DESIGN AND DEVELOPMENT OF AN AIRCRAFT PARKING DETECTOR (BLOCK ON/OFF) TO DETERMINE THE USAGE TIME OF PARKING STANDS AT PT. ANGKASA PURA I JUANDA SURABAYA

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ABSTRACT
This research focuses on the design and development of an aircraft parking detector (Block On/Off) aimed at determining the usage time of parking stands at PT. Angkasa Pura I Juanda Surabaya. Utilizing ultrasonic sensors and the NodeMCU ESP32, the system is engineered to detect the presence of aircraft in real-time. The primary goal is to enhance operational efficiency and management at the airport by providing immediate and accurate information regarding the usage of parking stands. The system's design ensures high accuracy in aircraft detection, enabling quick and precise data dissemination. The development process involved extensive testing to ensure the system's reliability and effectiveness. Results indicate that the parking detector performs well under various conditions, maintaining consistent accuracy in real-time detection. This innovative approach to parking management not only optimizes the use of parking stands but also contributes to smoother airport operations, reducing delays and improving overall service quality. The integration of this technology at PT. Angkasa Pura I Juanda Surabaya showcases a significant step forward in leveraging modern technology for better airport management.

Keywords: Design, Development, Aircraft Parking Detector, PT. Angkasa Pura I Juanda

1. INTRODUCTION

Juanda Airport in Surabaya is one of the busiest airports in Indonesia, with steadily increasing air traffic over time. Along with this growth, Juanda Airport is also faced with the demand to maintain high levels of service for passengers and airlines. Timely and efficient aircraft parking time determination is crucial to ensure that these aircraft can operate smoothly without disrupting flight schedules. The increase in the number of aircraft entering and exiting this airport necessitates the optimization of apron and aircraft parking stand usage.

According to Law No. 1 of 2009 on Aviation, an airport is an area on land and/or water with specific boundaries used as a place for aircraft to land and take off, embark and disembark passengers, load and unload goods, and facilitate intra and intermodal transportation, equipped with flight safety and security facilities, as well as basic and supporting facilities.

The apron is an area at the airport used for parking, loading and unloading, and aircraft maintenance. Efficient and structured use of the apron can help enhance the capacity and operational effectiveness of the airport. Determining aircraft parking stand time is a key factor in managing aircraft arrival and departure schedules. By accurately estimating parking stand time, airport management can optimize resource usage, such as apron utilization, workforce, and fuel.

Despite the increase in the number of aircraft operating at this airport, infrastructure improvements such as the addition of aprons or aircraft parking stands do not necessarily keep pace with this growth. This poses challenges in managing the limited apron capacity more effectively, necessitating smart solutions to optimize the use of existing space.

Currently, the determination of aircraft parking stand time is still done manually or using suboptimal systems. This can cause delays, congestion, and uncertainty in airport operations. The development of an aircraft parking detector system (block on/off) using advanced technology such as sensors, IoT (Internet of Things), and design can be an effective solution to these problems. This system can help detect aircraft arrivals and departures automatically, enabling airport management to manage the apron more efficiently.

The implementation of an aircraft parking detection system at Juanda Airport in Surabaya is expected to provide benefits such as increased operational efficiency, reduced flight delays, and enhanced customer satisfaction. Additionally, the use of this technology can also improve the safety and security levels of airport operations.

From the above explanation, the author intends to design an aircraft parking detector (block on/off) to determine the usage time of parking stands at PT. Angkasa Pura I Juanda Surabaya, which can help Juanda Airport management determine the usage time of aircraft parking stands located on the apron.

2. METHOD

The research method used in this study is the development of the waterfall method. The waterfall method is a systematic and sequential information system development model.

