# ABSTRAK

## RANCANG BANGUN SISTEM PENDINGIN UNTUK KOMPONEN ELEKTRIK PADA KAPAL TANPA AWAK MENGGUNAKAN PELTIER DENGAN METODE LOGIKA *FUZZY*

**Oleh**

**JENTRIO TAMBA HALOMOAN PURBA**

Kapal tanpa awak memiliki keterbatasan dalam pengendalian suhu dan kelembaban pada komponen elektrik, yang dapat menimbulkan kerusakan serta menurunkan keandalan sistem. Penelitian ini merancang dan membengun sistem pendingin terintegrasi berbasis modul Peltier TEC12706 yang dikendalikan mikrokontroler ESP32 menggunakan metode Logika *Fuzzy* Sugeno. Sistem dirancang untuk mengatur pendinginan secara adaptif berdasarkan data sensor suhu dan kelembaban DHT22. Mekanisme kendali dilakukan melalui *Pulse Width Modulation* (PWM) 8 bit pada frekuensi 5 KHz untuk mengatur tegangan peltier serta pengendalian kipas dan pompa melalui *relay*. Integrasi *Internet of Things* (IoT) menggunakan protokol *Message Queue Telemetry Transport* (MQTT) dan dashboard *Node Red* memungkinkan pemantauan suhu, kelembaban, dan status aktuator secara *real time*. Hasil pengujian menunjukkan bahwa sistem mampu menurunkan *duty cycle* PWM Peltier dari 100% hingga 1.18% ketika suhu mendekati *set point*, serta menyesuaikan dari 50.2% menjadi 25.1% sesuai variasi suhu dan kelembaban, sementara kipas dan pompa tetap beroperasi. Uji komunikasi IoT menunjukkan keandalan transmisi data dengan waktu 0 detik antara mikrokontroler, MQTT, *Node Red*, mengindikasikan keandalan komunikasi. Implementasi sistem ini diharapkan dapat meningkatkan keandalan dan performa kapal tanpa awak melalui pengelolaan komponen listrik yang efektif, hemat energi, serta, termonitor dari jarak jauh. Dengan demikian, sistem pendingin berbasis Peltier dan Logika *Fuzzy* Sugeno terbukti efektif menjaga kestabilan suhu dan kelembaban komponen elektrik sekaligus meningkatkan performa, efisiensi energi, dan keandalan operasional kapan tanpa awak.

**Kata Kunci**: Kapal Tanpa Awak, Peltier TEC12706, ESP32, Logika *Fuzzy* Sugeno, dan *Internet of Things.*

## *ABSTRACT*

## *DESIGN AND DEVELOPMENT OF A COOLING SYSTEM FOR ELECTRICAL COMPONENTS IN UNMANNED SURFACE VESSELS UTILIZING PELTIER WITH A FUZZY LOGIC METHOD*

***By***

**JENTRIO TAMBA HALOMOAN PURBA**

*Unmanned surface vessels have limitations in controlling the temperature and humidity of electrical components, which can lead to damage and reduced system reliability. This research designs and builds an integrated cooling system based on the TEC12706 Peltier module, controlled by an ESP32 microcontroller using the Fuzzy Logic Sugeno method. The system is designed to regulate cooling adaptively based on data from the DHT22 temperature and humidity sensor. The control mechanism is performed through 8-bit Pulse Width Modulation (PWM) at a frequency of 5KHz to regulate the Peltier voltage and control the fan and pump via a relay. Internet of Things (IoT) integration using the Message Queue Telemetry Transport (MQTT) protocol and a Node-Red dashboard enables real-time monitoring of temperature, humidity, and actuator status. The test results show that the system is able to reduce the Peltier PWM duty cycle from 100% to 1.18% when the temperature approaches the set point, and adjust from 50.2% to 25.1% according to temperature and humidity variations, while the fan and pump remain operational. The IoT communication test demonstrates reliable data transmission with a 0-second time delay between the microcontroller, MQTT, and Node-Red, indicating excellent communication reliability. The implementation of this system is expected to enhance the reliability and performance of unmanned vessels through effective and energy-efficient management of electrical components, along with remote monitoring. Thus, the cooling system based on Peltier and Fuzzy Logic Sugeno proves effective in maintaining the stability of electrical component temperature and humidity while improving performance, energy efficiency, and operational reliability of unmanned surface vessels.*



***Keywords**: Unmanned Surface Vessels, Peltier TEC12706, ESP32, Fuzzy Logic Sugeno, and Internet of Things.*