International Journal of Marine Engineering Innovation and Research, Vol. 10(3), Sept. 2025. 920-929
(pISSN: 2541-5972, eISSN: 2548-1479)

Development A Fire Extinguisher Nozzle Drive Mechanism with Android Monitoring and Control

Cahya Kusuma[1*], Vega Indra Citra Utama [2], Wawan Kusdiana[2], Aris Tri Ika R[3]
(Received: 5 March 2025 / Revised: 6 June 2025 /Accepted: 28 August 2025 / Available Online: 22 September 2025)

Abstract*— The warehouses on land are rooms that are prone to fire hazards. The Spare Parts warehouse contains engine spare parts, rubber lifeboats, ship paint, thinner, maritime equipment, lubricating oil, dry food, and other logistics support. These materials have a high level of vulnerability to fire hazards. Thus, the danger of fire is one of the potential threats that can occur in Dismatbek. A fire protection system is needed that can minimize losses due to fire. This research is intended to develop a design for a fire extinguisher nozzle drive mechanism with Android monitoring and control. By building a mechanical movement mechanism for the nozzle in the vertical and horizontal directions so that the focus can be directed to the fire source with the Esp 32 Microcontroller. There is a monitoring and control unit via an Android smartphone which is equipped with three sensors, namely fire, temperature, and smoke sensors which are connected to an Arduino microcontroller to identify fire hazards. From the overall test results, it was found that the nozzle was successful in moving vertically and horizontally with a good mechanism for driving the fire nozzle arm in transmitting the power distributed to the nozzle arm resulting in a gear ratio of 2.06: 1 with a final rotational speed of 3.8 rpm at In the elevation direction, the torque is 1,606 Nm and in the azimuth direction, the speed is 7.28 rpm, the final torque is 3,028 Nm. The fire nozzle monitoring and control unit is capable of detecting potential fire hazards and the nozzle can be controlled with an Android smartphone and can extinguish fires by spraying water at the source of the fire well.

Keywords— Android, Arduino, Fire Extinguisher, IoT Based ESP32-CAM Camera, Nozzle.

[*]*Corresponding Author:kusumacahya99@gmail.com*

I. INTRODUCTION

Logistics warehouses have a high level of vulnerability to fire hazards because the goods stored are flammable, so the danger of fire is one of the potential threats that can occur.[1]. Major losses due to fire in addition to material and property damage can cause the risk of loss of life. This can happen to personnel on duty when extinguishing the fire because of health problems due to smoke from the fire.[2]. The biggest loss from a fire is the disruption of logistics distribution. Several factors underlying the occurrence of obstacles and failures in fire control are inadequate early fire protection systems, lack of personnel preparation, inadequate fire extinguishing equipment, and other obstacles.[3]. The existence of an adequate fire protection system will greatly assist the fire extinguishing process. So that it can minimize major losses that can occur due to a fire. Fire extinguishing with a conventional system is still not optimal.[4]. Because the operating system applied is still manual and requires personnel to operate the system. Where the fire extinguishing system depends on the readiness of personnel and the extinguishing equipment used. This study designed a fire extinguisher nozzle drive mechanism equipped with a monitoring and control unit via an Android smartphone and identified fire hazards equipped with three sensors, namely fire, temperature, and smoke sensors connected to the Arduino Microcontroller. This design is intended to assist firefighters tasked with extinguishing fires in detecting, monitoring, and extinguishing fires effectively, especially in warehouses.

This paper adopts a four-part structure to present its content systematically. The initial segment elucidates the fundamental motivations and justifications underpinning the research endeavor. Subsequently, the following part delineates the specific procedures and analytical techniques utilized in executing the investigation. The third division then expounds upon the empirical results obtained, accompanied by a comprehensive analysis and interpretation of the gathered evidence. Concluding the work, the final segment synthesizes the core insights derived from the study and proposes potential avenues for subsequent scholarly inquiry.

II. METHOD

This chapter discusses two main lines in designing the Fire Extinguisher Nozzle Drive Mechanism system and Android Monitoring and Control.

[1]Cahya Kusuma, Departemen Teknik Mesin Kapal Perang, Politeknik Angkatan Laut (AAL), Surabaya, 60178, Indonesia. E-mail: kusumacahya99@gmail.com
[2]Vega Indra Citra Utama, Departement of Mechanical Engineering, Sekolah Tinggi Teknologi Angkatan Laut (Indonesian Naval Technology College), Surabaya, 60178, Indonesia. E-mail: *vegaindra007@gmail.com*
[3]Wawan Kusdiana, Departement of Mechanical Engineering, Sekolah Tinggi Teknologi Angkatan Laut (Indonesian Naval Technology College), Surabaya, 60178, Indonesia. E-mail: kusdiana2744@gmail.com
[4]Aris Tri Ika R, Departement of Mechanical Engineering, Sekolah Tinggi Teknologi Angkatan Laut (Indonesian Naval Technology College), Surabaya, 60178, Indonesia. E-mail: aristripk7@gmail.com

A. The Fire Triangle

Fire occurs due to a chain reaction between the elements in the fire triangle, namely fuel, oxygen, and heat (calories) quickly and in balance.[5]. Oxygen is the core element in the fire triangle, this is because oxygen is very abundant in the wild so it will greatly determine the level of combustion activity. Fire is an emergency that arises because of a flame, either small or large in a place that we do not want, is detrimental unnecessary, and difficult to overcome. Fire is a disaster that can happen at any time, the incident can occur due to deliberate or unintentional elements. The impacts can be fatal. Therefore, efforts are needed to overcome the dangers of fire so that if a fire occurs it can be overcome immediately and is expected to minimize the impacts caused. Indonesia follows the classification issued by the National Fire Protection Association (NFPA), this is stated in the regulation of the Minister of Manpower and Transmigration dated April 14, 1980.[6].

