



doi:10.5281/zenodo.18845300

# Design Of An IOT Based Remote Controlled Lawn Mower

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## ABSTRACT

The need to cut grass around home, institution and neighbourhood is of great importance, and it helps remove unwanted weed and pests, promote healthy growth of useful grass, improving aesthetics, as well as beautifying our surrounding. A number of methods are currently used for clearing grasses which includes manual human effort, combustion engine lawn mower, and recently electric mowers. However, some of these methods are rather exhausting, requires extensive human labour, as well as subject humans to hazards during operation. The proposed research to developing and constructing a remote-controlled electric lawn mower using android aim to eliminate existing problems, as well reduce the amount of carbon emission to the environment by lawn mowers using combustion engines. This paper presents the design and development of a remote-controlled lawn mower using Internet of things (IoT). An android device is used to control the lawn mower. The lawn mower blade is powered by an 800W DC motor, and controlled using ESP32 microcontroller, and also for system functionality, monitoring and control. The system also adopts both the Internet and WiFi technology to communicate between the android device and the Mower, this is to ensure real-time communication even when the internet service is not available in a particular location.

**Keywords:** Lawn mower, Internet of Things, Latency, Remote

## 1.1 INTRODUCTION

Grasses and other unwanted plants (weed) often grow in an open area with humidity, moisture and a soil that can supply them with the nutrient they need to spread. The grasses around our environment and houses usually contribute to a number of environment benefit such as air purification, erosion and soil protection, water management and also beautify the environment Nimkar et al (2020). These grasses tend to grow rapidly and tends to overgrow if it is not properly maintained allowing invasive weeds to thrive and grow, which overrun or competes with the useful grass. It becomes a breeding ground for dangerous pest, insect and reptiles such as snakes, and also reduce the beauty and aesthetic of a building, making the house look like an abandoned or desolate building.

A Lawn mower is a machine used for cutting or trimming grasses in our surrounding, so as to give a beautiful look or to improve the aesthetic of the environment. Lawn mowers have been in existence since its first designed the early 1800s by Edwin Beard (Sujendran and Vanitha 2019). Lawn mower is powered by either a combustion or electric engine to push the blades. For a lawn mower to cut grasses effectively, the motor torque must be sufficient to overcome the mechanical cutting resistance imposed by the grass, blade inertia, and system losses. Lawn mower is categorised based on different criteria, such as the axis of rotation with blades having reel lawn mowers and the axis is horizontal. Engine type, either an electric motor or a combustion engine.

Existing lawn mowers in their operations for cutting grasses are accompanied by a number of challenges which includes requiring a great amount of human effort and labour, excess engine noise from combustible engine, prone to dangerous insect or reptile attack, fatigue, and high cost of running and operation. Though there have been a considerable number of advancement and development in lawn mower especially, it still has a lot of lapses. The proposed system is a remote controlled lawn mower, and it is a very efficient, cheap, and environmental friendly alternative to existing lawn mowers. It uses android device to remotely control the lawn mower using either the internet (IoT) or WiFi. A microcontroller embedded in the Lawn mower communicates with the android device to control the speed and height of the blade at real time so as to obtain different grass level. This machine enable users to prioritise their safety, reduce cost of purchasing remote control (RF communication), excessive deafening noise (combustion engine), and short range. The lawn mower was powered by a 24V DC supply and it is remotely controlled using android device. ESP32 Microcontroller was used for system control, monitoring and navigation, ensuring real-time communication between the lawn mower and android device. To ensure a seamless communication, Message Queue telemetry text (MQTT) communication protocol was adopted for data transfer through the internet. They messaging technique adopts the publish and subscribe model, which is lightweight, faster transmission speed, less power consumption, event-oriented architecture, reducing latency in communication.

### **Problem statement and Justification**

Though different types of lawn mowers currently exists and also serves its purpose for cutting grasses, most of them are plaque with a number of problems which greatly affects their efficiency, power consumption, and environmental safety compliance. Lawn mowers using combustion engines produces a great amount of noise, and carbon-monoxide which is poisonous to both human and the environment. Push mowers require human effort and labour to manually move the machine around during its operating, cutting grass. This makes the operator vulnerable to sunburn, snake and dangerous insect bite. It also requires a large amount of energy to move the mower due to it's heavy weight and vibration. Also, Electric lawn mower using RF remote controller is very expensive to purchase or repair when defective, and it is non-modular as it is only a number of designated buttons, and function designed solely for controlling the lawn mower. These problems led to the conception and development of a remote electric mower using android for control and monitoring.

