Vol 11 No. 1 (2026) 69-78 ISSN (Online) : 2502-0943

Jurnal Katalisator

DESIGN OF A CHAIN-BASED RASPBERRY PI 4 ROBOT FOR SEARCHING FOR VICTIMS IN RUBBERRY

Arya Wijaya, Sartika Anori, Titi Sriwahyuni, Rido Putra.
Electronic Engineering Education, Padang State University, Padang City, Indonesia

Article details

Received : 4 June 2026
Revised : 18 Agustus 2026
Published : 1 September 2026

Key Word

Raspberry Pi 4
Search and Rescue Robot
Chain Wheel Robot

Corresponding Author

Name : Arya Wijaya
Affiliation : Universitas Negri Padang
E-mail :Rayentom986@gmail.com

Abstract- Indonesia is a country with a high level of natural disasters, especially earthquakes that cause many building collapses and cause many casualties. The process of searching for disaster victims in the rubble area is high risk due to the unstable environmental conditions, narrow and the possibility of dangerous gases spreading. This study aims to design and build a Raspberry Pi 4-based tracked wheel robot as a medium for exploration and search for victims in the rubble area. The robot uses a tracked wheel drive system controlled by a Raspberry Pi 4 with Wi-Fi-based wireless communication. The system is equipped with a Raspberry Pi camera for real-time visual monitoring, an ultrasonic sensor as an obstacle detector, a sound sensor to detect the possible presence of victims, and an MQ-8 gas sensor to detect dangerous gases. The research method uses a prototype method consisting of needs analysis, design, implementation, testing, and system evaluation. The results show that the robot is able to move in a simulated rubble area, conduct real-time visual monitoring, detect obstacles, detect sounds, and identify the presence of gas so that it can assist the initial observation process before the rescue team enters the disaster site.

1. Introduction

Geographically, Indonesia lies on the Ring of Fire, a region surrounded by numerous active volcanoes. Furthermore, Indonesia lies along three tectonic plate lines, making it prone to natural disasters (Arifin, 2016). Earthquakes are one of the most common natural disasters in Indonesia. These impacts include building collapses, leading to numerous casualties and endangering lives (Sausan et al., 2017).

The process of searching for victims amidst the rubble is also very risky for the rescue team on duty. Confined spaces, obstructing debris, limited visibility, unstable building structures, and the potential presence of hazardous materials make direct human access limited and dangerous. These conditions faced by rescue teams pose significant obstacles that can delay the rescue process. These delays can endanger the safety of victims still buried within the rubble (Fandidarma et al., 2021).

http://doi.org/10.22216/jk.v5i2.5717
Published by LLDIKTI Wilayah X

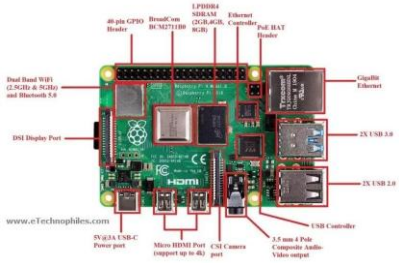
Jurnal Katalisator Vol 11 No. 1 (2026) 69-78

2. Hardware

A. Raspberry pi 4

Ghael et al. (2020) explain that the Raspberry Pi is a small version of a modern computer capable of performing tasks effectively. The Pi also allows users to access the internet, write and send emails, and so on. The Raspberry Pi supports various programming languages, including Python, C, C++, BASIC, Pearl, and Ruby.

In the robot design process in this study, the researcher used the Raspberry Pi 4 type. The Pi 4 type provides a higher level of computing and storage capacity than the Pi 3 type, and has the advantage of a cheaper price and more efficient use of electricity compared to the latest type, namely the Raspberry Pi 5.