B. Temperature and Humidity Sensor (DHT11)

The DHT 11 sensor simultaneously quantifies two environmental variables: temperature and humidity. This integrated module delivers digitally calibrated output signals.[7]. Internally, it incorporates a Negative Temperature Coefficient (NTC) thermistor for temperature assessment and a resistive element for humidity detection. An embedded 8-bit microcontroller processes inputs from both sensing elements, transmitting the resultant data through a single bi-directional output pin.[8]. The device exhibits rapid signal response characteristics and robust signal integrity.[9]. alongside exceptional operational stability and precision calibration capabilities.[10]. Calibration coefficients reside within On-Time Programmable (OTP) memory – functionally analogous to Electrically Erasable Programmable Read-Only Memory (EEPROM) – ensuring these parameters are algorithmically integrated during sensing operations. Distinguished by superior performance metrics including responsiveness, rapid data acquisition, and interference resistance, the sensor features a compact form factor and supports signal transmission over distances extending to 20 meters, with detailed specifications presented in Table 1.

TABLE 1.
CHARACTERISTICS OF AIR HUMIDITY SENSOR

Device Model	DHT11
Physical Dimensions	12.0 × 15.5 × 5.5 mm
Operating Voltage Range	3 to 5.5 V DC
Typical Response Time	2 seconds
Environmental Parameters	Humidity Range 20% to 90% Relative Humidity (RH) Humidity Tolerance Maximum permissible deviation: ±5% RH Temperature Range 0°C to 50°C Temperature Tolerance Maximum permissible deviation: ±2°C
Measurement Accuracy	Humidity Humidity ± 4%RH (Max ± 5%RH); Temperature ± 2.0 C
Data Transmission Protocol	Digital signal via single-wire bidirectional interface
Measurement Repeatability	Humidity ± 1%RH; temperature ± 1 ºC
Resolution or Sensitivity	Humidity 1%RH; temperature 0.1 ºC
Long-term Stability	Annual Drift: ≤ ±0.5% RH
Humidity hysteresis	± 1%RH
Unit Interchangeability	Full interchangeability without calibration

C. Smoke Sensor (MQ - 135)

The MQ-135 gas detection module serves to quantify atmospheric concentrations of various combustible gases and smoke. Its sensitivity is user-adjustable via an integrated trim potentiometer. This device finds common application in leak detection systems across both domestic and industrial settings. Specifically, it is capable of identifying ammonia (NH_3), nitrogen oxides (NO_x), ethanol (C_2H_5OH), benzene (C_6H_6), carbon dioxide (CO_2), and hydrogen sulfide (H_2S). Operating at a 5V DC supply voltage, the sensor generates analog resistance output signals proportional to gas concentration. Comprehensive operational characteristics are documented in Table 2.3. The unit employs a four-pin interface comprising VCC (power supply), GND (ground), DOUT (digital output), and AOUT (analog output) terminals.

D. Flame Sensor KY - 026 (Flame Sensor)

KY - 026 Flame Sensor is a light sensor that is sensitive to the intensity of light wavelengths. To detect light, this sensor is equipped with a photodiode component and a trim pot to adjust the intensity of the received light wavelength based on its resistance value. The light that can be detected by the KY-026 sensor includes sunlight, infrared light, visible light, x-rays to ultraviolet light. This module has 4 pins consisting of VCC, GND, Digital Output, and Analog KY-026 sensor specifications:

a) Infrared sensitivity to light waves between 760-1100 nm.
b) Detection Angle Range: About 60 degrees.
c) Working voltage: 5V DC.
d) Maximum current: 15ma
e) There is a potentiometer setting

TABLE 2.
CHARACTERISTICS OF MQ - 135 GAS SENSOR

Parameter Category	Technical Specification
Device Model	MQ-135
Circuit Operating Voltage	5 V (AC or DC)
Heater Operating Voltage	5 V (AC or DC)
Primary Target Analytes	Ammonia (NH_3), Nitrogen Oxides (NOx), Ethanol, Benzene (C_6H_6), Combustion Aerosols (Smoke), Carbon Dioxide (CO_2)
Detection Concentration Ranges	10-300 ppm (NH_3), 10-1000 ppm (Benzene), 10-300 ppm (Ethanol)
Signal Output Type	Analog voltage (variable resistance proportional to gas concentration) ±0.1% full scale

