotation, the more steps, the more precise the motion produced. For higher accuracy, some stepper motor drivers divide normal steps into half steps or micro steps [8]. Stepper motors can rotate or rotate at angles/steps that can vary depending on the motor used. The step size can be in the range of 0.9^{o} to 90^{o}. The rotation position is also relatively precise and stable. With angle variations, it will be easier to control without using closed-loop feedback to monitor the position [9]. Based on the design method of the control circuit, stepper motors can be divided into unipolar and bipolar types. The unipolar stepper motor control circuit is easier to make because it only requires one on signal using a switch/transistor on each winding [10].

2.4. ULN2003.

The ULN2003 stepper motor driver module provides an interface that will drive the motor directly between the microcontroller and the stepper motor [11]. The ULN2003 IC can be used as a stepper motor driver, where the ULN2003 IC has seven NOT logic gates. However, for this stepper motor driver, four NOT gates are used, pins 1, 2, 3 and 4 as input while pins 13, 14, 15 and 16 as output and pin 9 as +12 Volt voltage input [12]. The ULN2003 is an IC that has 7 Bit input, a maximum voltage of 50 volts. This IC is a type of logic transistors (TTL). Inside this IC there are Darlington transistors and 7 pairs of drivers. Darlington transistors are 2 transistors that are arranged in a special configuration to obtain double amplification so that they can produce large current amplification [13].

2.5. Relay

The relay module is a device that operates based on the electromagnetic principle to move the contactor to move the ON to OFF position or vice versa by utilizing electrical power [14].

A relay is a switch that is operated electrically and is an electromechanical component consisting of 2 main parts, namely an electromagnet (coil) and a mechanical (a set of switch contacts) [15].

2.6. Push button

Push button is an electronic component that works by being pressed. Push button functions as a switch to connect or disconnect electric current. Push button itself has on and off function. Because of how it works, push button is one of the important components in the control system, especially used as a trigger input in the system [16]. Because the system works unlocked and directly connected to the operator, push button switch is the most important device commonly used to start and end the work of machines in industry. No matter how sophisticated a machine is, it is certain that its working system cannot be separated from the existence of a switch such as a push button switch or other similar devices that work to regulate the On and Off condition [17].

3. Method

To create a working system for an electronic device, a systematic and structured arrangement of the tools is required, here are several stages of the process:

3.1. System Block Diagram

To describe the entire system of this tool can be seen in Figure 1 below:

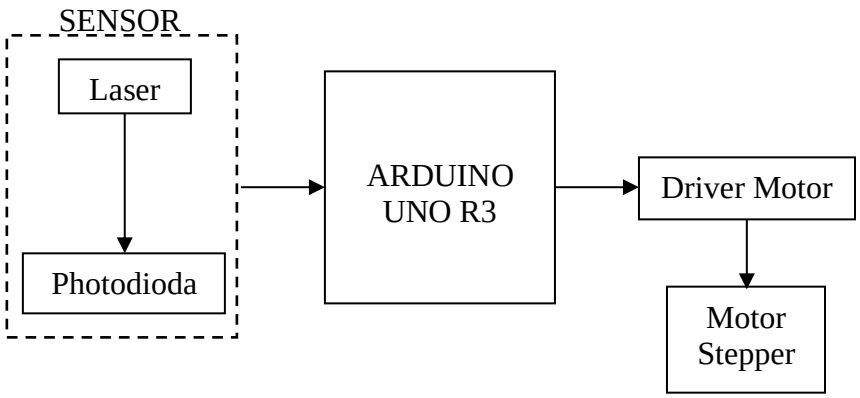

Figure 1. Circuit Block Diagram

From the picture above, each block diagram can be explained, namely:

1. Laser
   The laser in this tool functions to give a logical condition of one to the Photodiode. The laser was chosen because the intensity of its light emission does not decrease even though it is emitted at a great distance.
2. Photodiode
   Functions to convert light energy, in this case the Laser light energy into an electrical signal (in this case an electric current).
3. Arduino
   Arduino Uno in this block is the process center for controlling all devices on the tool. In this block, arduino has been programmed to convert input from the sensor into output in the form of a stepper motor rotation.

