

ABSTRACT

This study aims to design and implement a prototype of an autonomous electric tractor based on the Internet of Things (IoT), which can be controlled via mobile and web applications. This innovation emerges as a solution to the challenges faced by the agricultural sector in Indonesia, such as the declining interest of younger generations in farming, high emissions from fossil-fueled equipment, and the low level of mechanization on narrow plots such as rice field embankments. The developed system integrates an ESP32 microcontroller, nRF24L01+ wireless communication module, and INA219 power sensor, while utilizing the MQTT protocol and Supabase as the backend to support real-time remote control.

The system was tested in terms of application functionality, communication performance (QoS), as well as maneuverability and plowing capability. The results show that the system, equipped with the nRF24L01+ module, achieved low communication latency (<100 ms), acceptable jitter and packet loss within TIPHON standards, and sufficient throughput for a cloud-based system. The application successfully controlled the tractor in a stable and responsive manner.

Mechanical performance tests were conducted on two DC motor configurations: a 25 RPM variant with a 1:65 gearbox ratio, used as the primary configuration due to its higher torque and better traction on challenging terrain, and a 100 RPM variant tested for comparison in speed maneuvering. The results indicate that the 25 RPM motor performed better in grassy and plowing conditions due to its superior torque, while the 100 RPM motor was suitable for flat terrain but failed under heavier load. The overall system also demonstrated efficient power consumption throughout operation.

Overall, the Agrotech Automation system shows strong potential to support the modernization of agriculture in an efficient, environmentally friendly, and adaptable manner for small- to medium-scale farms. This innovation also offers opportunities to engage younger generations in the digital and sustainable transformation of the agricultural sector.

Keywords: Agrotechnology, Electric Tractor, Internet of Things, MQTT, nRF24L01+, Remote Control, DC Motor, Smart Farming.