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Application of Sensors in Arduino as a control in Smart Home

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***Abstract*—The application of sensors in smart homes using Arduino to control equipment such as lights, fans, alarms, and so on. Sensors used in Arduino include LDR, Ultrasonic, DHT11, and MQ2. LDR is used to automatically control railing lights, balcony lights, garden lights, and backyard lights if, during the day, the lights will turn off and on at night. Ultrasonic sensors are used to open the gate. The rolling door is driven by a DC motor, while a servo motor drives the house door. Testing on the ultrasonic sensor can open the gate and roll when the ultrasonic sensor reads objects with a distance of 5-25 cm. Testing on this sensor is done by utilizing heat from a match that is placed ± 10 cm from the sensor with a time of 5-25 seconds to turn on the fan when the temperature is above 30^0 C. The MQ2 sensor is used to detect gas leaks and will turn on the blower. This test was carried out 50 times resulting in 4 wrong times so that the system as a whole has an accuracy of 92% and an error of 8%.**

Keywords— Smart Home, Ultrasonic Sensor, LDR, DHT 11 and MQ2

I. INTRODUCTION

The rapid development of technology causes humans to continue to learn by improving and developing equipment that makes work easier. These jobs were originally done by humans to become fully automatically controlled by machines using sensors. The use of sensors in electronic devices has been widely applied to almost all fields in our daily lives, ranging from personal devices, health services, security, industry, entertainment, transportation, military, household appliances, and so on [1]-[2].

The sensors used require a microcontroller so that it can be used to control a piece of equipment. The equipment controlled by a microcontroller can run automatically by embedding a program into the microcontroller [2]. One example of a microcontroller is Arduino which can be used to control equipment such as automation in smart homes. Automation in a smart home includes all technologies and makes it possible to control home appliances (lighting, heating, shutters, televisions, and alarms). Home automation has several advantages [3]-[4]:

- Can be used as a home security system through an automatic door lock.
- Can add a security system with lighting control.
- Can save costs by increasing comfort.
- Can make it easier for people to maintain security.
- Can increase the efficiency of energy use in the home by turning off equipment that is not used remotely.

This study discusses how to apply sensors in the Arduino microcontroller, which is applied to smart homes. The smart home system can control various equipment, including lights, fans, garage doors, and gates, and detect gas leaks [5]-[6]. The DHT11 sensor is used to determine the temperature in the house, and if the temperature in the room is hot, the system can automatically turn on the fan. The system can also automatically control fence lights, balcony lights, garden lights, and taillights by utilizing a Light Dependent Resistor (LDR). The lights will turn on if the sensor is not exposed to sunlight [7]. Ultrasonic sensors open gates, and garage doors are driven by a DC motor, while a servo motor drives house doors. The MQ2 sensor detects gas leaks; if a gas smell is detected, it will turn on the buzzer and the blower [8].

In previous studies, relatively few inputs and outputs were used and were carried out in simulations on electronic circuits only. This research has an update, namely using far more input outputs, including 2 ultrasonic, 2 dc motors, 2 servos, buzzer, MQ2, DHT11, 8 LEDs, LDR, relay, 16x2 LCD, and applied directly to the smarthome prototype which can run automatically. It is very important to do because it can simplify the work of homeowners and can provide information in the event of a fire.

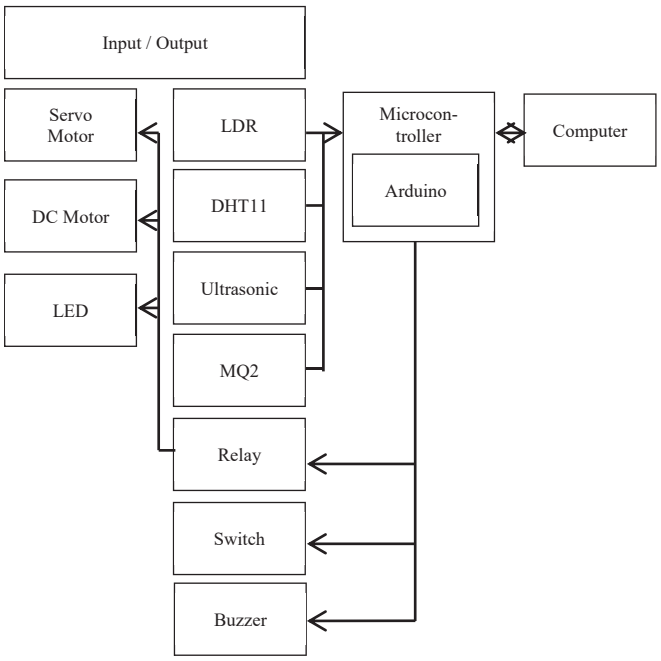

Fig. 1. Block diagram system.