E. Driver Motor IC L293D

The L293D integrated circuit functions as a dual H-bridge driver for bidirectional DC motor control. Its operational parameters, per the referenced L298N module datasheet, include:

a) Fundamental architecture: Dual H-bridge DC motor driver (IC L293D)
b) Operating supply voltage range: 4.5 V to 35 V DC.
c) Control logic voltage requirement: 5 V DC
d) Analog input signal voltage thresholds:
   - Logic Low State: Input signals between -0.3 V and +1.5 V are interpreted as invalid control commands.
   - Logic High State: Input signals ranging from 2.3 V to V_{SS} (supply voltage) are recognized as active control command).
e) Current for input between 0 - 36mA
f) Maximum current for output per Output A or B: 2A
g) Maximum power is 25W
h) Temperature: -25 ℃ ~ +130 ℃

F. Microcontroller

A microcontroller constitutes an integrated computing architecture wherein core computational components are consolidated within a monolithic integrated circuit (IC), alternatively termed a single-chip microcomputer system.[11]. Unlike general-purpose personal computers designed for multifunctional operation, these devices execute dedicated functionality. Architecturally, they incorporate a central processing unit (CPU), read-only memory (ROM), random-access memory (RAM), input/output (I/O) interfaces, timing circuitry, and ancillary peripherals—all interconnected through optimized on-chip integration. This consolidation enables users to programmatically define ROM contents through established development languages. For the present investigation, the Arduino Nano platform implementing the ATMEGA328 processor serves as the designated microcontroller, selected for its compact form factor and versatile I/O configuration comprising 8 analog input channels alongside 14 configurable digital I/O terminals.[12]. In addition to the 14 digital output pins that are already available, 8 analog output pins can be used as digital output by changing the pin configuration in the program. Programming using a micro USB Computer.

The Arduino Nano microcontroller specifications are:

a) The integrated circuit employs either an ATmega328P or ATmega168 microprocessor.
b) Nominal operating voltage: 5 V DC.
c) Recommended input voltage range: 7 V to 12 V DC.
d) Fourteen digital input/output (I/O) terminals, six of which support pulse-width modulation (PWM).
e) Eight analog input channels.
f) Maximum direct current per I/O terminal: 40 mA.
g) Flash memory capacity: 16 KB (ATmega168) or 32 KB (ATmega328P), with 2 KB reserved for bootloader functions in both configurations.
h) Static random-access memory (SRAM): 1 KB (ATmega168) or 2 KB (ATmega328P).
i) Electrically erasable programmable read-only memory (EEPROM): 512 bytes (ATmega168) or 1 KB (ATmega328P).
j) Clock oscillation frequency: 16 MHz.

Wemos D1 mini is a wifi module device based on the ESP-8266 microcontroller, this device can be used in the development of Internet of Things projects. Wemos can run stand-alone without the need to be connected to a microcontroller, wemos d1 mini is equipped with a CH340 chip as an internal USB to serial converter. Wemos can run stand-alone because inside it there is a CPU that can program via serial port or OTA and transfer programs wirelessly.

TABLE 3.
MICROCONTROLLER SPECIFICATION

Parameter Category	Specification	unit
Device Model	ESP8266EX	
Operating Potential Voltage	3.3	V
Digital I/O Terminal Count	11	
Analog Input Configuration	1 channel (3.2V maximum input)	V
Clock Frequency Range	80 /160	MHz
Integrated Flash Memory	4	MB
Physical Dimensions		
Longitudinal Axis	34.2	mm
Transverse Axis	25.6	mm
Unit Mass	10	g

The ESP32-CAM represents an advanced microcontroller variant integrating supplemental capabilities including Bluetooth 4.2 BR/EDR, Wi-Fi 802.11 b/g/n, a camera interface, and a microSD card slot. This module is predominantly employed in Internet of Things (IoT) applications necessitating visual data acquisition.[13]. Comparative analysis reveals a reduced complement of General-Purpose Input/Output (GPIO) terminals relative to the preceding ESP32-WROOM module, attributable to the internal allocation of significant pin resources for camera functionality and microSD interface operations. Furthermore, the design omits an onboard USB interface, necessitating alternative methodologies for programming data transmission from host computing devices. The ESP 32 CAM module has two sides in its module circuit. On the top, there is a camera module that can be disassembled and there is a micro SD that can be filled, as well as a flash as an additional light for the camera if needed. On the back of the module, there is an internal antenna, a connector for an external antenna, a male pin for I / O, and ESP 32 S as its IC chip.

a) Dual-core 32-bit LX6 microprocessor utilizing Xtensa architecture
b) Integrated 802.11 b/g/n wireless local area network (WLAN) connectivity
c) Bluetooth v4.2 implementation with Bluetooth Low Energy (BLE) support
d) Serial communication interfaces: Universal Asynchronous Receiver-Transmitter (UART), Serial Peripheral Interface (SPI), Inter-Integrated Circuit (I^2C), and Pulse-Width Modulation (PWM)
e) Maximum clock frequency: 160 MHz
f) Computational performance: 600 Dhrystone Million Instructions Per Second (DMIPS)
g) Volatile memory configuration: 520 KB Static Random-Access Memory (SRAM) supplemented with 4 MB Pseudo-Static RAM (PSRAM)
h) Wireless image transmission capability via Wi-Fi protocols
i) Multiple low-power consumption states for energy management
j) Remote firmware update functionality via Over-The-Air (OTA) methodology
k) Nine configurable General-Purpose Input/Output (GPIO) channels
l) Integrated light-emitting diode (LED) illumination unit for photographic applications
m) Embedded digital image acquisition subsystem.