### **Objectives**

The objectives of this proposal are to:

- 1) Design and construct an electric lawn mower driven by a DC motor, to enable efficient movement, control, and grass-cutting operations.
- 2) Develop an interactive Android application that facilitates wireless communication, monitoring, and remote control of the lawn mower from an Android device
- 3) Design an adjustable blade shaft coupling using linear actuator to move the blade to match the grass cutting height of the lawn.
- 4) Integrate real-time communication using either IoT or WiFi, and also monitor the connection or internet service, so as to switch to local WiFi when internet service is disrupted

### **Proposed solution**

The developed remote controlled lawn mower is of huge importance to residential house owners, or institutions with a large lawn or environment with grasses or weeds growing on it. This will provide them a cheaper, and modular alternative to clearing lawn and grasses and eliminating the problems of excess noise and carbo-monoxide from lawn mowers with combustion engines. Also the proposed project is of immense benefit to the student and staff of Electrical department of the Federal college of Education Technical Ekiadolor, as it will provide them practical knowledge in Electronics, embedded systems design, control systems, IoT, robotics. This will bridge the gap between classroom learning and practical implementation, exposing them to real world problems. Hence improve their practical knowledge in electronics and embedded systems designs.

## **Literature review**

Grasses are a variety of plants, hence they grow in areas where there is soil with moisture and temperature, sunlight, and carbon dioxide. If not curtailed and controlled, their growth can be rapid. They spread and can take over the entire area, with dangerous insects and reptiles like snakes breeding underneath them. Cutting the grass is a major way of controlling the menace of grasses when they over-grow. When cut, they help to control erosion and beautify the area Kinnander Ola et al. (2015). As human's evolved, different technology has been invented over the years to aid humans in their daily task. One of such is the development of machines to cut grasses, this has gradually phased out the use of machetes, hoes and cutlasses to using motorized grass cutters. Technology had continued to advance and better techniques of grass cutting has been invented and constantly improved upon. This gave birth to the invention of lawn mower. A lawn mower is a machine used for cutting grass reducing human effort and labour.

There are conceptually two types of mowers: the reel/cylindrical and the rotary mowers. The cylindrical mowers are made up of blades mounted on a rotating cylinder that produces clean trim by scissors action. For its operation, a stationary metal bar known as bed knife is placed on the ground, Grass is cut by the shearing action of the blade(s) against the bed knife. Rotary mowers are usually powered either by an electric motor or an internal combustion engine and are generally moved manually, leaving the engine or motor to rotate cutting blades (Sujendran and Vanitha, P, 2014). Despite the obvious advantages of lawn mower, noise and vibration are two of the associated health hazards while using manually propelled type, which may have irreversible impairment on human health. In workplaces there are health and safety requirements for those affected by noise and vibration, but for public or occasional users there is no legislation mitigating against the potential health hazards for vibration.

Lawn mowers have evolved over the years, it gradually moved from manual to automated, reducing total human input. The first lawn mower was invented in 1830 by Edwin Beard Budding Prasada et al. (2019). In his work, the idea to develop a machine powered lawn mower came after watching a machine being used to trim clothes in a local cloth mill by a cutting cylinder mounted on a bench for a smooth finishing after weaving. He realized that a similar concept could be used to cut grass if the mechanism is mounted in a wheel frame to enable the blades rotate close to the lawns surface. Thomas Green patented the first lawn mower to be driven by chains, a fundamental development named Silent Messer which implies silent running Prasada et al. (2019).

## **MQTT Communication**

MQTT an acronym for Message Queuing Telemetry Transport was designed and developed by Arlon Nipper and Andy-Stanford-Clark in 1999 for connecting Oil Pipeline data measurement and transfer systems via satellite. MQTT was initially a proprietary protocol who later became royalty-free in 2010 and was finally declared as the standard protocol by the Organization for the Advancement of Structured Information Standards (OASIS) in 2014 (Steve, 2016). Its core architecture comprises of two components which are the Client and Broker.