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II. Research Method

Along with the development of technology in the digital era, currently, many studies are trying to make the house easier to control. Many researchers and activists have put forward the term smart home in the field of automation. The utilization of smart homes is used to improve the security system, save energy and increase the comfort of homeowners [9]-[10].

This research uses several devices such as Arduino Mega, LDR, LED, ultrasonic sensor, DHT11, and MQ2 [7]. In this study, Arduinomega receives data from the sensor, then as a processor that can execute programs to validate data and make decisions based on the inputted data as shown in Fig. 1.

A. Electronics Design of Smart Home

The design of the electronic circuit from the smart home is needed in order to describe the path of the Arduino that connects the components with the sensors required by the system.

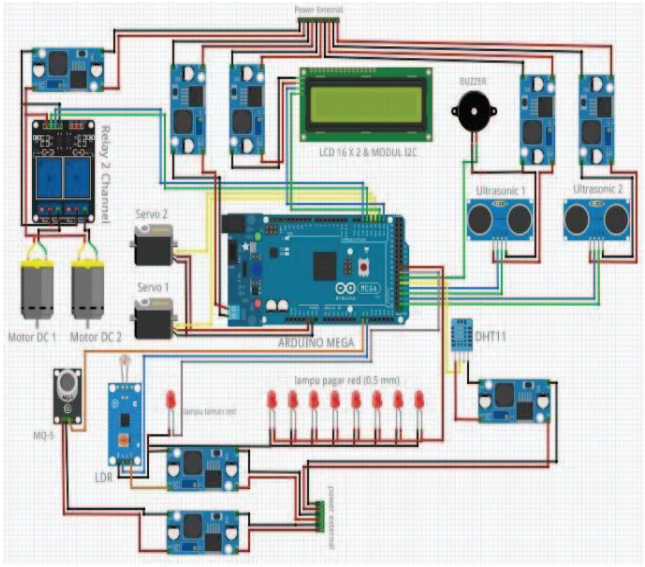

Fig. 2. Electronic circuit.

The electronic circuit shown in Fig. 2 shows that this system uses 5 volts of power obtained from the DC Step down module sourced from external power with a 12-volt power source. Then the Arduino microcontroller is connected to the modules and other components via the Digital pin as a data transmission line, VCC, and GND to get the voltage [11]. In Fig. 2. there is an Arduino Mega as the controller, a DHT11 sensor that can run a DC motor, a US sensor to drive the servo motor, the MQ2 sensor activates the buzzer, the LDR module will turn on the LED if it is not exposed to light, 16x2 LCD to display the activities being carried out [12].

B. *Arduino*

Arduino is a microcontroller that has been widely used because it is open source, Arduino is designed to make it easier to apply electronic science in various fields.

There is an Arduino Mega as the main control of the design of this smart home system. Arduino mega is needed because it has many digital I/O pins, then this type of microcontroller also has analog pins. Where this system requires a digital input-output of 14 pins and also an analog input [12]-[13].

C. LDR (Light Dependent Resistor)

LDR is a kind of resistor whose resistance is determined by the size of the light intensity it receives [14]. The resistance of the LDR will be of a small value if it gets a large light intensity, and it will get a large value if it gets a low light intensity, meaning that the resistance in the LDR is inversely proportional to the intensity of the light it receives. The resistance in the LDR is between 500 Ohms - 200 KOhms, in the dark the LDR resistance decreases to 500 Ohms, while in light conditions the LDR resistance can reach 200 Kohms [15].

