بسم الله الرحمن الرحيم

REMOTE CONTROLLED LAWN MOWER

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DHAKA- BANGLADESH

March 2021

Certificate of Research

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Acknowledgment

First of all, we thank Allah the almighty who makes all things possible and for giving us the patience in performance and completing of this project. And also we express our sincere gratefulness to our respected supervisor Dr. Mohammad Monjurul Ehsan for all his endless efforts in supporting, patience, and believe in us. Moreover, we thank our family members, friends, lecturers and the department of Computer Science and Engineering of the Islamic University of Technology (IUT) for their kind support and help.

We would like to convey our deep gratitude and appreciation to the Bachelor of Science students of the Islamic University of Technology (IUT) for their guidance and valuable suggestion regarding this study.

Finally, our special thanks to everyone who contributed in one way or the other towards the successful completion of our thesis.

Abstract

The remote-controlled solar-powered lawnmower has been developed to reduce the amount of work required of humans in trimming the lawn. Due to the increased availability of sophisticated equipment, our work has become more convenient, effective, precise, and productive. The research investigates the possibility of a wireless service system that can be used remotely. In this report, the feasibility and design of a push lawnmower that can be operated by remote control and a remote-controlled riding platform are discussed. It is powered by a DC motor. Current from the battery is sent to the motor, and the shaft begins to rotate. Furthermore, two tires are connected to the hub which also rotates. Yet another motor is added onto the base of the lawnmower and is connected to the center of the base. In addition to this cutting blade, which cuts the grass at the highest speed, is attached.

The mower's movement and speed may be controlled through remote operation. Given that the lawn is being mowed by an autonomous device, the user can relax and stop worrying about their lawn. Also, this project replaces inefficient designs using advanced technologies to conserve resources in the most efficient manner possible. To be effective, this project has specific goals which are to be easy to understand, accurate, and timely. Moreover, this paper reviews technological developments in the design and construction of lawnmowers, and the stages of the engineering process.

Chapter 1
Introduction

1.1 Significance of the project

A lawnmower is a machine used to trim long grass and short grass at the desired height and to cut fast and effectively, the lawnmower uses high-up speed rotary blades. Nowadays, lawnmowers are essential to our lives. A growing number of lawnmowers are being manufactured and used today. When all of this is taken together, there is large energy consumption by lawnmowers. We can also observe that lawnmowers have caused air and noise pollution, particularly in urban areas. This has led to a large number of consumers devising methods to limit their carbon footprints. Furthermore, there are governmental regulations that limit the range of pollutants emitted from the device, and these are being decreased over time. We have also noted this, and have chosen to develop and manufacture a remote-controlled lawnmower, which is going to minimize both air and noise emissions while reducing the work effort required for both. This lawnmower combines a conventional lawnmower, a remote-controlled unit for operation, and a storage space for the collected grass. We offer a lawnmower with several features at the lowest possible price. In the immediate future, we expect this system can become the industry norm.

1.2 Problem statement of the project

Today's grass shaper machines are relatively basic in use to our day-to-day living. Moreover, many buyers are attracted to grass cutting machines because of their natural strength and reliability. Thus, purchasers desire ways to alleviate and settle their carbon footprints. Besides, contamination in the natural environment continues expanding and will impact people's everyday lives, especially at home. In consideration of an investigation, it is accounted that 70% of the people of Malaysia cut their lawns using fuel-powered grass trimmers, which necessitates high maintenance to maintain the mower running. For example, one should regularly change the fuel or oil of a lawn trimmer to keep the unit in operational condition. Besides, this too will add a variable expense, but the fuel cost has been expanded recently to address these issues, and eco-accommodating grass cutter should be planned and manufactured to help the green innovation activities. In this experiment, a battery-powered battery was created that could be controlled with a switch. The grass cutting machine was created through the careful consideration and development of viewpoints such as lightweight, strong, and eco-friendly.

1.3 Project objectives

The followings are the objectives of the project:

i. To design and construct an efficient lawnmower of practical size.
ii. To design and build a lawnmower that is inexpensive, affordable and durable.
iii. To build and manufacture the lawnmower which can function in diverse areas.

1.4 Project Motivation

The project's main drive is to discover the advantages of an internet-based lawn-mowing service. Through designing an autonomous lawnmower, the user is freed from the time consuming and physically demanding task. The projected design will assist those without the physical ability to plant and maintain a garden for themselves. Additionally, the fully autonomous lawnmower frees the owner from worry and gives him much more spare time. Another group of people looking for this service is small-business owners with smaller areas of grass that require weekly mowing. They have a consistent need to have for a nearby area to mow. The RoMow would allow for the mowing of that patch of grass quickly, and with little exertion. This product can be marketed to consumers who are tech-savvy and want to use a product in which they can remotely control.

1.5 Project Goals

In the context of this project, the goal is to reduce end-user work by utilizing a helpful device that eases the burden from having to mow the lawn weekly and it removes the need to focus on your lawn every week, which means less busywork. An automated system capable of remote-mowing would be equipped to address both of the previously mentioned needs. The tool can be connected and disconnected from the push mower. When mounted, the mower allows for remote control with a hands-free device. The mower can be rolled off the platform and can be used conventionally without any changes. This is besides the wheel height being raised and removing the emergency stop plug. To some extent, automated research is possible, but is currently beyond our scope. The design of the RoMow (Bluetooth and wireless lawnmowers) should demonstrate how a product is functional while also expressing the qualities of a responsive design.

1.5.1 Transparency

One of the goals for this project is to ensure that the input system would be compatible with any mower of a similar make and model. To prevent this from occurring, the design should be done in such a way that makes the product easy to use by the general public. The product should be flexible and have a wide range of possible applications for a customer to use. The customer should be aware of how they can use the RoMow effectively and safely. The mechanical design should be sturdy and have the safety factors needed to be built in during development to guarantee the system's reliability.

1.5.2 Mindful

The RoMow is intended for those who are unable to care for their lawn, and so must be easy to operate. The design needs to be sensitive to the target audiences and their needs. It should allow people to easily mow the lawn with little physical effort. It should be easy to use and safe. The platform should make lawn mowing more dangerous but reduce the risk of injury completely or as much as it can.

1.5.3 Trustworthiness

The design process shall be guided by integrity in the context of the RoMow. This means that the design will be both exquisite and useful. This paper focuses on how the RoMow will be designed so that the operation by the user is intuitive. There shouldn't be any difference between what we expect and what we get.

1.6 The scope and limitations of the project

1.6.1 System Requisites

The device outlined in this report needs to take into account motion, making a turn, keeping the motion in line, tracking the location, and more. the robot is configured to maintain a steady pace throughout the garden so that it can perform its key function of cutting grass It is necessary to hold the unit in a straight line to be able to transform it at a 180-degree. Figure 23 depicts the position of the robot and the turn that it must make. The robot should be able to navigate itself even in the case of a power failure. A simple approach to tackling the problem involves placing borders around the garden to be used as limits. It was left up to the selection of the poles to be autonomous of technological devices which could be located in the garden or bought. Searching can be done before everything else. The robot must measure the polar gap, and then set its position where it needs to go to start the desired motion (as shown in Figure 23). Feedback is given to ensure that the robot is following the right direction and is not making any mistakes Therefore, a sensor is required. The sensor needs to consider all potential errors or inaccuracies in the details. More attention is paid to the performance of the sensor(s) under different weather conditions because the robot needs to be operational outdoors, where all kinds of environmental disturbances can occur. Variation in temperature and sunlight levels will impact the device efficiency and specifications. Other critical considerations include the overall architecture, form, and scale of the robot, as well as the motor parameters. Anything necessary to carry out the function of cutting the lawn is included in the design of the robot.

1.6.2 Specifications

A motor mechanism that would provide different observation angles has been chosen because it is an economical option, it has sensors capable of providing multiple observation angles. The expense of using a single sensor is less attributed to the decreased cost.

The two-wheel-drive was selected since each wheel can be moved independently of the other; thus virtually complete rotation is achievable while one is in motion. It may be done by controlling the motor such that it rotates in the opposite direction as its movement is stopped. This will cause the vehicle to transform according to its previous trajectory.

1.6.3 Vehicle Specifications

The robot was designed to be equipped with two-wheeled, so the two-wheeled vehicle was selected. The radius of curvature relates to the 180-degree change that the vehicle would make to bring itself in next to the previous route. When the car approaches the limit of its travel, it must change course. An additional concern rendered for the car is the location of the blades that are used to cut the grass, as well as the fact that the blades must be able to move through the garden area without the need for the vehicle to move through the garden more than once. Additionally, attention is given to the vehicle's wheelbase lengths, since they affect both the vehicle's straight-line and steering capabilities. In cases where there is more cover to assist the wheels have to cover a larger area to minimize the amount of help and the amount of drift.

1.6.4 Limitations

One of the design method's drawbacks is the ability to calculate the minimum and maximum distances with the unit accurately. Due to reliance on data captured by the sensor, the system is likely to malfunction or fail if the sensor malfunctions or fails. The garden shape and width, as well as their length and depth, have a significant impact on the mechanism mentioned in the study; the analysis here is dependent on the selected motion pattern.

1.7 Construction process of the project

The flowchart below represents the method of constructing the lawnmower.