4. Motor Driver
   This motor driver functions to control the direction of motor rotation so that the tool can work properly.
5. Stepper Motor
   This stepper motor functions as a tool rotation. The stepper motor used is the 28BYJ-48 5V DC Stepper Motor.

3.2. How the System Works

The tool is installed in the river or water gate channel, the tool is like an iron spoke. Then a sensor is installed in front of the iron spoke and there is also a stepper motor that is tasked with rotating the iron spoke. If there is garbage that blocks the sensor, the sensor gives a signal to the Arduino, then the Arduino gives a command to the stepper motor and the stepper motor rotates the iron spoke to lift the garbage from the river and throw it into the trash bin that has been provided.

4. Results and Discussion

4.1. Arduino Uno Testing

This test is done whether Arduino works as it should or not. To find out is to try downloading the Blink LED source code. The result is the red LED on pin 13 Arduino Uno lights up for 1000ms.

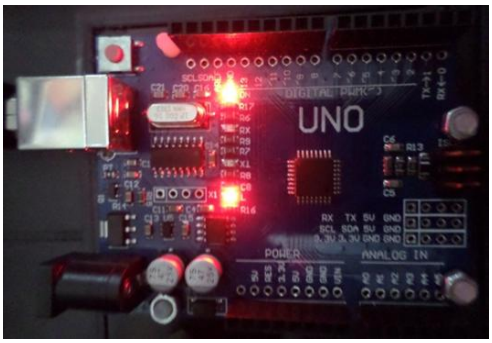

Figure 2 When the LED Blinks and the LED Pin 13 is On for 1000ms

4.2. Waste Sensor Testing

Garbage sensor testing is done to ensure that the Garbage Sensor is working properly, because this will affect the data processing results. If the data reading from the garbage sensor is an error, the data processing results will also be an error.

Table 1. Results of the Garbage Sensor Test on Water

No	Trash Sensor Condition	Distance Laser and Photodiode (cm)	Vout Sensor
1	Unhindered	5	7,88
	Blocked		0,73
2	Unhindered	10	7,52
	Blocked		0,39
3	Unhindered	15	7,31
	Blocked		0,23

Based on the test results that have been carried out as in table 1, when the garbage sensor is not blocked by garbage, the output voltage is greater than when the garbage sensor

is blocked by garbage. Because when the garbage sensor is not blocked (receiving laser light), the photodiode will act as a voltage source and its resistance value will be small, and vice versa when the photodiode is not exposed to light, the resistance value will be large or can be assumed to be infinite.

4.3. Stepper Motor Driver Circuit Testing

Testing was carried out on the motor driver circuit. The purpose of testing this motor driver circuit is to drive the stepper motor and also to control the speed of the motor. The test of the motor driver circuit obtained the results as in table 2.

Table 2. Motor driver circuit test results

Testing to -	Number of Steps	Stepper motor movement (°)	Stepper Motor Condition
1	0	0	Not moving
2	2048	360	Move clockwise
3	-2048	360	Move counterclockwise
4	1011	180	Move clockwise
5	-1011	180	Move counterclockwise

4.4. Overall Test Results

The overall system testing is carried out with the aim of knowing the overall system function, so that the accuracy of the system that has been designed and the shortcomings and advantages of the system can be known. The testing is carried out by combining the equipment that has been tested one by one before into an automatic river waste cleaning tool.

Table 3. Overall Test Results

Laser and Photodiode Distance (cm)	Trash Sensor Condition	Vout Sensor	Stepper Motor Condition	Stepper Motor Rotation (°)	Motor rotation direction
10	Unhindered	7,52	of	0	Shut up
	Blocked	0,39	on	180	Clockwise

Based on the test results that have been carried out as in table 3, when the garbage sensor is not blocked by garbage, the stepper motor turns off and does not rotate. If the garbage sensor is blocked by garbage, the stepper motor turns on and rotates clockwise.

5. Conclusion

After the design and manufacture process as well as tool testing, it can be concluded:

1. If the laser beam is blocked by garbage for 5 seconds, the stepper motor rotates 180^0 considering that the garbage is ready to be lifted.
2. The stepper motor stops after rotating 180^0.
3. The required stepper motor rotation is 180^0 up with a step count of 1011.
4. The maximum garbage sensor test is only 10 cm according to the width of the tool box.

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