The LDR sensor module has 3 pins, namely DO (output), GND, and VCC. The LDR sensor module works on a DC voltage of 3.3 Volts - 5 Volts.

D. Ultrasonic Sensor

The proximity sensor that will be used is the ultrasonic sensor HC-SR04 which utilizes physical quantities (sound) and then converts them into electrical quantities and vice versa. The ultrasonic sensor HC SR04 is a ready-to-use sensor consisting of a sender, receiver, and controller of ultrasonic waves and can measure object distances between 2cm to 4m, with an accuracy of 3mm. HC SR04 has four pins: VCC, GND, Trigger, and Echo. The VCC pin is for receiving positive current, GND is ground, the trigger pin is the trigger for the output signal from the sensor, and the echo pin is used to capture the reflected signal from objects in front of the sensor [16].

E. DHT11 Temperature and Humidity Sensor

The DHT 11 sensor is used in this study to determine the temperature and humidity in the house. The output of the DHT 11 sensor is a digital signal that has been calibrated so that it can measure temperature from 0-50o C with an accuracy of ± 2°C and the relative humidity of 20-90% with an accuracy of ± 4%. The DHT11 sensor has three pins, namely VCC, Data, and GND, and requires a power supply of 3.3 to 5 volts [17], [5].

F. MQ-2 Sensor

The MQ-2 gas sensor is used to detect gas contained in Liquid Premium Gas (LPG) [8]. The MQ-2 sensor is made of lead dioxide (SnO2) material with very low conductivity in clean air. This gas sensor is sensitive to butane gas and other types of natural gas, such as smoke (CO) and alcohol. The MQ-2 sensor can also be used to detect combustible gases such as methane [18].

III. Results And Discussion

Testing is carried out as a whole and aims to find out whether the system that has been made can function properly. In this research, the Smart Home prototype is based on Arduino and is equipped with ultrasonic sensors, DHT 11, LDR, and MQ2 so that it can be controlled automatically including:

1. Can open the gate and garage automatically when there is a car.
2. Can show temperature and humidity
3. Can give warning in case of LPG leak
4. Can turn on the lights automatically at night

The design variables to be tested include:

1. Testing the LDR Sensor to control the condition of the lamp
2. Gas Leak Detection Sensor Test (MQ-2)
3. Temperature and Humidity Sensor Testing (DT11)
4. Ultrasonic Sensor Test

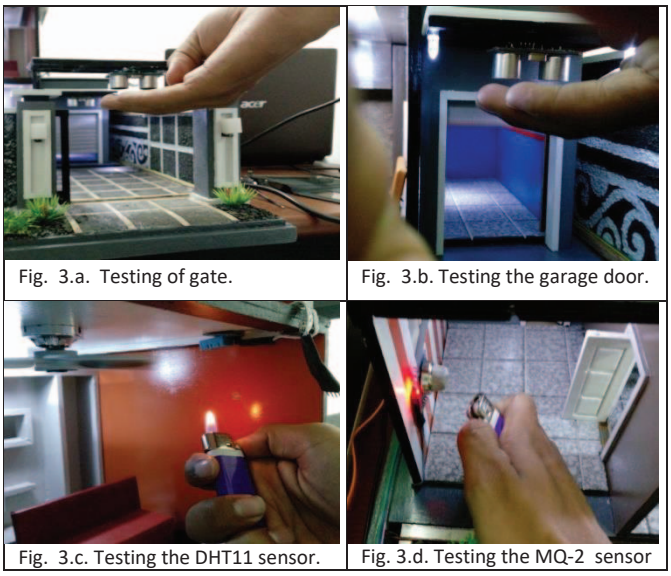

Fig. 3.a. Testing of gate.
Fig. 3.b. Testing the garage door.
Fig. 3.c. Testing the DHT11 sensor.
Fig. 3.d. Testing the MQ-2 sensor

Fig. 3. Testing of Sensor

A. Testing of lamps

Testing of lamps by utilizing LDR which will work if it gets a little light (dark), so it can activate various kinds of lamps that are connected to the sensor [7]. The test results when the LDR does not get light can automatically turn on the lights on the smart home can be seen in Table 1.