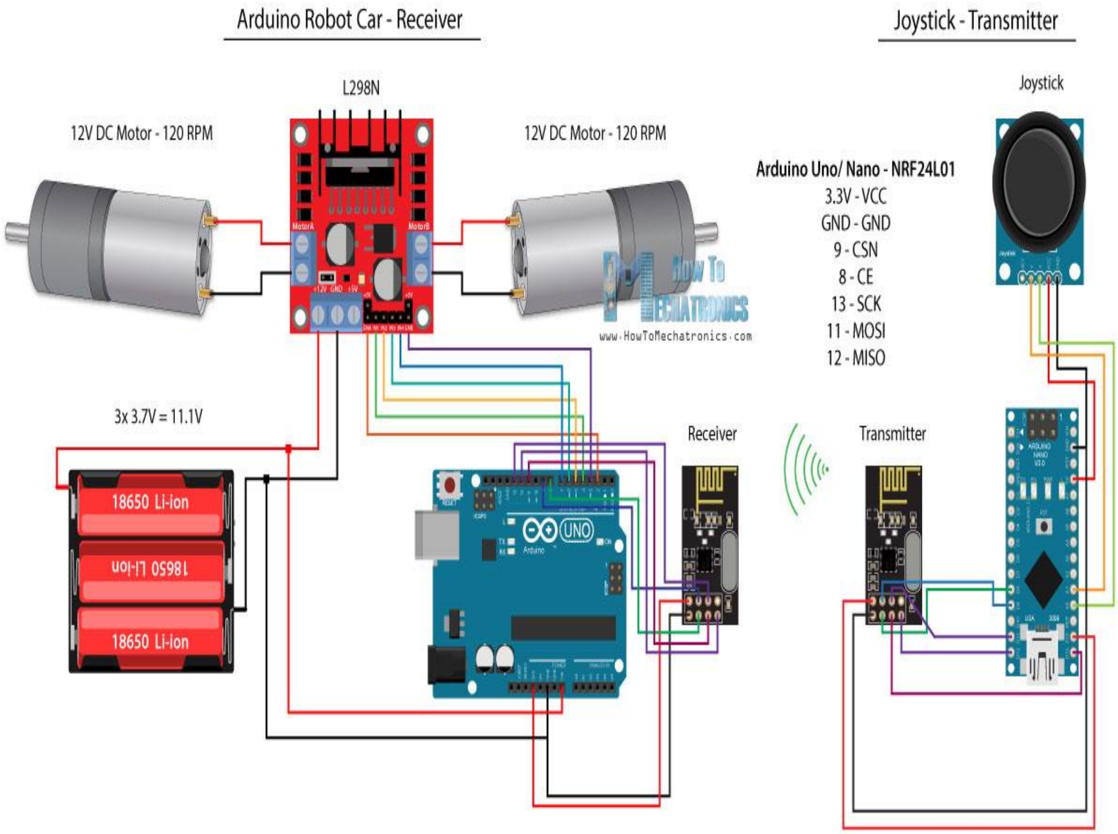

Figure 1 System design diagram of project

This project follows the prototype analysis method. We used a remote control lawnmower for this project: Its approach is as follows:

- This system has to be constructed in a particular way, and it should have an effective pattern.
- A long-term, less expensive life-cycle option than the guidance wire.
- Creative cutting and styling methodologies.
- An improved sensor array will allow obstacle and gardening limits to be established.
- Using a four-wheel vehicle versus some other vehicle will enable the robot to travel across the track more easily.
- As compared to additional electronics being set in the garden; therefore, all electronics could be situated on the machine itself to obtain the desired result.

The methods used to create these components are detailed in the following section:

- Ways of attachment.
- How the remote control mower operates.
- Additional Components.

The important features of the solar-powered lawnmower are as below:

- Circuits
- Mechanism involved
- Blades
- Tires
- Polyvinyl Chloride (PVC) Pipe
- Batteries

Chapter 2
Literature Review

2.1 Introduction

The blade-driven lawnmower is used to cut the top of a grassy lawn to the same height. The height of the cut grass may be regulated by either a single knob or a series of knobs or bolts on each of the machine's wheels. The blades may be driven by muscles, and wheels may be mechanically linked to the mower such that they function while the mower is in forwarding motion. The most famous power source for lawn mowers is an internal combustion engine. Walk-behind mowers sometimes aren't self-propelled; they need a person to assist with the push. Many power mowers are either self-propelled "self-walking" mowers or the user may control with a "ride-on" power mower. An operator-controlled mower ("lion elite") collects the motion completely by remote control or autonomously. Some lawnmowers serve other purposes than only cutting the grass, including mulching the grass or collecting the clippings in a bag or container. Two primary cutting-mower blade shapes are used in residential mowers. Mowers are well-known (although in some versions, the cutting bar is the only blade, and the rotating assembly consists of flat metal pieces which force the blades of grass against the sharp cutting bar).

There are many types of mowers, each with various usages. Minimal automation needs minimal human effort people typically use electric or gas-powered push mowers in residential settings (although there is some overlap). Commercial riding mowers are ideal for big lawns, while zero-turn mowers look identical to home tractors. They are designed to operate at high speed, and they also are smaller and lack a large mowing deck.

Many multi-blade mowers are on tractors and intended for wide expanses of lawns and parks, but they are challenging to operate on courses that need maneuverability. Hand-guided or ride-on mowers are starting to make a change in certain countries, with the 15x faster increase in robotic mower sales in 2012. Given existing population development trends, conventional mowers are becoming a thing of the past and will eventually be eclipsed by electric lawnmowers. The first lawnmower was developed in Thrupple in the county of Stroud, England in 1830. Budding's lawnmower was built for sports and landscape purposes and is the model for a broad variety of other lawnmowers. Soon after, he started using the first machine, he bought a 21-inch machine built of wrought iron. It was moved from the rear. Power was delivered from the gear driven by the rear roller to the knives, which enabled the rear roller to function as a power source for its drive mechanisms. It is possible to add another roller to the cutting cylinder to lift or lower the cut height by some other means. There were clipped in a tray. As it turned out, it was discovered that a strap was required to assist in moving the mower. Generally, the devices were like new, reel-to-reel lawnmowers. One of the first implementations of the Budding computer was at Regent's Park and the University of Oxford. As a result of an arrangement dated May 18, 1830, John Ferrabee pays the expense of enlarging the small blades, secured patents, and is granted the freedom to market and to use lawnmowers. The establishment of a trademark for Budding and Ferrabee (another Ipswich-based company) allowed them to gain business from other firms as a result, enabling Ransome to start producing the mower in 1832. Ball courts, sports fields, and grass courts were developed based on his invention. The bill described some sports, including football, lawn bowls, and tennis, while excluding others, including croquet.

Figure 2: the first type of lawnmower

It took another ten years and development before a system that could be sculpted using steam-operated machinery was accessible. Leeds engineering company Thomas Green & Sons had developed a trimmer in the 1850s that used a chain to transfer control from the roller to the cutting chamber. While being more costly, these computers were smaller and quicker than previous models. When the number of participants in grass sports grew, so did the number of individuals bringing new ideas to the scene. Yard shears are safer, as far as livestock are concerned. Yard-cutters saw a surge in popularity in the 1860s. In the year of 1862, Ferrabee's machine shop was turning out eight roller designs in a variety of configurations. Till his death in 1863, he built tens of thousands of engines. The hayrack had a flat plate when it was first constructed, but has developed a V-shape over time. In 1897, James Sumner worked to make sure that none of the steam-powered tractor manufacturers in Lancashire became effective at monopolizing the market. Petroleum and naphthoquinones were used by him. It took a while for this large equipment to become acclimated to their work environment and comfortable with their tasks. These robots have now been brought to market by the Stott-Hall Chemical Company of Manchester and Sumner. The Leyland Steam Corporation or Leyland Motor Company was a well-known brand. In the early 20th century, Ransome Automat was the best chain-driven paradigm in existence. Petrol-powered rotary-cutters started to appear in the industry at the turn of the twentieth century. In 1902, the first of several gifts are delivered by Ransome. Following World War I, Leicester, the United Kingdom's production and maker of sewing machines was the first in the world. Toward this point in time, it would be possible for an admin to work behind mutants, on vehicles that are a lot larger than themselves. The special sort of riding cutters is known as primary cutters.

Figure 3: Lawn Mower Thomas Green & Son 8in Silens Messor

The development of the first gasoline-powered lawnmower, in 1902, took another thirty years until it was used for animal power purposes, and another sixty before a steam mower of this kind was constructed. Thomas Green & Son introduced a mower in the 1850s that used a chain drive to propel the cutter from the rear rollers. They were different from their gear-driven competitors in that they were smaller, louder, and more energy-efficient. As interest in lawn games rose, sales of lawnmowers went up. Dirt mowers and mowing were more effective when they were connected. In the 1860s, the first lawnmowers were built. By the year 1862, Ferrabee had made several roller sizes. Before he closed his workshop in 1863, he designed more than 5000 computers. While the style of the grass box is very squarish, it was made in the 1860s. The first steam-powered lawn mower was invented in 1873 by James Sumner of Lancashire. He uses gasoline or diesel fuel. These big machines were built to cool and pressurize for many years of research and development later, the devices were put on the market by the Stotts Fertilizer and Pesticide Machinery Company. The two men each had invested in the Leyland Steam Car Business. In the period following the 1900s, one of the most common toys was the chain or gear-driven automaton. Many mower makers joined the era of gasoline-powered lawnmowers since the creation of the 21st century. Rome's produced the first built rowing machine in 1902. Between World War I and World War II, JP Engineering developed a line of chain-driven lawnmowers. During this time, employees could travel in large vehicles. These were the first-ever built of these types of riding mowers.