F. MIT APP Inventor

MIT App Inventor constitutes an open-source, web-integrated development environment employing block-based programming paradigms to facilitate application construction for Android platforms. Originally established by Google and subsequently transferred to Massachusetts Institute of Technology (MIT) stewardship—resulting in its current nomenclature—this platform enables developers to create software through intuitive visual manipulatioN.[14].

Its graphical interface, architecturally analogous to the Scratch programming environment, features drag-and-drop functionality for assembling visual components into functional configurations. The system utilizes color-coded, puzzle-shaped code blocks categorized by computational domains including Logic, Control, Mathematical Operations, Text Processing, List Management, Color Manipulation, Variable Handling, and Procedural Definitions. Block here is a collection of code blocks in the form of a colorful puzzle-like graphic, where there are components of Logic, Control, Math, Text, Lists, Colors, Variables, and Procedures.

III. RESULTS AND DISCUSSION

A. The block diagram

The block diagram of the design of the fire extinguishing nozzle control system is shown in Figure 1:

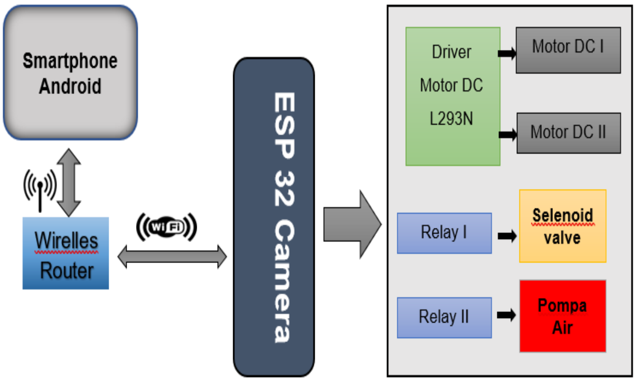

Figure. 1. Fire Nozzle Control System of Block Diagram

The nozzle mechanism for fire extinguishers is based on the direction control to the fire point, namely, the nozzle can be controlled to move at an elevation angle moving up and down 0° to 180 ° then the azimuth angle moving right and left 0° to 360°. The nozzle mechanism is designed using two DC gearbox motor drives with limits according to the vertical and horizontal x, and y axes that have been determined. The energy transfer system from the mechanical motion of the motor to the nozzle uses a reduction gear. In this study, the researcher created a mechanical design idea for a fire extinguisher nozzle using marine software with the concept of a series of nozzle pipes that will be assembled using two DC motors and equipped with gears and other supporting devices, namely solenoid valves and cameras and water pumps.

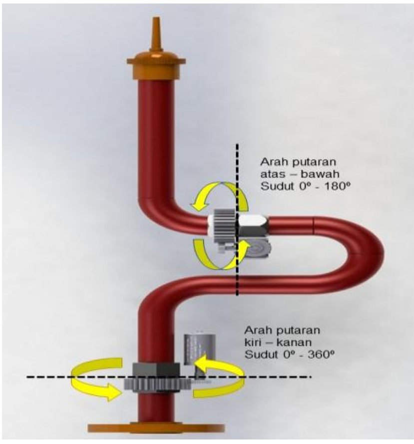

Figure. 2. Mechanism Model of Extinguishing Nozzle

Nozzle mechanism design to be able to describe a design that is made to be used as a reference for assembling the nozzle drive mechanism system as shown in figure 2. The force on the Nozzle arm is measured from an Elevation angle of 0º to move about 180º, the assumption of the heaviest force is 2.32 kg, and in the Azimuth direction of 0º to move about 180º, the assumption of the heaviest force is 2.01 kg with a fixed pull scale perpendicular to the direction of nozzle movement is taken from the largest force from various angles that have been measured. The weight of the force on the Nozzle in the Elevation direction is 22.7 N and the weight of the force on the nozzle in the Azimuth direction is 19.6 N.

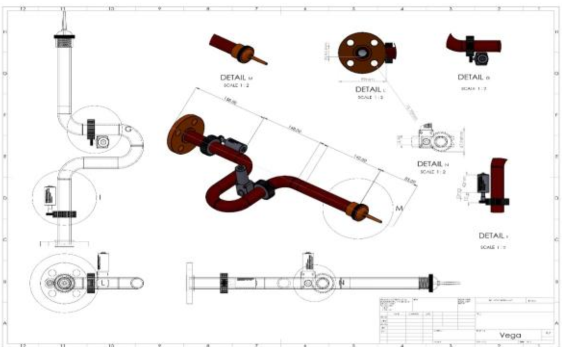

Figure 3. Nozzle Drive Mechanism Design

The calculation results when the nozzle arm forms a 90º angle, there is a moment of force (torque) of 0.590 Nm, and on the second gear, the torque is 0.509 Nm. This position is the position with the largest torque position, as evidenced by the results of the calculation analysis of various positions of the moving nozzle arm angles that can be shown in the figure 4 and figure 5.