The latest specifications of the Raspberry Pi 4 are as follows:

- Processor: Broadcom BCM2711, Quad core Cortex-A72 (ARM v8) 64-bit SoC @ 1.8GHz
- RAM: 1GB, 2GB, 4GB, 8GB LPDDR4-3200 SDRAM (depending on model)
- Bluetooth: Bluetooth 5.0, BLE
- Wi-Fi: 2.4 GHz and 5.0 GHz IEEE 802.11ac wireless
- USB: 2 USB 3.0 ports; 2 USB 2.0 ports
- Ethernet: Gigabit Ethernet
- HDMI: 2 × micro-HDMI ports (up to 4kp60 supported)
- Storage: MicroSD Card Slot
- Power Supply: 5V DC 3A USB Type C Power (Recommended)
- Dimensions: 85.6m m × 56.5mm

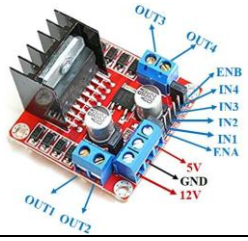
B. Motor Driver L298N

The L298n motor drive can control the direction and speed of two DC motors. The L298n has pins that are I/O pins for the two DC motors, a ground pin, a VCC pin, and a 5V pin that can be used for either input or output. (Maung et al., 2018)

The L298N motor drive can control the robot's forward and backward movement by regulating the voltage applied to the DC motor.

http://doi.org/10.22216/jk.v5i2.5717
Published by LLDIKTI Wilayah X

Jurnal Katalisator Vol 11 No. 1 (2026) 69-78



Out 1: Motor A lead out
Out 2: Motor A lead out
Out 3: Motor B lead out
Out 4: Motor B lead out
GND: Ground
5V: 5V input
ENA: Enables PWM signal for Motor A
IN1: Enable Motor A
IN2: Enable Motor A
IN3: Enable Motor B
IN4: Enable Motor B
ENB: Enables PWM signal for Motor B

C. Motor DC

A DC motor is an electric motor that converts electrical energy into mechanical energy using a direct current (DC). DC motors function based on their ability to rotate at high speeds and high starting torque.

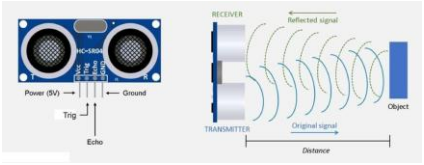
This motor requires DC voltage to operate. It's commonly used in electronic devices that use a DC power source, such as computer cooling fans and remote control cars. DC motors produce a certain number of revolutions per minute (RPM) and can rotate clockwise or counterclockwise, depending on the polarity of the supplied power.

D. Ultrasonic Sensor

An ultrasonic sensor is a sensor that uses ultrasonic waves. Ultrasonic waves are commonly used to detect the presence of an object by estimating the distance between the sensor and the object. This sensor functions to convert physical quantities (sound) into electrical quantities and vice versa. Ultrasonic waves have a frequency of 20,000 Hz.

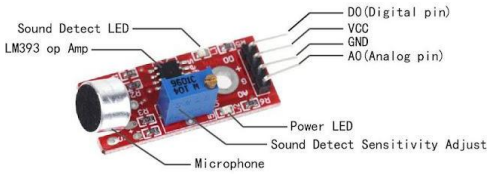
http://doi.org/10.22216/jk.v5i2.5717
Published by LLDIKTI Wilayah X

Jurnal Katalisator Vol 11 No. 1 (2026) 69-78



E. Sound Sensor

A sound sensor is a sensor that captures sound waves and converts them into electrical signals. The simplest form of a sound detector sensor is a microphone element as the primary input component. When sound waves reach the microphone's diaphragm, they cause small changes in voltage, which can then be amplified and processed by the circuit.



F. Sensor Gas

A gas sensor is a device that measures and detects the presence of various gases in the air. These sensors are widely used to detect LPG leaks in kitchens, monitor air pollution, and detect hazardous gases in industrial areas by converting gas concentrations into electrical signals.