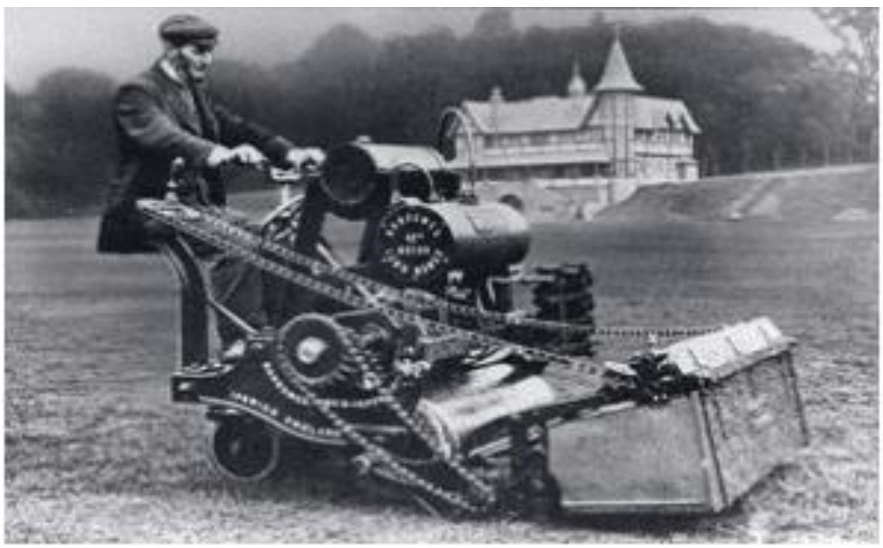

Figure 4: The first gasoline power lawnmower

A national lawn mower patent was awarded by the U.S. Patent Office on January 12, 1868. The economic success of the innovation of Elwood McGuire of Indiana in 1870 with the discovery of human-free technology John Burr made a higher-performance rotary mower, which he then upgraded by replacing the hubs and tyres. Amariah Hills established the Archimedes Lawn Company in 1871. Gasoline-powered lawn mowers were first manufactured in 1914 by the Ideal Power Co. of Lansing, Michigan in the United States. This is based on a patent issued to Ransom E. Olds. And in 1922, this brand launched the first self-propelled riding mower, called 'The Triplex.' Worthing made multiple-blade mowers, which cut a wider swath, was built in the US in 1919 by the Worthing Mower Company.

Figure 5: The first drive lawnmower

Charles H Pugh started his company, which became one of the most famous names in Atco Ltd., in the decade around the year 1920 Since Atco had quick success The only models "consisting of 22-inch blades, 900 in number," were produced in 1921, each for £75. In five years' time span, over 100,000 units were produced. Prices were reduced, thereby providing the very first standardized lawnmower. To be effective, modern rotary mowers must operate at high speeds. People of the 20s and 30s often played with rotary mowers, and in 1935, Power Specialties introduced a gasoline-powered version. Two-bladed rotary mower originator substituted the circular saw blade and cutter deck, making the first rotary mower The Australian Victa began making industrial rotary mowers in 1952. The new style of mowers is less cumbersome and easier to use. This first Victa mower was created in the Sydney, Australia. The very first Victa mowers were assembled in his garage and were available for sale on September 20, 1952. On that day on February 13, 1953, Victa was created. Thus, the firm relocated to greater premises in Parramatta Road, Concord, and then to Milperra, in which case, from outside sources, the engine had been custom built and assembled by Victa. Victa mowers, which were first manufactured in 1958 and used until the early 1970s, are on view in the National Museum of Australia. the Victa mower has achieved international recognition thanks to its commonly used use in the opening ceremonies of the Olympic Games reduces human effort from previous models by using a self-propelled lawnmower, which can also be operated using electric and internal-combustion fuel. Several improvements have been made to this lawnmower, including the following: The mower's height and weight have been cut in half. The mowing height of the lawnmower is often can be adjusted to meet various mowing needs.

2.2 Classification of Lawnmowers

2.2.1 Classification according to the rotation

2.2.1.1 Cylinder Lawnmowers

A cylinder mower or reel mower that holds its cutting blades at a specific height for optimum cut quality above it are blades that spin fast, forcing grass through the cutting bar. The blades are placed in a spiral around the spindle, and this form represents a cylinder. Cleanly cutting the lawn ensures that the grass sprouts more easily. Like straight blades, the lawnmower cuts its way across the grass. Since the mower's blade is sharp and narrow, development is more regulated, weeds and pests are less prevalent. If you have a cylinder mower, you are more likely to get yellow, white, or brown parts. As long as the cylinder is held parallel to the horizontal cutting bar, the cutting operation is not required, and if the blades are hardly distinguishable, it is possible to make a smooth slash. Dry grass, on the ground, will also be crushed. Power mowers are less successful on uneven ground that doesn't remain flat. There is a range of cylinder mowers to choose from. Push mowers are often used in smaller yards or for smaller yards where the room is at a premium, and where noise emission is not to be a problem. The mower's drive gears are moving rapidly as it cuts through the lawn Generally speaking, widths are in a range of 10 to 16 inches (410 mm). Improved manufacturing techniques and materials and engineering have reduced the weight and maneuverability of these mowers while maintaining all their technical attributes. Formal environmental incentives also a clear selling point for these kinds of organizations.

The style is often applied to human-powered and tractor-drawn groups. The V-formation behind the tractor is arranged to cover most of the tracks and to facilitate track clogging. Gang mowers are employed on a plethora of lawns and playing fields to grow vast quantities of grass. The cylinder mower may be started by an engine or an electric motor. Typically, in standard designs, electric motors are driving gas cylinders. The rechargeable versions may be plugged in or run by electricity. A car with a petrol engine may even have rear-rollers. Commercial reel mowers have many blades that will cut grass that is too tall for normal push mowers. Lawnmowers of the past have since been replaced by a conventional rear-wheel mower, which is now often seen on suburban lawns. A gas turbine attached to an electric motor is running internal combustion. The mower's wheels turned. Most greens are fitted with at least eight, but usually ten blades. It has a roller that levels freshly mown grass if used. Due to the weight of the motor, the mower is being pushed. Lawnmowers of this size and strength are mostly found in smaller, ornamental flower bed patches. Mowers are accessible, too. As usually, the mower is ahead of the cutting the grass, so the mow can be completed until the lawn is mowed. The reels are powered by electricity. The important features of cylinder type mowers are:

- **Blade chamber/ reel**, comprise different (3-7) windings that are fastened to a turning shaft. The blades pivot makes a scissor-like cutting motion.
- **Bed blade** is the fixed cutting component of a chamber/reel cutter. This is a fixed-position cutter that is fixed to the trimmer.
- **Body outline**, it's the primary underlying edge of the trimmer onto which different pieces of the cutter are mounted.
- Wheels, this assistance pushes the cutter in real life. For the most part, reel cutters have 2 wheels.
- Push handle, it is the power source of a physically worked reel trimmer. The overall configuration of the gadget has a T-shaped handle, but it is based on the tight fit of the casing and haggle chamber.
- Motor, it's the force source of a reel cutter that is fueled by either gas or electricity.

Figure 6: Cylinder lawnmower

2.2.1.2 Rotary lawnmowers

This kind of lawnmowers rotates around a perpendicular axis which makes the blades impel the turf. Discoloration of the leaves is more likely to happen if the leaf is damaged. Blunting of blades is a problem as they get dull or scratched. Corrugated and traditional rotary mowers ought to be set higher than cylinder ones for straight, including lawns; however certain more recent rotaries include a rear roller to have a more structured look. Rotary cutters have a field of operation that is below the four-wheel size.

The key pieces of rotary lawnmower are as below:

- **Cutter deck lodging** houses the drive and trimmer's cutting edge and it can be conveniently used to properly discharge the lawn clippings.
- **Drive framework and blade mounting**, Sharp edge of a rotational cutter is typically mounted straightforwardly to the driving rod of its motor, yet it very well may be moved by a pressure-driven engine or a belt-pulley framework.
- **Mower edge** is a turning cutter for the most part has one edge that pivots evenly. The edge highlights edges that marginally bent up to produce a ceaseless wind stream as the edge turns, consequently making sucking and tearing activity.
- **The engine** can be fueled either by gas or power.
- **Wheels** — rotating trimmers, for the most part, include a bunch of four wheels; two front haggles back tires.