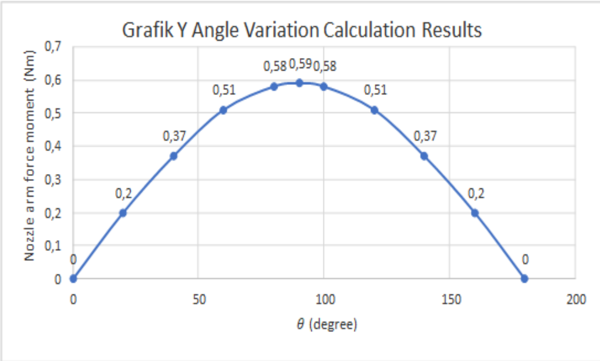

Figure. 4. Calculation graph on Elevation

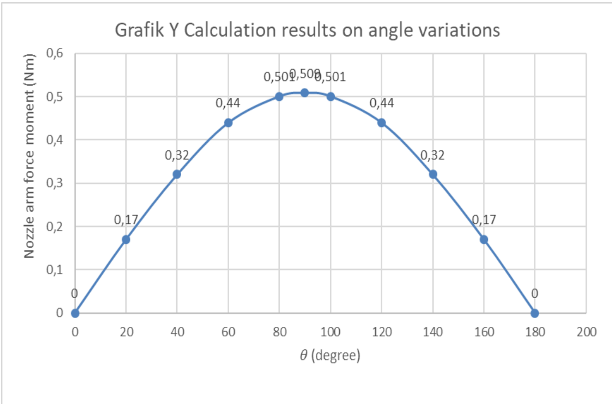

Figure. 5. Calculation graph in the azimuth direction

Based on the calculation results the desired first motor rotation speed of 3.3 rpm can rotate the arm as far as 180º for 9 seconds and on the second motor speed of 6.7 rpm rotates in the azimuth direction as far as 360º for 9 seconds. Calculation of DC gearbox motor with sufficient torque and speed to be able to move the fire extinguisher nozzle and with a minimalist shape so that it is efficiently installed on the fire extinguisher nozzle circuit mechanism. The DC motor type worm gearbox type JGY-370 is obtained, the specifications are known to be able to produce a torque of 8 kg. cm or 0.78 Nm and a rotation speed of 10 rpm voltage 12 V current 0.5 Ah This DC motor is used to rotate the fire extinguisher nozzle towards Elevation and while for the Azimuth direction, a DC gearbox motor with the type JYE MAW / JM400MA-3529 is selected with specifications that can produce a torque of 15 kg. cm or 1.47 Nm and a rotation speed of 15 rpm voltage 12 V current 0.8 Ah.

B. Analysis of Ratio, Speed , and Torque on Fire Nozzle Gear Mechanism

The gears used in the fire extinguisher nozzle mechanism with pinion gear specifications with several teeth of 16 with a pitch diameter of 26 mm and a large gear with several teeth of 33 with a pitch diameter of 52 mm. The following are gears installed in the fire extinguisher nozzle mechanism circuit, which can be seen in Figure 6.

Figure. 6. Fire Nozzle Gear Construction

C. Monitoring System Testing

The monitoring system is a system that is created based on the warning so that a display is needed to be able to see the value of the parameter, android monitoring by monitoring via an android device using Nodemcu Wemos D1 mini as a microcontroller, the parameter reading condition data will be sent to android via the firebase realtime database. On the Android device using the fire monitoring application will display the parameter values of each sensor which will provide notification information and activate the alarm if each sensor detects changes in temperature, smoke, and the presence of fire that exceeds the setpoint value

D. DHT 11 Sensor Testing

Experimental validation of the DHT-11 sensor is conducted to acquire ambient temperature and relative humidity metrics, with resultant parameter values visualized via an Android interface. This implementation simultaneously facilitates fire hazard assessment through algorithmic comparison against predefined threshold parameters programmed within the microcontroller environment.[15]. The primary objective of this sensor characterization is to quantify its operational sensitivity by establishing a percentage error metric derived from comparative analysis between experimentally observed values and reference ground-truth measurements. This discrepancy calculation serves as a critical performance indicator for the sensing apparatus.

TABLE 4.
DHT 11 SENSOR AND THERMOMETER CALIBRATION RESULTS

Detik	Client 1		Client 2		Client 3		Client 4		Thermomoter		error	error
	°C	%	°C	%	°C	%	°C	%	°C	%	°C	%
1	30	58	30	58	30	58	30	57	31	58	1	2
6	32	53	32	53	32	53	32	50	33	54	1	2
11	35	54	35	55	36	54	35	52	36	50	1	2
16	40	54	40	53	40	53	40	53	41	48	1	2
21	48	56	48	56	48	56	48	56	49	45	1	2
31	48	32	48	32	48	32	49	32	49	32	1	2
36	50	29	51	29	51	29	50	29	52	29	2	2
	40,4286	48	40,5714	48	40,7143	47,8571	40,5714	47	41,571	45,143	1,142857	2

Based on the results of the calibration process the table above, shows a comparison of the DHT-11 sensor with a digital thermometer by providing hot temperatures in the experiment at intervals of 5 seconds, so the average error is 1 - 2 ºC.