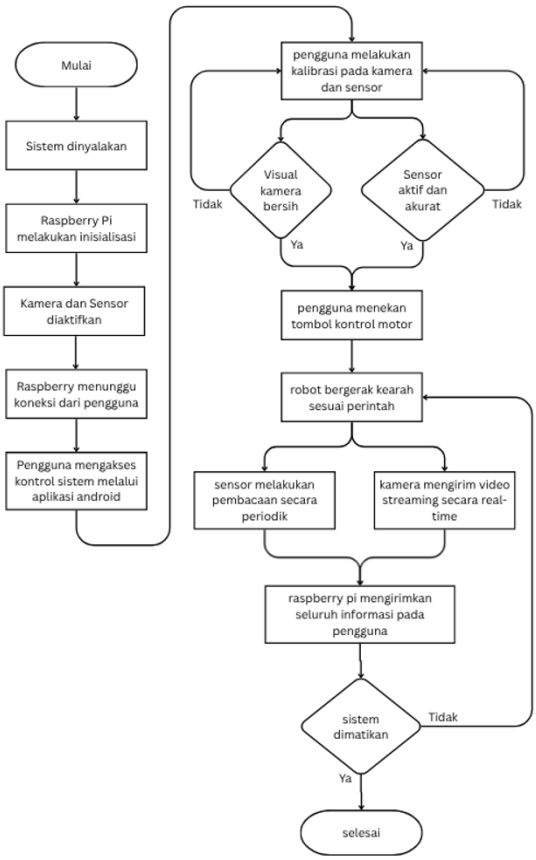
G. Tracked Wheel Robot

Wheeled robots are divided into several types, each with its own uses and applications depending on needs and objectives. One example is the tracked wheeled robot (*Tracked Wheel Robot*). The tracked wheel robot is equipped with two chain wheels that are able to distribute the robot's load evenly, providing high stability to the robot. The grip of the chain wheels helps prevent the robot from slipping easily on slippery terrain. The robot's motion system uses two separate DC motors, providing both wheels with independent driving power, giving the robot high maneuverability so that the robot does not easily get stuck in narrow areas.

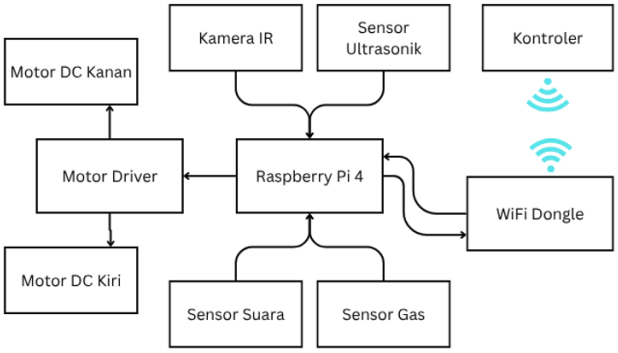
3. System Plan

The system designed in this research is a tracked wheel robot (*tracked wheeled robot*) which is controlled wirelessly using a Raspberry Pi 4 as the main controller. The robot is equipped with an IR camera for real-time infrared visual monitoring and various sensors to provide information on the condition of the area around the robot.

http://doi.org/10.22216/jk.v5i2.5717
Published by LLDIKTI Wilayah X



The planning of the tool is made in the form of a block diagram. Each block or sub-system has its own function, which will then be combined into a complete tool, and can work according to the expected purpose.



The software is designed to control the entire robot system using the Raspberry Pi 4 as the main controller. The system was developed using the Python programming language, as it is compatible with the Raspberry Pi OS operating system and supports various libraries for GPIO control, camera control, and network communication.

The software has several main functions, namely:

http://doi.org/10.22216/jk.v5i2.5717
Published by LLDIKTI Wilayah X

1. Control the movement of DC motors (forward, backward, turn right, turn left, stop)
2. Reading data from sensors
3. Manage video streaming from cameras in real-time
4. Set up wireless communication between the robot and the user.
5. Provides a control interface via an android application

Motor control system design

The motor is controlled using the differential steering method.

Table 2 differential steering

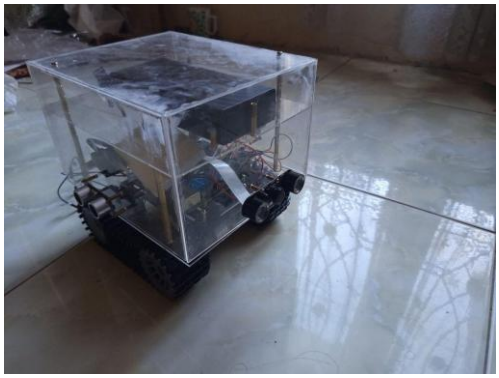
IN1	IN2	IN3	IN4	Robot Movement
LOW	LOW	LOW	LOW	Stop
HIGH	LOW	HIGH	LOW	Proceed
LOW	HIGH	LOW	HIGH	Defeat
HIGH	LOW	LOW	HIGH	Turn

Control is done via the Raspberry Pi GPIO pins connected to the motor driver module.

4. Results and Discussion

Hardware Design Results

The hardware design results represent the physical design, which has been assembled until the drone is ready for operation. A complete view of the tracked robot for industrial disaster area exploration can be seen in the image.