2.2.2 Classification according to Energy Basis

2.2.2.1 Gasoline (petroleum)

Almost all push mowers are powered by gasoline or an internal-combustion motor. The four-stroke engines give better power performance from a reduced engine displacement utilizing petrol or other liquid fuels. On garden tractors, internal combustion engines are more often used. In industrial applications, 2 to 7 horsepower is the standard, whereas the usual number in car applications is closer to (1.5-6.75 kW). Almost all engines are fitted with gasoline or crank-started, except those which can be ordered with an electric start. Some models have a throttle control on the operator's handlebars. For fixed-speed lawnmowers, the speed is already set when they move to mow. Gasoline mowers have greater strength and afield of operation than electric mowers. as result, engines give off tiny amounts of emissions, which need regular servicing such as washing and the removal of the spark plug and air filter.

Figure 7: Rotary lawnmower

2.2.2.2 Electric Lawnmowers

Electric mowers are classified into two categories, corded and cordless. In terms of decibels, both styles of mowers are silent though delivering fewer than the gas model. [18]

Corded mowers have a small range because of the cord; for that reason, they are corded. There is also the additional risk of tripping over the control line, and subsequent electrical shock when using the mower. Adding a GFCI outlet can reduce the shock risk. Battery packs, which usually need to be replaced for each mowing (usually 1-4). More batteries equal more running time and/and more fuel (and more weight). Batteries may be placed within or outside of the mowers. Batteries that have been fully discharged may be substituted by newly charged batteries electric mowers are more maneuverable, but they have fewer versions available than gas mowers. The rechargeable batteries in cordless lawn mowers appear to last longer and are typically weaker than their non-rechargeable equivalents (including batteries). Hand-operated, older models of push mowers are also in operation. It is connected to the mower's gearbox, resulting in the reel-spinning quicker than the tires rotate. There is no pollution generated when you use an in-ground mower. Owing to all of the effort being performed by the customer, this approach is unsuitable for wider lawns. This mower does not work well around barriers, for example, bushes, sidewalks, driveways, and hard surfaces; you would need a flat lawn to ensure an optimal cutting radius.

2.2.3 Additional Remarkable Types

Hover mowers use an impeller to keep the mower aloft while the mower rotates. By using the floating blades, the user can quickly mow over turf. Plastic bodies and electric motors must be used on hover mowers. A major drawback is that the lifting air-cushion may be damaged by the chassis being so far apart. The mowers are built to work on rough ground, making them common in commercial and golf landscaping. The grass may be collected but is hard to come by in certain versions. The amount of work you placed into the cutting of your lawn affects the consistency inside a fence, a robotic mower may determine the size of the region to be mowed. The wireless robot uses this cable to identify the region to be mowed and to search for a recharging place. Grass aerators were constructed to sustain more than five acres of lawn. If the robot mowers get more advanced, they can self-detect rainfall and mow themselves. More than one robotic mowers may be used at the same time. Tractor-drawn mowers are also installed on tractors. The accessories can be controlled in the same manner as lawnmowers, but their blades are often moveable. Typically, they are affixed to the tractor's side or back.

Figure 8: Riding lawn mower

In big lawns, riding mowers are well-regarded. The rider lies on the lawnmower and steers and pedals it. Most often, the horizontal spinning blades are used, but with several scoops, One kind of garden tractor is the standard push mower. There are generally mid-sized tractors with a cutting deck in the center and rear axles on each side.

Many forces are guiding these mowers. Manual transmission is the most popular way to operate tractors. Hydraulic and continuously variable transmissions are the two widely used transmission types. Such pumps use independent engines, with or without a gear reduction, while others are built-integrated. With greater comfort comes greater expense. The most prevalent drive style is electric, while the most uncommon is diesel. Multiple attempts have been made to substitute hydrostatic transmissions with lower-cost substitutes, including the variable-ratio MT◌◌◌D’s Auto Drive, which have hampered their overall market penetration or had performance issues, such as engine rheumatism, that have restricted their acceptance. More commonly, riding mowers will have accessories like a rototiller.

The snow blowers, snow ploughs, and front buckets will also be used for snow-clearing activities (these are more properly known as "lawn tractors" in this case, is designed for several tasks). There are several circular mowers on which the hull is built of concrete. For less costly ones, higher-stressed steel is used. Aluminum which doesn't rust is cheaper than composite but more expensive to produce, is heavier and less robust. Elderly lawn cutting-style mowers usually have plastic decks.

Lawnmowers normally have a chute or a mulching port on the side or back of the bag where the cut grass is ejected. Some of the models have an attachment that collects grass cuttings. Mulching blades are only required for rotary mowers. A razor is used to remove the grass that is cut short enough to be easily swallowed by the clippings. Any projects clip with twin blades. This function removes the extra labor of clipping while still creating compostable waste that is comfortable and minimizing costs and damage to the lawn at the same time.

2.3 Feature Selection

Feature selection (variable subset selection) is a method used for selecting a subset (or a set) of appropriate features. We have preprocessed SEER data of 2004 through 2013 to obtain a core set of variables with all the available 72 fields for breast cancer. The dataset had a total of 106,237 records and was first split into two groups, those that survived and those that didn't.

- **Supervised learning** takes functions and generically maps inputs to the desired output.
- **Unsupervised Machine Learning** models a set of inputs.
- **Semi-supervised learning** combines labels from previous examples with new examples to build a model.

- **Reinforcement learning** adapts to the world around it to learn how to act. Every action results in some change in the environment which in turn impacts the learning algorithm and leads to a favorable outcome.
- **Transduction** attempts to model new outputs based on the learned outputs, the learned inputs, and the first-time test input.
- **Learning to learn** often incorporates a form of bias based on experience.

2.3.1 Features Selection Techniques

From a theoretical perspective, it can be shown that features of any size must be selected and that the selection process must be exhaustive. A large range of features is presented. In particular, supervised learning techniques attempt to find the optimum feature set. The two most basic types of algorithms are deterministic and probabilistic. Feature-ranking makes the various features equivalent weight or worth, which is typical in knowledge visualization. Many types of research have been done using feature ranking as the foundation for the research.

2.4 Related Works

Bellachia et al. (2) used the SEER results to prove that three separate models are accurate and successful in identifying breast cancer. The results reveal that the C4.5 algorithm has an 86.7% success rate.

According to Delen et al., who examined and cleaned the data to rid it of redundancy [6], they also determined that the decision tree (C5) has the best rate of estimation on the held-out data and a hitting percentage of 93.6%.

Endo et al [3] introduced and contrasted three approaches for the estimation of breast cancer survival rate. The group included in this analysis comprises people who have cancer (18.5%). Logistic regression was the most accurate detection method, artificial neural networks were the most specific, and decision trees were the most sensitive.

Kotsis, et al. combined Bagging and Boosting as a single foundation using different base learners such as C4.5 and Naïve Bayes. A deep learning model was evaluated on benchmark data from the UCI Machine Learning Repository.

Chapter 3
Methodology

3.1 Introduction

Moving lawnmowers with a standard motor are tedious, tiring, and no one enjoys it. Trucking companies with big engines create pollution because of their delivery method. Engine-powered machines require periodic maintenance which includes changing machine oils. If an electric lawn mower is corded, it will require planning to move it safely. Unlike motor-powered lawnmowers, electric lawnmowers are hazardous and should not be used by inexperienced individuals. Even if the electric lawn mower is powered by a battery, cutting height could prove difficult and unsafe. The self-propelled electrically powered remote control lawnmower is a lawnmower that will also operate autonomously. This project's goal is to develop a mower designed to reduce human effort, enabling elderly individuals to perform tasks without assistance. The output can be increased as there are no main power supply wires.

3.2 Project Framework

The identification of a consumer need is one of the first things that needs to be done before the product development process begins. Designing and manufacturing new products won't be sold in the marketplace if there isn't an active need by the product customer. At the beginning of this project, we identified a few market and customer needs, which the design of the Ro-Mow addresses such as individuals who are unable to or find difficulty using a standard push lawn mower would benefit from a product that allows their property to be taken care of without the assistance of a third party and another niche group that benefits from this product is businesses with small amounts of lawn that need mowing weekly. They pay a relatively large amount of money for a small amount of grass mowed. The RoMow would allow them to easily mow the grass and reduce the work they have to do. This product is also geared towards consumers who are technologically savvy and may prefer a remote-controlled mower.

1. In addition to traditional methods of cutting grass, this wireless electrically-powered mower emits zero pollution into the air.
2. Lithium-Ion rechargeable 12V battery and a powerful motor let the consumer mow up to 100 sq. feet of lawn in ten minutes.
3. Height of cut = 0.5”

4. With a highly powerful blade, one may attain a well-groomed lawn without the inconvenience of a gas-powered lawnmower.
5. Users have the option of eliminating the battery and installing extra batteries for bigger lawns.
6. It is problem-free concerning starting issues with remote access.
7. Adjustable blade height accommodates the rack and pinion mechanism.
8. The mower is operated by a 12V cordless mechanism, which is highly efficient and emission-free. This scale requires it to be set to a maximum height of two inches. In comparison, it is lighter and smaller than other battery or cordless lawnmowers.