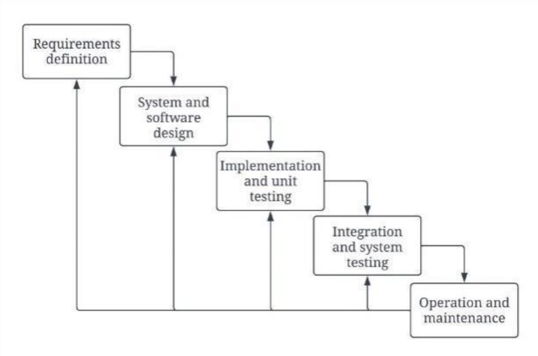

Figure 1. Waterfall Method

The waterfall method consists of the following stages (Sommerville, 2011):

2.1. Requirements analysis and definition

The system services, constraints, and goals are established through consultation with users, which are then defined in detail and serve as the system specification.

2.2 System and software design

The system design phase allocates the requirements of both hardware and software by creating an overall system architecture. Software design involves identifying and describing the fundamental abstractions of the software system and their relationships.

2.3 Implementation and unit testing

In this phase, the software design is realized as a series of programs or program units. Testing involves verifying that each unit meets its specifications.

2.4 Integration and system testing

Individual program units or programs are integrated and tested as a complete system to ensure that they meet the software requirements. After testing, the software can be delivered to the customer.

2.5 Operation and maintenance

Typically (though not always), this is the longest phase. The system is installed and used in a real environment. Maintenance involves correcting errors that were not found in previous stages, improving the implementation of system units, and enhancing system services as new requirements emerge.

3. RESULTS AND DISCUSSION

3.1 Parking Detector Design

The design of the Parking Detector (Block On/Off) involves several key components, including the NodeMCU ESP32 and Ultrasonic Sensor HC-SR04. The initial step in the design process is creating a wiring diagram that connects the components appropriately.

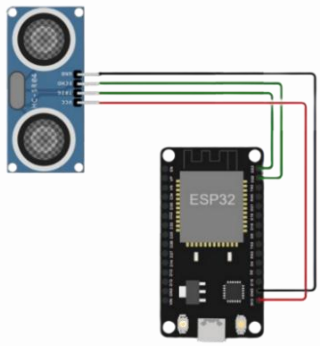

Figure 2. Wiring Diagram Used In The System

The NodeMCU ESP32 serves as the main controller, interfacing with the ultrasonic sensor to detect the presence of an aircraft. The sensor continuously sends ultrasonic waves, which reflect back upon hitting an object (the aircraft). The time taken for the waves to return is used to calculate the distance, thereby determining whether the parking stand is occupied.

The design process of the Parking Detector was iterative, involving several rounds of testing and modifications. Initially, the sensor's placement was crucial to ensure accurate detection. The ultrasonic sensor needed to be positioned at a height that allowed it to detect various types of aircraft reliably.

Figure 3. Actual Setup of The Sensor and Nodemcu ESP32 On A Mock-Up Aircraft

The placement and angle of the sensor were optimized through trial and error to achieve the best detection range and accuracy. Additionally, the NodeMCU ESP32 was programmed to handle noise and fluctuations in sensor readings, ensuring that only valid detections were logged.

3.2 Working Principle of Parking Detector

The principle of operation for the Parking Detector is based on the time-of-flight measurement of ultrasonic waves. When an aircraft enters the parking stand, the ultrasonic sensor detects the change in distance and signals the NodeMCU ESP32. This information is then processed and sent to a central server, where the data is logged and displayed via a web interface.