The basic frame supporting the wheels is made of iron with a length of 180mm and a width of 75mm and the component casing located above the base frame is made of acrylic with a plastic chain wheel as a driving tool.

http://doi.org/10.22216/jk.v5i2.5717
Published by LLDIKTI Wilayah X

Jurnal Katalisator Vol 11 No. 1 (2026) 69-78

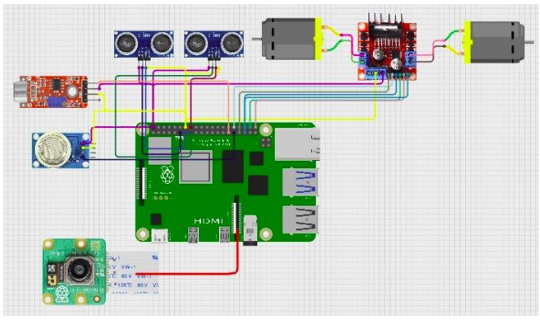
The position of the components and electronic circuits is positioned inside the casing, under the frame, on the left, right and front of the acrylic casing. The Raspberry Pi as the center of the entire system is placed right above the iron frame and the power bank as the robot's power source is placed above the raspberry bordered by an acrylic layer.

The design of a tracked robot allows it to operate via a wirelessly connected control device. This process requires the integration of hardware and software with appropriate communication protocols to ensure compatibility and efficiency between components. The following are the system integration steps:

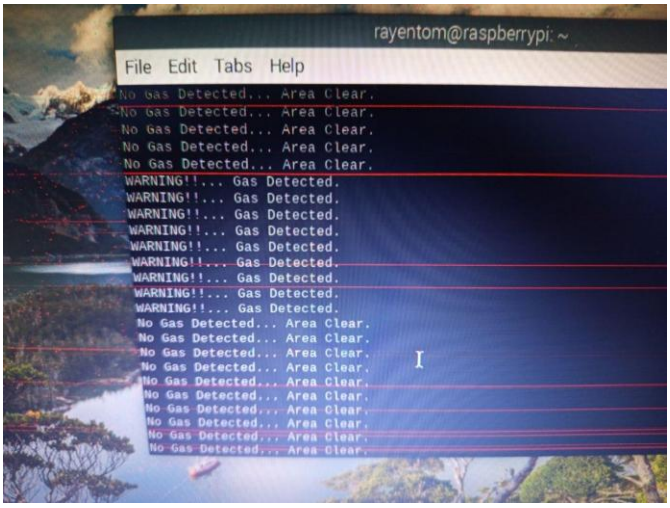
System network

The robotic system is designed to efficiently and safely explore disaster-affected industrial areas. The system is equipped with additional components such as ultrasonic sensors, sound sensors, gas sensors, and IR cameras, all working in a coordinated manner.

The control system circuit can be seen in the following picture:



Gas Sensor Test Results



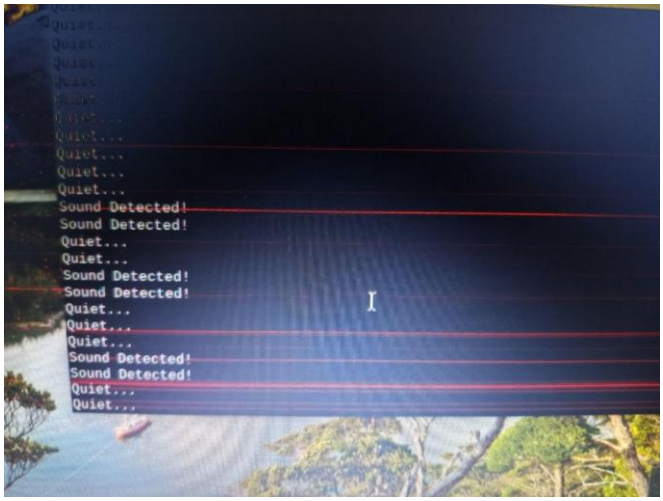
Distance of sensor from gas source	The presence of gas
2 cm	Detected very high
4 cm	High gas detected
6 cm	Gas detected