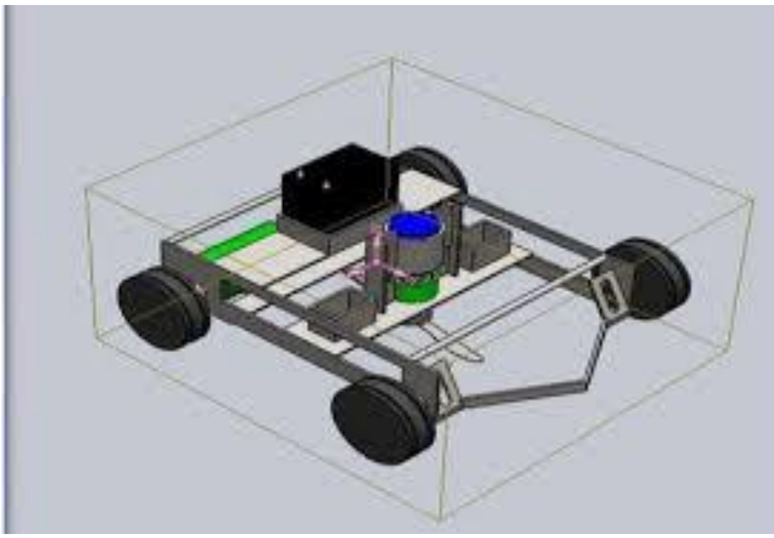

Figure 9: Project framework (AutoCAD model)

3.3 Outline of data collection

3.3.1 Design Team of the Project

The design of an intelligent lawnmower requires the integration of several subsystems into a fully functioning machine. The project has two key aspects within the different categories, electrical and mechanical. The electrical engineers are in charge of providing all the electrical components e.g. batteries, motors, computers, and the controller. Mechanical engineers focus on mechanical components such as the deck, chassis, wheels, mounting brackets, and wheel adapters. A majority of the electrical components are produced by Invacare and MTD, while a few mechanical items are sponsored by Invacare and manufactured by MTD. Projects involving a process will be assigned according to the discipline required. It is critical to take a structured approach in this project by addressing each subsystem in turn.

3.3.2 Complete System Operation

Five different methods are used in our experiments which are Naïve Bayes, Artificial Neural Network, Logistic Regression, Support Vector Machine and Decision Tree. After comparing the results of the experiments the logistic regression model performed the best. Classification of data is deemed one of the most critical issues for data mining and deep learning.

i. Naïve Bayes

Naive Bayes is a statistical method that is used for probabilistic modelling [15]. NB is based on Bayesian probabilities. This classification method uses information from a relationship table to derive a conditional probability of each attribute value and each possible class. During training, the class dataset is used to compute the posterior probabilities of each class. The probability a class C occurs is P(C=c). The algorithm also computes a probability for how likely it would be for example x to have class c if the attributes are independent. The probability resulting from all the probabilities of all the characteristics. The values of several probabilities can be estimated using the frequency with which each instance occurs in the training set.

ii. Artificial Neural Network

Neural networks are capable of analyzing complex functions with poorly-defined start-and-end points. The phrase includes interconnected structures (artificial neurons). The functions or computations are performed by the input/output characteristics of the components. The function could accept a weighted sum of inputs, and if it reaches a certain threshold it will produce an output. The results collected by the network can act as inputs to other neurons. This process iterates until one achieves the final result.

iii. Logistic Regression

Logistic regression is a leading method for modelling binary data [16]. At each class stage in the class hierarchy, one may use linear regression to assign a model to each instance and simulate other instances using a plurality vote. Instead of predicting the occurrence of the event itself, the model builds an estimator of the probability of the outcome. For two-class problems, when the probability is greater than 50%, then the outcome is coded as 1 to indicate Yes and 0 to indicate No. The given equations, Equation 1 and Equation 2 are the linear regression and logistic regression respectively.

iv. Support Vector Machine (SVM)

Support Vector Machine includes a range of supervised learning methods that, analyses and classifies data, and functions as a linear discriminant model. Support Vector Machine is a mathematical algorithm that finds a hypothetical hyper-plane to make a separation between two classes of data points. Support Vector Machine is a mathematical approach to learning and data fitting based on principles of machine learning [14]. In support vector machines, the key goal is to find a division of data that minimizes the total number of misclassifications. Support Vector Machines use support vectors (training tuples) and minima during training (support vectors). The SMO algorithm can be an easy way to train an SVM in a short period.

v. Decision Tree J48

A decision tree is described as a tree structure, where each node may be labelled as either a leaf node, showing the importance of the goal attribute or a test to test, or as a decision node, and each branch of the tree represents a test or any of the cases. Classifying an instance begins at the root node and continues to each successive leaf node, which defines the form of the instance.

3.3.3 System Requirement

The machine should recognize various factors including the capacity to control motion, ability to be turned in a straight line, and the ability to stick to maintain a straight course must be factored in. maintaining the pace would assist the mower in maintaining a steady field speed The mechanism must be able to turn 180 degrees at the boundary of the garden to maintain the same direction of travel. The robot should be able to revert to a previous setting regardless of its current position. An easy way to approach the problem is to have boundaries defined by poles set-up in the garden. The poles were chosen because they could be made from a stick that is not dependent on any electronics, and the dimensions are to be determined. The robot would initially scan the area in hopes of finding poles. Once the position of the poles is located, the robot will have to know where it was in the yard. Feedback from the machine is necessary to maintain the robot on its track and ensure there are no errors in motion, so a sensor is needed. to get rid of/reduce or affirm any errors or inaccuracies, the sensor data must be analyzed under various conditions. More importance is placed on high-performance sensors when choosing the robot's sensors because the robot must operate outdoors, where many environmental disturbances are present.

3.4 Proposed Design

3.4.1 Design and Configurations of the Lawnmower

Simulations of the prototype models were done in Autodesk Inventor 2016 before any physical models were made and the handlebar, pedals, and key were the main components of the lawnmower. The handlebars and wheels will form a navigation panel for the lawnmower, and the base will act as the foundation for the e-motor bikes and batteries.

An electric lawnmower is an inconvenience to use, and no one likes using it. Walking to cut grass is difficult for older, younger, and disabled people. Considering our contextual issues, we decided to first explore remote-controlled robotic lawnmowers. The intended outcome of this project is the construction of a self-powered remote-controlled lawnmower and creating a dependable and effective robotic lawnmower is its key objective. Furthermore, this project aims to customize the current versions of lawnmower so that it just needs little effort to operate. This design incorporates all of the necessary features to complete all of the tasks within the lawnmower. Once a final design has been achieved, components must be obtained to start production on the mower. The final design will utilize hardware and software communication to increase system capacity. The two major aspects of the project are that the machine can safely cut grass and that the company be able to successfully sell the product. The next step involved designing an automated mower that a user would have to do very little to set up initially. Another idea in which we considered as resource-saving and innovative. Lawnmower For these reasons, we have decided to develop a platform design with this design.

3.4.1.1 Motor Controller

To control the two wheels of the lawnmower's drivetrain, the motor controller can raise or decrease the speed of the unit's speed until the mower is at the desired position. To meet this goal, we need a strong controller that can provide approximately 5A to each motor continuously. Also, we require a sensitive controller, so we need a responsive controller. Additionally, our design is to be usable in diverse conditions and terrains necessitates a controller that maintains constant current. To base our controller choice on our motor's power requirements, we chose the Sabretooth 25A.

High-Performance Motor: This controller has several attractive features that render it ideal for our purposes, including power distribution and flexibility. The Sabretooth can be powered by two motors in tandem, delivering 25 Amps of current (with a peak current of 50A). Although the level of service our motors are capable of delivering is present, it also ensures that our batteries can never cease to work because of voltage fluctuations (assuming an adequate battery). More specifically, Sabretooth is well-suited for our project. This is a regenerative braking device, which when employed would replenish the onboard battery. Because of this, we may operate our design in reverse to keep the battery continuously charged, but we just need to plug it in for a short period to recharge it This motor controller features R/C, analogue, and serial control options. Control stability helps us to expand without needing to make major improvements to the hardware, and as a result, further growth is feasible. In digital or analogue, we can use PWM using our microcontroller to monitor the brightness of an LED. We would eventually be using Tuner mode with an RC filter at the end. Additionally, the Sabretooth helps us to modify the reaction, signal mixing, making it much easier to fine-tune our design.

Sabretooth motors are excellent for our application: they have a supersonic frequency (32 kHz), on-board heat sinks, and greater voltage control flexibility. These on-board heat sinks often save the motors from becoming unavailable and reduce lead time. The only real issue with this package is its price: A small one. Despite the total price of the other parts, we should go for the Sabretooth for our project.

3.4.1.2 NRF24L01 Transceiver Module

In view of the core features of the critical NRF24L01 transceiver module. The device uses the 2.4 GHz band and can transmit at rates up to 2 Mbps. If used at a lower baud rate, the transmission range can go up to 100 meters. The module uses 125 different channels which allows it to have a network of 125 independently connected modems. Each channel can receive messages from up to 6 other channels, or each unit can connect to up to 6 other units. Three of these pins are for the SPI communication, and they connect to the SPI pins of the Arduino, but each Arduino board will have different SPI pins. The CSN and CE pins can be connected to any digital pin of the Arduino board. These pins are used to set the module in standby mode or active mode, as well as to switch between transmit and command modes. The last pin is effectively a disconnect pin, which doesn't have to be used.