MQTT is an open-source communication protocol, lightweight, faster transmission speed, less power consumption. These attributes have made them popular. As an event-oriented architecture they use the publish/subscribe model, which is easier to use and implement in both client and server with simple commands. It is highly reliable due to its Quality of Service (QoS) levels, multicasting, better congestion control mechanisms.

## **DESIGN AND METHODOLOGY**

### **Methods**

The design adopts the waterfall design methodology, which is a methodology that follows a linear, step by step approach for project development. In this method, each phase of the project are well defined, predictable and have specific documentation. It follows an array of sequence which includes, Requirements, Design, Implementation, Verification or Testing, and Maintenance or deployment.

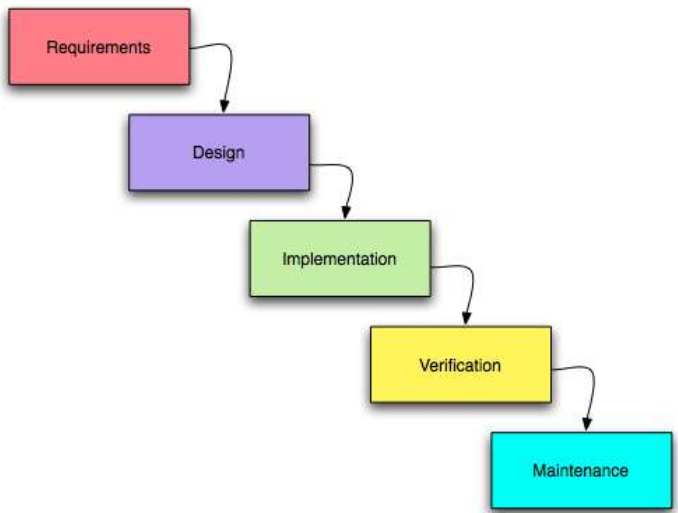


Fig 1 Block diagram of the waterfall design methodology

**Design**

The system comprises of 2 parts which are the lawn mower, and an android application. The application installed on an android device, controls the physical device. ESP 32 microcontroller is used to control the lawn mower, and to communicate with the android application. Two (2) 24V 250 Watts DC motor is connected to each of the 2 back wheels, through a chain and sprocket to increase torque, and to improve lawn mower movement on uneven terrain. The direction and speed of the DC motor is controlled by a H-bridge module interfaced between the MCU and the motor. To send and receive data between the lawn mower and android device, the IoT technology is adopted as a medium for communication, using MQTT protocol to send and receive data. The lawn mower blade is driven by a 36V 800Watt geared DC motor, and is powered by a 36V DC battery source.