E. MQ-135 Smoke sensor testing

The MQ-135 smoke sensor test was conducted to determine the intensity of the smoke content in the form of PPM levels.[16,17].The main purpose of this sensor in the fire hazard monitoring system is to provide a warning alarm notification based on the smoke content in the air.[18]. Based on the ISPU Air Pollution Standard Index value set not to exceed 300 PPM, the author provides programming logic to the Arduino microcontroller if the MQ-135 sensor value produced exceeds 300 PPM, the warning notification will turn on the alarm and provide a notification on the Android.[19]. The results of this smoke sensor test can detect the thickness of the smoke so the test carried out aims to find out whether the MQ-135 sensor can function properly by providing different levels of smoke density. The results of this test are displayed on Android. The following are the data results from the MQ-135 sensor test.

In this research, 300 parts per million of smoke content was determined as an indicator of fire hazard. In the tests that have been carried out, the smoke content from the paper that has been burned was identified by the system that there was a fire hazard in the form of notifications and alarm sounds. From the results of the measurements that have been carried out, the maximum reading of the smoke content of paper burning was 416 PPM with a sensor reading distance of approximately 5 cm. In the actual test, the sensor reading distance to the smoke source varied from 1 meter to the maximum length of the room.

F. KY-026 Flame Sensor Testing

Testing of fire sensors on the early fire identification system using the KY-026 sensor and the Arduino Nano microcontroller, the test carried out aims to determine the distance of the intensity of the fire light received by the sensor.[20].

Testing this fire sensor uses a flame from a candle that is aligned, the test determines if fire is detected is a digital signal value of 1 which means (HIGH) fire is detected, and if no fire is detected then 0 (LOW.)[21]. The results of the fire sensor test using a candle flame aligned based on the difference in distance measured with a meter, the measurement starts from a distance of 10 cm to 100 cm with a distance difference of 10 cm. So the results are shown in Table 5.

TABLE. 5.
FIRE SENSOR TEST RESULTS BASED ON DISTANCE OF RECEIVED LIGHT

No	Range (Cm)	Digital Signal Out	Category
1	10	1	High
2	20	1	High
3	30	1	High
4	40	1	High
5	50	1	High
6	60	1	High
7	70	1	High
8	80	1	High
9	90	1	High
10	100	0	Low

G. Testing the Monitoring Unit Circuit with HC-11 Wireless Serial Data Communication

In this test, a series of fire identification systems from fire, temperature, and smoke sensors are combined to send data via serial communication from the HC-11 wireless module (Transceiver) to the receiver unit. The function of the HC-11 module is to send or receive serial data with a wireless network. In this monitoring system, there are 2 (two) series of tools, namely the identification unit series equipped with the HC-11 module to send Transceiver data and the Receiver data receiving unit shown in Figure 7.

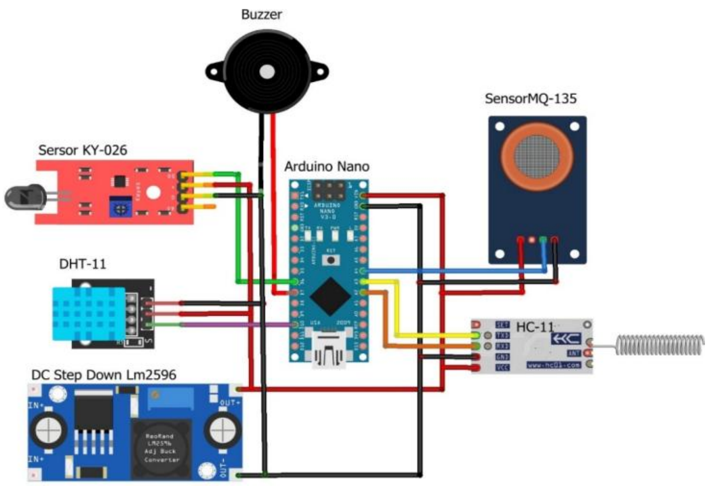

Figure. 7. Transceiver Identification Unit Circuit Schematic

H. Testing of the Extinguishing Nozzle Mechanism System

The testing process of the nozzle drive mechanism that has been made consists of testing the mechanical circuit and the fire extinguisher control electronics. The following is a picture of the design of the fire extinguisher nozzle drive mechanism that has been made, shown in Figure 8.

Figure. 8. Overall Nozzle Drive Mechanism

ESP 32 Cam microcontroller as the nozzle control center of several components, namely a camera to display video results in real-time, relay 1.2 as a control switch to activate the solenoid valve, SSC (Solid State Relay) also as a control switch to activate the water pump and IC L293D as a control direction of the DC motor rotation in the direction specified CW (Clockwise) or CCW (Counter-clockwise). Electronic circuit in the control system for the fire extinguishing nozzle drive mechanism which can be seen in figure 9.