http://doi.org/10.22216/jk.v5i2.5717
Published by LLDIKTI Wilayah X

Jurnal Katalisator Vol 11 No. 1 (2026) 69-78

8 cm	Gas is starting to be detected
10 cm	Detected low
20 cm	Not detected

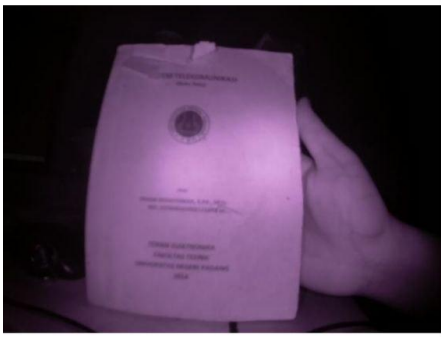
Sound Sensor Test Results



Distance of sound source	information
5 cm	The detected sound is very high
10 cm	High sound detected
15 cm	Sound detected
20 cm	Moderate sound detected
30 cm	Sound is almost undetectable
40 cm	Sound is not detected.

IR Night Vision Camera Capture Results

http://doi.org/10.22216/jk.v5i2.5717
Published by LLDIKTI Wilayah X



Conclusion

Based on the research results, it can be concluded that:

1. A Raspberry Pi 4-based tracked wheel robot was successfully designed and implemented as a prototype victim search robot.
2. The tracked wheel system provides good mobility on simulated rubble terrain.
3. The Raspberry Pi 4 is capable of integrating motors, cameras, and sensors into one system that works in real-time.
4. Ultrasonic sensors, sound sensors, and gas sensors are able to provide environmental condition information to operators.
5. The Wi-Fi-based communication system allows the robot to be controlled from a safe location, thus assisting in the initial observation process before rescue teams enter the disaster area.

Bibliography

Arifin, R. W. (2016). Utilization of information technology in web-based natural disaster management in Indonesia.*Bina Insani ICT Journal*, *3*(1), 1–6. https://ejournal-binainsani.ac.id/index.php/BIICT/article/view/771

Sausan, S., Sakti, B., Leo, H., Yuliani, A., Permatasari, I., Rahman, A., & Syaryadhi, M. (2017). Robot Pointer as a Guide for SAR Teams to Facilitate the Search for Earthquake Disaster Victims.*Journal of Electrical Engineering*, *13*(2), 112. https://doi.org/10.17529/jre.v13i2.7761

Fandidarma, B., Laksono, R. D., & Pamungkas, K. W. B. (2021). Design and Construction of an IoT-based Remote Control Area Monitoring Car using ESP 32 Cam.*Jurnal ELECTRA: Electrical Engineering Articles*, *2*(1), 31–38. https://pdfs.semanticscholar.org/c64d/6dbda3bda1f5cf47c50cd0a43da85c345f42.pdf

Ghael, H. D., Solanki, L., & Sahu, G. (2020). A review paper on raspberry pi and its applications. *International Journal of Advances in Engineering and Management (IJAEM)*, *2*(12), 4. https://www.researchgate.net/profile/Hirak-Ghael/publication/348993428_A_Review_Paper_on_Raspberry_Pi_and_its_Applications/links/601a350245851589397a54e9/A-Review-Paper-on-Raspberry-Pi-and-its-Applications.pdf

Maung, M. M., Latt, M. M., & Nwe, C. M. (2018). DC Motor Angular Position Control using PID Controller with Friction Compensation. *International Journal of Scientific and Research Publications (IJSRP)*, *8*(11). https://doi.org/10.29322/IJSRP.8.11.2018.p8321

Raspberry Pi 4 Model B specifications – Raspberry Pi. (n.d.). Retrieved May 16, 2026, from https://www.raspberrypi.com/products/raspberry-pi-4-model-b/specifications/

http://doi.org/10.22216/jk.v5i2.5717
Published by LLDIKTI Wilayah X

Jurnal Katalisator Vol 11 No. 1 (2026) 69-78

Dharmawan, H. A., Press, U. B., & Media, U. B. (2017).*Microcontrollers: Basic and Practical Concepts*. Brawijaya University Press. https://books.google.co.id/books?id=GQJODwAAQBAJ

Engelberger, J. F. (1983). *Robotics in Practice* (1st ed.). Springer US. https://doi.org/10.1007/978-1-4684-7120-5

http://doi.org/10.22216/jk.v5i2.5717
Published by LLDIKTI Wilayah X