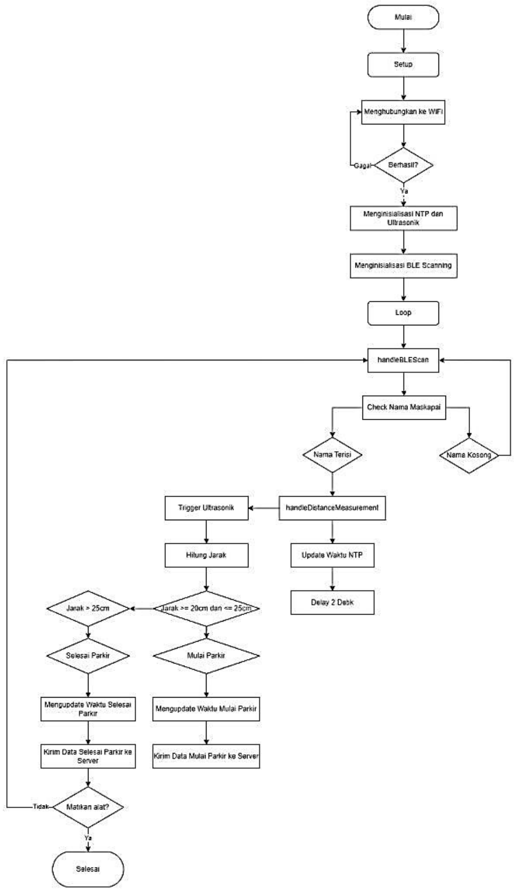

Figure 4. Flowchart of The System Operation

The working principle of this system involves the emission of ultrasonic waves by a sensor, the reception of signals reflected by the aircraft, and the calculation of distance to determine the parking status. The microcontroller converts the parking status to "block on" or "block off" based on the data received from the sensor. The use of the MQTT communication protocol ensures that data is transmitted efficiently and in real-time to the control center, allowing for accurate and rapid monitoring.

This research produces a system capable of detecting the presence of certain airlines using Bluetooth Low Energy (BLE) technology and measuring distance using the HC-SR04 ultrasonic sensor. The system has been successfully implemented with the following components:

a. WiFi Connection: The system successfully connects the device to a WiFi network using the specified SSID and password. This allows the device to communicate with the server to send parking data.
b. NTP Client: The system successfully retrieves accurate time from the NTP server pool.ntp.org and sets the time zone to Asia/Makassar (UTC+8). This time is used to record the start and end times of parking.
c. BLE Scanning: The system can perform BLE scanning to detect devices emitting signals with the strongest RSSI. The detected airline name is stored in the variable nama_maskapai.
d. Distance Measurement: The system uses an ultrasonic sensor to measure the distance of detected objects. This distance is used to determine whether an aircraft is parking or leaving the parking area.
e. Data Transmission to Server: The system successfully sends start and end parking times to the server via HTTP POST request. The data sent includes start time, end time, airline name, and parking area.

3.3 Determining The Time To Use The Parking Stand

Determining the usage time of the parking stand involves recording the exact time an aircraft arrives and departs. This is achieved through real-time monitoring enabled by the ultrasonic sensors and the NodeMCU ESP32. The system logs the timestamp of each Block On (arrival) and Block Off (departure) event, which is then used to calculate the total usage time.

The system's ability to determine the time to use the parking stand was tested by simulating the arrival and departure of aircraft. The timestamps of Block On and Block Off events are recorded and compared with manual logs to verify accuracy. The system consistently logs events demonstrating its effectiveness for real-time monitoring.

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Jarak: 21 cm
Mulai parkir: 19:30:15, Nama Maskapai: GA 409
Jarak: 35 cm
Selesai parkir: 19:40:10, Durasi parkir: 595 detik
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Figure 5. Sample of The Log Data Recorded by The System

Log data includes the date and time of each event, enabling precise calculation of parking duration. This information is very important for airport management to optimize parking usage time calculations and improve overall operational efficiency.

4. CONCLUSION

The enhanced Parking Detector system successfully detects the presence of aircraft and accurately logs the usage time of parking stands. The use of NodeMCU ESP32 and Ultrasonic Sensor HC-SR04 proves to be effective for real-time monitoring in various conditions. The integration of this technology at PT. Angkasa Pura I Juanda Surabaya marks a significant step towards leveraging modern technology for improved airport management. Further improvements can focus on enhancing sensor robustness and exploring additional applications of the system in different airport environments.

By expanding the results and discussion with detailed descriptions, diagrams, and data tables, this section now provides a comprehensive view of the research findings and their practical implications. If you have any specific images or data points you'd like included, please provide them, and I can integrate those into the discussion as well.

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