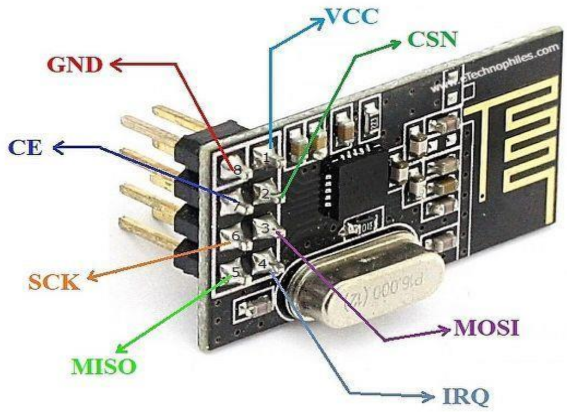

Figure 10: NRF24L01 Transceiver module

3.4.1.3 Arduino UNO

The Arduino UNO uses an atmega328 micro-controller with 32kb data memory. Feasible software programmability due to its open-source and compact style. Enhanced feasibility due to the use of a USB cable. It has 14 optical input/output pins, an analogue input/output port, and ceramic resonators of 16 MHz.

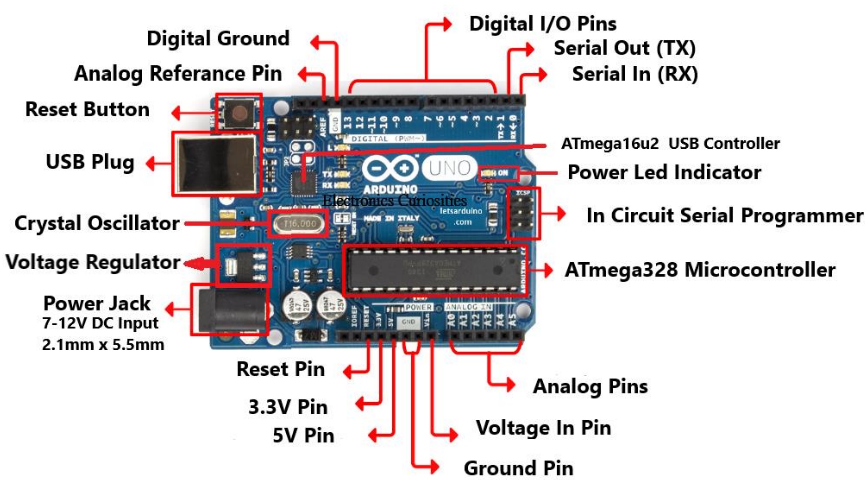

Figure 11: Arduino Uno

3.4.1.4 Arduino Nano

The Arduino board supports entry-level micro-controller boards that are easy for beginners to learn to use. The board is breadboard friendly due to its plug and play design. Let's begin with power requirements.

- **USB Jack:** Plug a mini USB jack into a handset or device to enable the power and the power required for the board to function will be maintained.
- **V_{in} Pin:** To power the board the Vin pin with an unregulated 6-12V should be supplied and the onboard voltage regulator regulates it to +5V.
- **+5V Pin:** After regulating +5V supply the +5V pin of the Arduino can be supplied.
- **Input/output:** Nano board has 14 digital and 8 Analog pins. The digital pins can be used to interface sensors by using them as input pins or drive loads by using them as output pins. A simple function like pin Mode () and digital Write () can be used to control their operation. The operating voltage is 0V and 5V for digital pins. The analogue pins can measure analogue voltage from 0V to 5V using any of the 8 Analog pins using a simple function liken analogue Read ().

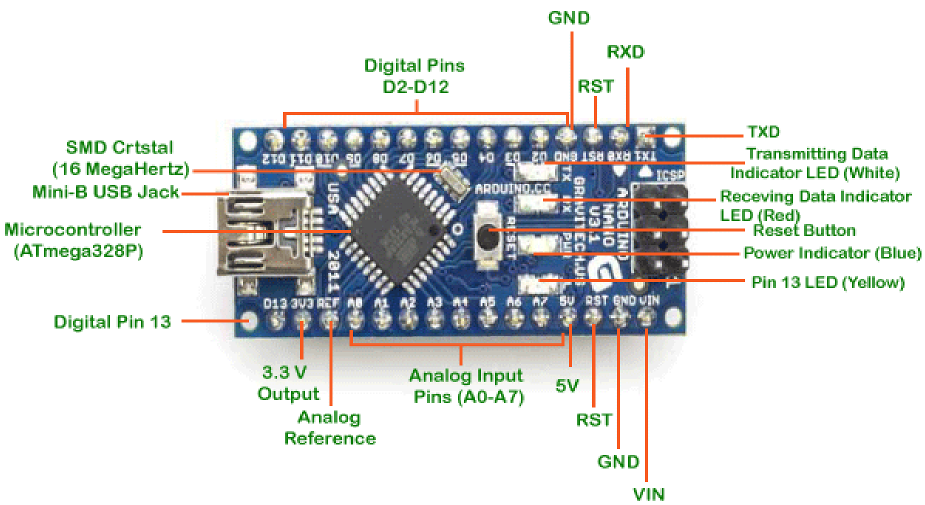

Figure 12: Arduino Nano

3.4.1.5 H-Bridge L298

• The agility of the S.A.G.E BOT is derived from the 200 rpm geared motors.

• The above mentioned geared DC motors are current hungry and the L298 will help quench the current thirst.

• Key features

– Operating Supply Voltage up to 46 volts.

– Total DC Current up to 4A.

– Over Temperature Protection.

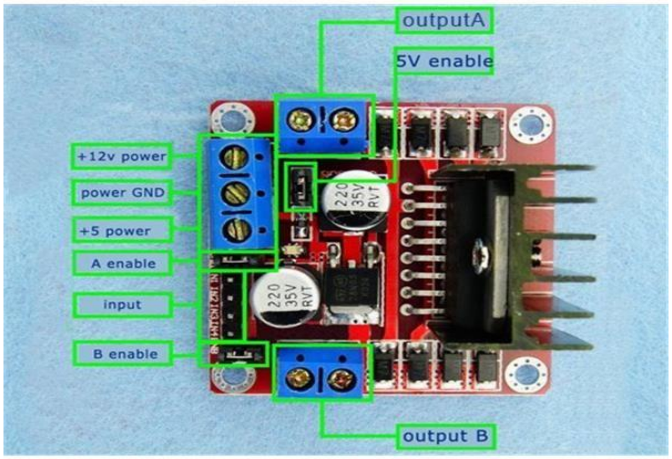

Figure 13: H-Bridge l298

DC Gear Motor:

Figure 14: DC Gear motor

This two DC gear motor is used for the movement operations of the robot's wheel. These two are driven by the motor driver L298 D. It is a high speed, high torque, low power consumption, low noise and simple machine. It features an arena structure, easy maintenance, and long service life.

Specifications:

_ Model: DC motor RS-555

_ Rated voltage: DC 12V

_ No-load speed: 3000-3500 rpm/min

_ Load speed: 40rpm/min

_ Weight: 502g

_ Size: Diameter 37mm, Length 65mm

3.4.1.6 DC Motor

DC motor is used to initiate and control the movement of the robot's wheel. The two motors in this motor driver are driven by an L298 D. It's a high speed, high torque, low power consumption, and low noise motor driver. It features easy maintenance, long service life, and a state-of-the-art design.

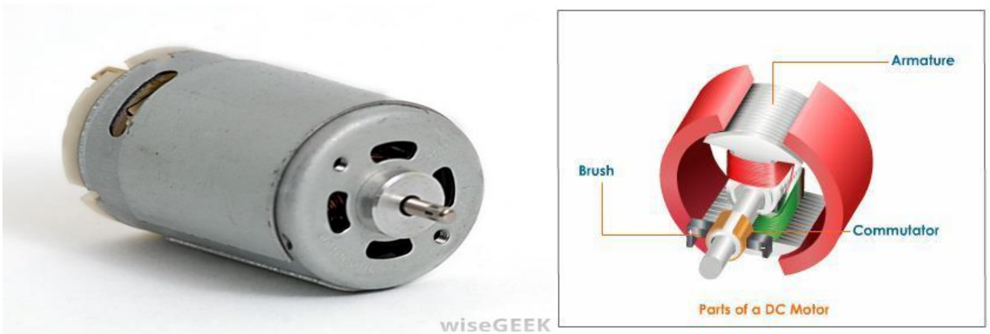

Figure 15: DC motor

3.4.1.7 Joystick

The joystick is a component of an input device that allows the user to control a character or machine by moving their hand or arm. They resemble the technology used in arcade games, but they are usually equipped with extra functionality beyond the game. The picture depicts a Logitech Freedom 2.4, an example of a Keyboard Mouse.

Figure 16: Joystick

3.4.1.8 Switch

A switch is a small electrical component used to interrupt an electrical circuit, or diverting it from one conductor to another, or divert electricity to a different part of the circuit.

Figure 17: Switch

3.4.1.9 Battery

The battery supplies the required energy to the device for functioning properly. The battery should be able to supply the required power for the component to run when being heavily loaded. It takes three 12V/15Ah batteries to power our robot. This allows powering of the wheels, the rotating brush and the cutter-thread.