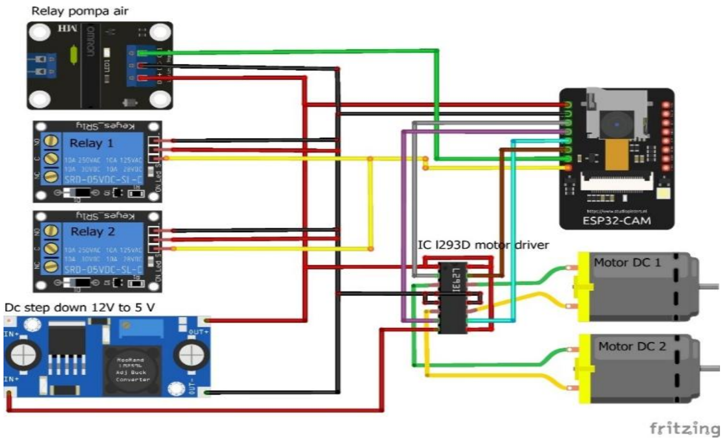

Figure 9. Fire Nozzle Mechanism Control Unit Circuit

Android device as a control and monitoring system connected to the wireless router network of the fire extinguisher nozzle. Furthermore, the user who is acting as the fire extinguisher nozzle controller opens the web browser on Android by entering the specified IP address. The results of testing the fire extinguisher nozzle drive mechanism circuit, the nozzle can move vertically and horizontally according to the specified rotation angle, namely in the elevation direction of 0 ° to 180° and in the azimuth direction of 0 ° to 360 ° smoothly, the control system for controlling the water pump and solenoid valve works well, the video display results are visible on the android screen, assumed with the test distance of the android control to the nozzle, which is 50 meters in outdoor places more than 50 meters, the wireless network is unstable and causes the video display on the android to stutter. In the water spray shooting range test, the nozzle can spray water as far as 12 meters by looking at the pressure parameter of 2.5 bar assuming the specified water pump.

IV. CONCLUSION

The design of the nozzle drive mechanism that can be operated properly in vertical and horizontal directions was obtained. Development of a monitoring system and control of a fire extinguishing nozzle that can be moved to the fire source via an Android smartphone via a wireless network using the ESP 32 Microcontroller properly. With a connection time interval from Android to the nozzle control mechanism of 5 seconds for a control distance of 50 meters. Development of a fire hazard detection system using fire, temperature, and smoke sensors. The parameter data for each sensor was successfully sent from the Arduino client Microcontroller to the Wemos D1 mini microcontroller. After that, the data was received by the Firebase server via a wifi network with a time interval speed of 10 seconds. Based on the nozzle system design trial, a fire extinguishing nozzle design was produced that was able to move properly to detect fires. Monitoring fire sources that have the potential to cause fires. And extinguishing fires by spraying water media with an android remote control. The monitoring and control system using Android can display data parameter values in real-time on the Android smartphone fire monitor application. Based on the data that has been tested with the specified water pump, the nozzle can spray water as far as 10m with a pressure of 2.5 bar. Suggestions for further research development, the nozzle drive mechanism circuit is given protection from fire-resistant materials to reduce damage to the mechanical and electronic circuits due to heat from fire and the development of the nozzle mechanism can be developed automatically so that it can move to the fire point and extinguish the fire itself.

ACKNOWLEDGMENTS

The authors extend appreciation to Sekolah Tinggi Teknologi Angkatan Laut, Surabaya, Indonesia, for their substantive advisory support and laboratory infrastructure..

REFERENCES

[1] W. Ju, G. Su, L. Wu, and P. O. Oforiwaa, *The 3D-Dynamic Fire Risk Evaluation Method of Modern Logistics Warehouses: A Modified Gustav Method*. 2023. doi: 10.1007/s10694-023-01367-x.

[2] W. Ju, G. Su, and L. Wu, “Study on Logistics Warehouse Dynamic Fire Risk Assessment Based on Gustav Method,” no. Isaic 2022, pp. 110–114, 2023, doi: 10.5220/0011905900003612.

[3] L. Kátai-Urbán, Z. Cimer, and É. E. Lublóy, “Examination of the Fire Resistance of Construction Materials from Beams in Chemical Warehouses Dealing with Flammable Dangerous Substances,” *Fire*, vol. 6, no. 8, 2023, doi: 10.3390/fire6080293.

[4] Y. Hulida and V. Sharii, “Ensuring the Permissible Value of Fire Risk in Open Warehouses Production Facilities,” *Fire Saf.*, vol. 36, pp. 38–43, 2020, doi: 10.32447/20786662.36.2020.03.

[5] S. J. Pyne, “Squaring the triangle: fire at San Carlos,” pp. 1–9, 1995.