TABLE. 1. LAMP TEST RESULTS

No	Lamp	Relay Condition	Lamp Condition	Display on LCD
1	Garden lamp	ON	ON	"ON"
2	Fence Light	ON	ON	"ON"
3	Balcony Light	ON	ON	"ON"
4	Backyard light	ON	ON	"ON"

B. Testing of gate

At first, the gate could not be opened because the ultrasonic sensor did not detect any objects, when placing objects under the sensor from a distance of 5-25 cm the door could open automatically. Testing of the gate can be seen in Fig. 3.a.

At first, the garage door was closed because the ultrasonic sensor did not detect an object. When the ultrasonic sensor detected an object starting from a distance of 5-25 cm, the rolling door could open automatically. Tests on rolling doors can be seen in Fig. 3.b.

The results of testing ultrasonic sensors placed on the gate and garage door can be opened automatically if the sensor detects an object. Tests on the gate were carried out six times, and the results can be seen in Table 2.

TABLE. 2. TEST RESULTS OF GARAGE DOORS AND GATES

No	Object Distance with Ultrasonic	Gate	Display on LCD	Garage door	Display on LCD
1	Nothing	Close	"Close"	Close	"Close"
2	5 cm	Open	"Open"	Open	"Open"
3	10 cm	Open	"Open"	Open	"Open"
4	15 cm	Open	"Open"	Open	"Open"
5	20 cm	Open	"Open"	Open	"Open"
6	25 cm	Open	"Open"	Open	"Open"

C. Testing of temperature

The test was carried out under two conditions: before and after being heated. The DHT11 temperature sensor is tested by heating that comes from a match and placed ± 10 cm with the DHT 11 sensor, as shown in Fig. 3.c. The experiment was carried out for 5-25 seconds if the temperature was below 30ºC then the fan would rotate, and the reading of the temperature value would be displayed. On the LCD. Room temperature testing using DHT 11 was carried out six times, and the results can be seen in Table 3.

TABLE. 3. RESULTS TEST OF THE DHT11 SENSOR

No	Condition	Fan	Display on LCD
1	Normal	OFF	29^0 C
2	Heated 5 seconds	ON	32^0 C
3	Heated 10 seconds	ON	33^0 C
4	Heated 15 seconds	ON	37^0 C
5	Heated 20 seconds	ON	39^0 C
6	Heated 25 seconds	ON	43^0 C

D. Testing of Gas leak

Fig. 3.d shows the test on the MQ-2 sensor by giving a matching gas for 5 – 25 seconds and placing ± 10 cm with the MQ2 sensor to give a signal to the Arduino microcontroller when the amount of gas received by the sensor is above 200 ppm. In these conditions, the buzzer will sound and be displayed on the LCD. Gas leak testing was carried out six times; the results can be seen in Table 4.

TABLE. 4. A TEST RESULT OF THE MQ2 SENSOR

No	Condition	Buzzer	Display on LCD
1	Gas doesn't leak	OFF	-
2	Gas Leak 5 seconds	ON	Gas Leak
3	Gas Leak 10 seconds	ON	Gas Leak
4	Gas Leak 15 seconds	ON	Gas Leak
5	Gas Leak 20 seconds	ON	Gas Leak
6	Gas Leak 25 seconds	ON	Gas Leak

IV. CONCLUSION

Smart Home can control electronic equipment that has been built using microcontrollers include lights, gates, room temperature, and gas leaks. The LDR sensor can turn on the light automatically when the sensor does not receive light and turns off when light hits the LDR. The ultrasonic sensor works as desired, which can detect objects within a distance

of 5-25 cm so that it opens the gate automatically. The DHT 11 sensor works well, that is, it can activate the fan when it is hot, namely the room temperature is above 30^0 C. While the MQ2 sensor can work well when the gas distance from the sensor is ± 10 cm so that it activates the buzzer and turns on the blower which is displayed on the LCD. Testing of lamps by utilizing LDR which will work if it gets a little light (dark), so it can activate various kinds of lamps that are connected to the sensor. so that it activates the buzzer and turns on the blower which is displayed on the LCD. This test was carried out 50 times resulting in 4 wrong times because the LDR sensor is less sensitive to light so that the system as a whole has an accuracy of 92% and an error of 8%.

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