Figure 18: UPS Battery 12V 15Ah

Electrical system

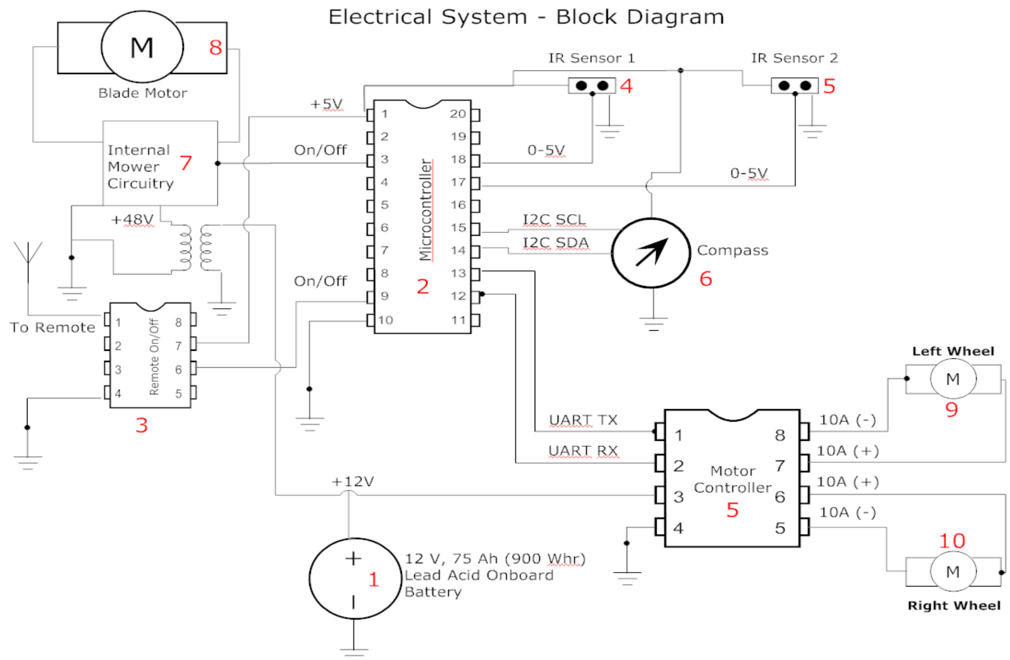

Figure 19: Electrical Circuit

To guide us in the construction of the device, we created a block diagram that shows how each module would attach mechanically to the other; furthermore, we use this diagram to quantify wire lengths and route the whole system's wires and circuit. The final method is outlined above.

The system operates as follows:

- The Main Battery (1) is a 12 V, 75 Amp-hour (Ahr), rechargeable, lead-acid battery. This provides all power for the electrical system, and feeds directly into the Remote On/Off unit (3) and the Motor Controller (5), as the motors require significant amperage and will be the largest drain on the battery. Moreover, the battery feeds directly into the Internal Mower Circuitry (7), as this is the default lawnmower configuration.
- The Microcontroller controls the compass and proximity sensors (2); additionally, the microcontroller controls the pulse-width modulation (PWM) signal needed to drive the Motor Controller (5).
- The Remote On/Off unit (3) turns the mower blade on and off via the Internal Mower Circuitry (7); it also turns the Microcontroller (2) on and off, allowing the wheel motors to be controlled independently from the blade motor.
- The Proximity Sensors and Compass transmits this signal to the Microcontroller to be stored for future waypoint following.
- The Motor Controller (5) receives its modulated signal from the Microcontroller (2), determining which way to turn, how fast to move, and whether to drive forward or in reverse. The motor controller’s power is derived directly from the Main Battery (1), and it feeds both Wheel Motors (9, 10).

- The Internal Mower Circuitry (7) is the existing onboard circuitry that came with the lawnmower itself. This controls the recharge feature of the battery, as well the blade motor control and the existing on/off switch on the lawnmower handle (not shown).
- The Blade Motor (8) is an existing motor that spins the lawnmower's blade.
- The Left and Right Wheel Motors (9 and 10, respectively) control the left and right wheels, respectively.

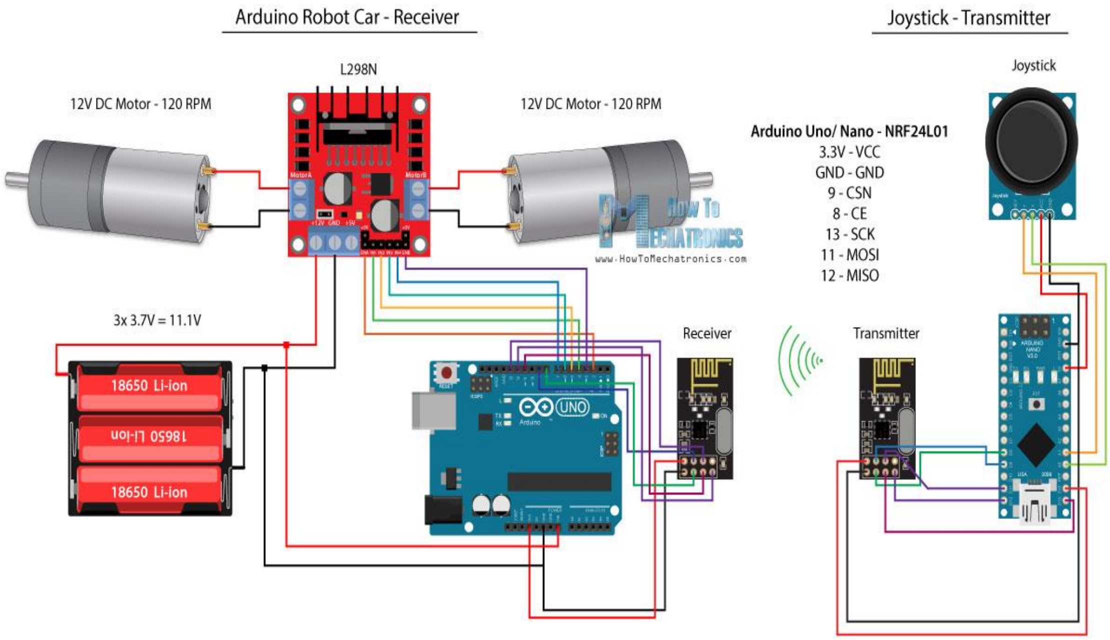

Figure 20: Electrical Design

Project budget

The project expense is set at 2000TK. The subsequent table illustrates the average machine expense and as little redundancy as possible.

Risk Analysis

This risk review highlights recent developments. The lower section of the chart shows the possibility that the incident will arise, the upper part of the chart represents the magnitude of the event. On the other hand, power has a 10% to 50% probability of happening, for example, that can be known as having a mild occurrence percentage such as this. If the project were to be effective, this will be a significant case. The risk analysis can include parameters such as accuracy, price tag, density, magnitude, availability, energy source, etc.

ARDUINO PROGRAMMING

lawnmower_code.lnk

```
#define trig1 4
#define echo1 3
#define trig2 2
#define echo2 1 // 2-> controls

int motor1_forward = 7;
int motor1_reverse = 6;
int motor2_forward = 9;
int motor2_reverse = 8;


// the setup routine runs once when you press reset:
 void setup()
{
 Serial.begin  (9600);
 pinMode (trig1, OUTPUT);
 pinMode (echo1, INPUT);
 pinMode (trig2, OUTPUT);
 pinMode (echo2, INPUT);
 pinMode(motor1_forward, OUTPUT);
 pinMode(motor1_reverse, OUTPUT);
 pinMode(motor2_forward, OUTPUT);
 pinMode(motor2_reverse, OUTPUT);
 }

// the loop routine runs over and over again forever:
```

Figure 21: Arduino program

```
void loop() {
 int distleft,distright;
 distleft = sensorleft();
 distright = sensorright();
if (distleft <= 50 && distright > 50)
{
 digitalWrite(motor1_forward,0); //terminal D1 will be HIGH
 digitalWrite(motor1_reverse,1);
 digitalWrite(motor2_forward,1); //terminal D1 will be HIGH
 digitalWrite(motor2_reverse,0);

 }
else if (distleft > 50 && distright <= 50)
{
 digitalWrite(motor1_forward,1); //terminal D1 will be HIGH
 digitalWrite(motor1_reverse,0);
 digitalWrite(motor2_forward,0); //terminal D1 will be HIGH
 digitalWrite(motor2_reverse,1);
 }
else if (distleft < 50 && distright < 50)
{
 digitalWrite(motor1_forward,0); //terminal D1 will be HIGH
 digitalWrite(motor1_reverse,1);
 digitalWrite(motor2_forward,1); //terminal D1 will be HIGH
 digitalWrite(motor2_reverse,0);
 }
```

Figure 22: Arduino programming

```
else
{
 digitalWrite(motor1_forward,1); //terminal D1 will be HIGH
 digitalWrite(motor1_reverse,0);
 digitalWrite(motor2_forward,1); //terminal D1 will be HIGH
 digitalWrite(motor2_reverse,0);
 }

}
```

Figure 23: Arduino programming

```
 int sensorright() {
  int duration, distance;
  digitalWrite (trig2, HIGH);
  delayMicroseconds(1000);
  digitalWrite (trig2, LOW);
  duration = pulseIn(echo2, HIGH);
  distance = (duration/2) / 29.1;
  Serial.print (distance);
  Serial.println ("\a");

  return distance;
}

 int sensorleft() {
  int duration, distance;
  digitalWrite (trig1, HIGH);
  delayMicroseconds(1000);
  digitalWrite (trig1, LOW);
  duration = pulseIn(echo1, HIGH);
  distance = (duration/2) / 29.1;
  Serial.print (distance);
  Serial.println ("\a\a");

  return distance;
}
```