[6] NFPA, “First Revision No. 36-NFPA 914-2021 [Detail],” no. 36, pp. 1–52, 2021, [Online]. Available: https://www.nfpa.org/api/files?path=%2Ffiles%2FAboutTheCodes%2F914%2F914_F2022_CUL_AAA_FD_FRStatements.pdf

[7] G. M. Debele and X. Qian, “Automatic Room Temperature Control System Using Arduino UNO R3 and DHT11 Sensor,” *2020 17th Int. Comput. Conf. Wavelet Act. Media Technol. Inf. Process. ICCWAMTIP 2020*, no. February, pp. 428–432, 2020, doi 10.1109/ICCWAMTIP51612.2020.9317307.

[8] P. Kamweru, O. Ochieng Robinson, K. Paul Kuria, and M. Mutava Gabriel, “Monitoring Temperature and Humidity using Arduino Nano and Module-DHT11 Sensor with Real Time DS3231 Data Logger and LCD Display Ultraviolet-Irradiated Mushrooms View project Solid Waste Management View project Monitoring Temperature and Humidity using Ar,” vol. 9, no. 12, pp. 416–422, 2020, [Online]. Available: https://www.researchgate.net/publication/347950991

[9] A. D. Saputro and M. Yantidewi, “Analysis of Air Temperature and Humidity in Kedunggalar against BMKG Data Based on DHT11 Sensor,” *J. Phys. Conf. Ser.*, vol. 1805, no. 1, 2021, doi: 10.1088/1742-6596/1805/1/012045.

[10] E. S. Mudofar Baehaqi, Abdul Rosyid, Agus Siswanto, “Pengujian Performa Sensor DHT11 dan DS18B20 Sebagai Sensor Suhu Ruang Server,” *Mestro J. Ilm.*, vol. 2, no. 02, pp. 6–12, 2023.

[11] A. S. Ismailov and Z. B. Jo‘rayev, “Study of Arduino microcontroller board,” *"Science Educ. Sci. J.*, vol. 3, no. 3, pp. 172–179, 2022, [Online]. Available: www.openscience.uz

[12] A. Syafrudin, J. Jackson, and Y. Afrida, “Study On Implementation Of Watergate Control System From Manual To Automatic Based Arduino Nano ATmega328,” *Emerg. Inf. Sci. Technol.*, vol. 5, no. 1, pp. 30–35, 2024, doi: 10.18196/eist.v5i1.22424.

[13] S. A. Arrahma and R. Mukhaiyar, “Pengujian Esp32-Cam Berbasis Mikrokontroler ESP32,” *JTEIN J. Tek. Elektro Indones.*, vol. 4, no. 1, pp. 60–66, 2023.

[14] A. Top and M. Gökbulut, “Android Application Design with MIT App Inventor for Bluetooth Based Mobile Robot Control,” *Wirel. Pers. Commun.*, vol. 126, no. 2, pp. 1403–1429, 2022, doi: 10.1007/s11277-022-09797-6.

[15] P. Dani and P. Adi, “IOTA (Internet of Things and Artificial Intelegence) Journal ZigBee Test Performance with DHT11 Temperature sensor,” *IOTA (Internet Things Artif. Intelegence) J.*, vol. 1, no. 1, p. 2021, 2021.

[16] S. Usha rani, S. Usha Rani, S. Rajarajeswari, J. George Jaimon, and R. Ravichandran, “Real-Time Air Quality Monitoring System Using Mq135 and Thingsboard Journal of Critical Reviews Real-Time Air Quality Monitoring System Using Mq135 and Thingsboard,” vol. 7, no. December 2020, p. 2020, 2021, [Online]. Available: https://www.researchgate.net/publication/347946855

[17] Y. A. Janitra, A. Aditya, H. N. Hadi, D. A. P., and S. Widodo, “The Development of Automatic Cigarette Smoke Detection System Using Ta12-100 and Mq-135 Sensors,” *J. Techno Nusa Mandiri*, vol. 21, no. 1, pp. 29–36, 2024, doi: 10.33480/techno.v21i1.5294.

[18] A. R. Suharto, A. Henderson, and S. Supriyadi, “Characteristics of the MQ-135 Sensor for Testing Medium Speed Ship Engine Exhaust Gases,” *Adv. Sustain. Sci. Eng. Technol.*, vol. 6, no. 3, p. 0240310, 2024, doi: 10.26877/asset.v6i3.615.

[19] P. Alusvigayana, A. S. Yuwono, M. Yani, and S. Syarwan, “Evaluation of the Air Pollutant Standard Index (ISPU) parameter concentration limits in industrial estates on Java Island,” *J. Pengelolaan Sumber. Alam dan Lingkung.*, vol. 13, no. 4, pp. 537–548, 2023, doi: 10.29244/jpsl.13.4.537-548.

[20] G. Dizayn-, “Possibilities Of Using The Ky-026 Fire Sensor In Fire Detection,” pp. 2023–2025, 2024.

[21] A. Fire, E. Simulation, U. Arduino, and U. F. Sensor, “Automatic Fire Extinguisher Simulation Using Arduino Uno-Based Flame Sensor,” *E-Komtek*, vol. 7, no. 2, pp. 302–310, 2023.