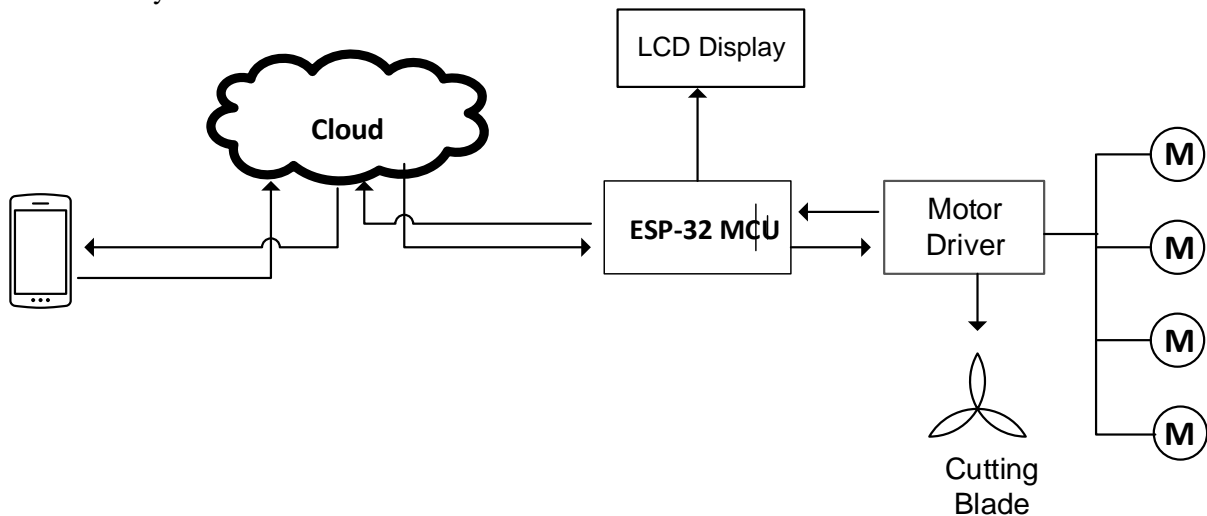


Fig 1: block diagram of the proposed remote controlled Lawn mower.

### Components used

**Esp32:** The brain and central unit of the lawn mower responsible for control and wirelessly communicating with the android device.

**DC-DC Buck Converter Step Down Module:** It's a switch mode power system (SMPS) that converts high dc voltage to a lower dc voltage. The buck converter reduces the lawn mower supply voltage of 36V to 24V compatible with the DC motor rating.

**LM358 voltage regulator:** A low power operational amplifier, supplying a voltage of 3v - 36V when used as a regulator. It provides a steady 5V to power ESP32 MCU.

**Wheels and tires:** Provides mechanical support, transmitting motion to the lawn mower, and also enabling the forward, reverse navigation, and turning of the mower.

**24V 240W DC Brushed motor:** The DC motor connected to the wheels converts electrical signal to mechanical motion, enabling forward and reverse movement of the lawn mower.

**Mower blade coupler:** A steel component used to securely connect and transmit rotational motion from the lawn mower DC motor shaft to the cutting blade.

**Lawn mower blade:** The blade connected to the coupling shaft, and is rotated by the DC motor to cut grasses and weeds. It rotates at high speed with enough torque to overcome the grass strength and resistance.

**50Ah 36V Battery:** The battery provides the supply DC power to power all the lawn mower electric component including the Microcontroller, DC motor, linear actuator and other components.

**Linear actuator:** The lawn mower component is a mechanical device that converts electric signal to linear motion. It is used to move the mower blade up and down so as to achieve a grass cutting level



Fig 2: 3D Model of 24V 240 DC motor



Fig 2: Model of lawn model

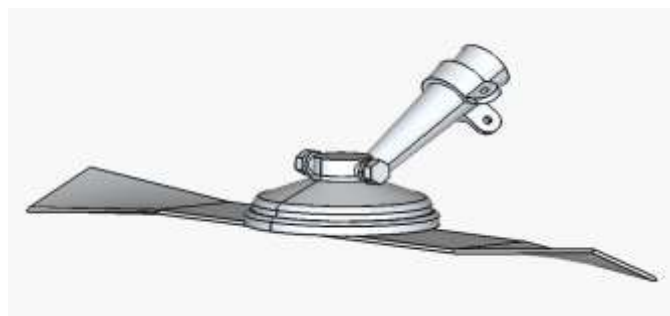


Fig 3: Model of lawn mower blade coupling with the blade connected to it



Fig 5: 24V 250W DC motor connected to H-Bridge module for direction and speed control

## CONCLUSION

The developed lawn mower adopts IoT technology in real time remote controlling and monitoring of the Lawn mower. It integrates MQTT communication protocol to optimise data transmission at real-time, enhancing latency, and faster transmission speed. The need for a remotely controlled Lawn mower is of great importance as it eliminates major problems of existing Lawn mowers. Some of the current draw back includes high noise from combustion engines lawn mower. Machine operators using push lawn mowers are prone or vulnerable to insect or reptile attacks, high cost of re-fuelling and payment for human Labour. Additionally, conventional lawn mowers require significant human effort and excessive energy expenditure to push the machine from one location to another during operation, especially when covering large areas of land or expansive lawns. This results in operator fatigue, reduced efficiency, and longer mowing time, thereby highlighting the need for an automated or remotely controlled lawn mower system. The proposed system will be of immense benefit to lawn mower operators and to home owners.

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