Figure 24: Arduino programming

Chapter 4

Analysis & Data Interpretation

4.1 Observations of the Lawn Mower

1) Wheel diameter, d = 18 cm
2) The rotation speed of wheels, N_1 = 60 rpm
3) The rotation speed of brush, N_2 = 80 rpm
4) The rotation speed of cutter thread, N_3 = 150 rpm
5) Mass of the lawnmower, m = 30 Kg
6) Length of storage unit, l = 34 cm
7) Breadth of storage unit, b = 14 cm
8) Height of storage unit, h = 12cm
9) Diameter of blade, d_2 = 3 mm
10) Mass of the cutter, m_2 = 0.5 Kg
11) Length of blade, l_2 = 40 cm
12) Power capacity of solar panel, P' = 5 W
13) Voltage rating of the battery, V' = 12 V
14) The storage capacity of battery = 7.5 Ah

4.2 Design Calculations

Speed of lawn mower

Circumference of wheel

C = 3.142 x d=3.142 x 18 = 56.54 cm

Speed of movement of the device

= (N_1/60) x C

= (60/60) x 56.54 x 10-2 = 0.57 m/s

= 0.57 x 18/5= 2.052 km/hr

Power required to drive the lawnmower

Force (F) = m x g = 30 x 9.81 = 294.3 N

Power (P) = F x V = 294.3 x 0.57 = 167.751W

The power produced by wheel motor

Effective mass on each motor, m’ = m/2 = 30/2 = 15 kg

Force F = m’ x g = 15 x 9.81 = 148N

Radius of the wheel, r = d/2 = 0.18/2 = 0.09 m

Torque produced T= F x r_1

= 148 x 0.09= 13.32 Nm

Power = (2 x π x N_1 x T)/60

= (2 x 3.142 x 60 x 13.32)/60 = 83.7 W

Total power produced by both wheels

P = 83.7 x 2 = 167.4W

The volume of the storage unit

Volume V = l x b x h = 34 x 14 x 12= 5712 cm^3

Angular velocity of the blade

ω= $2\pi N_3/60$= 2 x π x (150)/60 = 15.70 rad/sec

Torque produced by the blade

Area of cross section of the cutter thread

A = πd2

2/4 = π x (0.3)2/4 = 0.07 cm^2

Volume of the cutter thread V = A x l_2

V = 0.07 x 40 = 2.8 cm3

Weight of the cutter W_2 = m_2 g

= 0.5 x 9.81 = 4.9N

Torque T = W_2 x l_2/2 = 4.9 x 0.4/2 = 0.98 Nm

Force produced by the blade

Fc = m_2 (l_2/2) ω_2 = 0.5 x (0.3/2) x (15.7)2 =18.5N

Battery charging time

Current produced by solar panel, I = P’/V’

= 5/12 = 0.416 A

Charging time, Battery capacity/current

= 7.5/0.416 = 18 hrs

a) Selection Of Electric Cutting Motor

DC motor

Speed = 2000 rpm

Voltage = 12 volt

Power = 180 w

$T = (P \times 60)/ 2 \Pi N$

$= (180 \times 60)/2 \Pi 2000$

Hence Torque produced by the cutting motor is 0.862 Nm.

b) Selection Of Lifting Motor

Force = (Wt. Of motor + rack Wt. + misc.) x 9.81

= 0.85 kg x 9.81

= 8.338 N

T = force x radius of lifting pinion

= 8.338N x 0.02m

= 0.1667 Nm

$P = (2\Pi NT) / 60 = (2 \times \Pi \times 2000 \times 0.1667) / 60$

$= 34.91 \approx 35$ watt

Hence the power and torque of the lifting motor is 35 watt and 0.1667Nm.

4.3 Performance Factors

The device needs to be examined to determine its working efficiency, and how practical it is. The main factors involved are:

- **Cutting Time:** It is one of the crucial aspects that effects the performance of the device. Cutting time is the amount of time required for the mower to finish mowing a specified area. Time is the most important resource, and it is a crucial factor in determining the usability and efficiency of the system.
- **Trimmed lawn condition:** When measuring a lawnmower efficiency, two things are taken into account are the cut produced, and how clean the cutting was maintained on the lawn. A desirable effect of trimming is to provide a uniform, tidy lawn.
- **Movement Pattern:** It is another important factor that can affect the performance of the device. It is inefficient and wasteful in terms of time and energy if the mower would repeatedly traverse an already-trimmed section of lawn. And so, the movement pattern needs to be determined in advance to avoid such un-needed resource consumption.
- **Power requirements:** The power requirement of a device determines its efficiency. According to the power requirements of the device, the energy used for mowing the lawn varies. The more power it needs, the more energy it costs to maintain the lawn.

Chapter 5

Application, Conclusion And Future Work

5.1 Application

The lawnmower can be used in various ways:

- At the home, garden or backyard.
- In parks, to remove the unwanted weeds.
- In Grassland at university and departments of the office.
- In Playgrounds, baseball fields, football fields, etc.

5.2 Advantages

- The remote-controlled lawnmower is designed to reduce the workload on humans.
- This lawnmower is simple in design compared to many existing lawnmowers.
- It is an economical lawnmower than many other marketable mowers.
- This mower can function wirelessly at a remote location.
- It can be used as fertilizer for a variety of plant and vegetation fertilization.
- It helps elderly people and those with disabilities.

5.3 Limitations

- The extensive time involved to remove grass from the lawn.
- Difficult to use in rainy seasons.
- Manually operated.
- In some cases, an autonomous lawnmower is not safe enough.

5.4 Future Work

- This is the key system that makes the mower able to recognize obstacles, know how to avoid them, and mow in a pattern.
- Quite a lot of experience has already been gained with the other sensors (infrared, solar, etc.) for previous generations of autonomous lawnmowers especially the first two generations.

5.5 Conclusion

Robotics is a very broad field with multiple technological branches this will aid in the reduction of human effort and provide maximum efficiency in the production process. Today, a lot of energy is wasted throughout the world by mowing the lawn in different areas and is a difficult and exhausting task. The overall goal of this project is to create a robotic remote-controlled lawnmower system that is capable of cutting the lawn efficiently with less effort. Advantages of this system partly can include inexpensive components that can be produced in large quantities which makes the lawnmower cost-effective. Moreover, the auto controlled lawn mower provides many benefits and the technology is viable for the market. However, most people aren't familiar with this new technology on the mower. Each aspect of the previous lawnmowers is incorporated in this new design to further improve the function, efficiency and usability of the mower. The safety, reliability, and cost-effectiveness of the new mower will be comparable to or exceed, the benefits of available mowers.

References

[1] "Mower History." The Old Lawnmower Club Collection, Preservation and Display of Old Lawn Mowers. N.p., n.d. Web. 29 Feb 2012.

[2] Diggs, Steven. "Corded vs. Cordless Electric Lawn Mowers." ehow. N.p., n.d. Web. ,29 Feb 2012.

[3] A.Dipin and T.K.Chandrashekhar, ―Solar-powered vision-based robotic lawnmower, International Journal of Engineering Research and Reviews, vol. 2, pp: 53-56, April 2014 - June 2014.

[4] O. A Tanimola, P. D Diabana, and Y. O. Bankole,―Design and development of a solar-powered lawnmower, International Journal of Scientific & Engineering Research, vol. 5, June-2014.

[5] D.Satwik, N.Ramalingeswara Rao, SreeramReddy, ―Design and fabrication of lever-operated solar lawnmower.

[6] "Mower History." The Old Lawnmower Club Collection, Preservation and Display of Old Lawn Mowers. N.p., n.d. Web., 29 Feb 2012.

[7] Diggs, Steven. "Corded Vs. Cordless Electric Lawn Mowers." ehow. N.p., n.d. Web. ,29 Feb 2012.

[8] A.Dipin and T.K.Chandrashekhar, ―Solar-powered vision-based robotic lawnmower, International Journal of Engineering Research and Reviews, vol. 2, pp: 53-56, April 2014 - June 2014.

[9] O. A Tanimola, P. D Diabana, and Y. O. Bankole,―Design and development of a solar-powered lawnmower, International Journal of Scientific & Engineering Research, vol. 5, June-2014.

[10] A.Dipin and T.K.Chandrashekhar, "Solar-powered vision-based robotic lawnmower," International Journal of Engineering Research and Reviews, vol. 2, pp:
53-56, April 2014 -June 2014.

[11] O. A Tanimola, P. D Diabana, and Y. O. Bankole, "Design and development of a solar-powered lawnmower," International Journal of Scientific &
Engineering Research, vol. 5, June-2014.

[12] D.Satwik, N.Ramalingeswara Rao, SreeramReddy, "Design and fabrication of lever-operated solar lawnmower and contact stress analysis of spur gears,"
International Journal of Science, Engineering and Technology Research, vol. 4, August-2015.

[13] G. Newstadt, K. Green, D. Anderson, M. Lang, Y. Morton, and J. McCollum, "Miami Redblade III: A GPS-aided Autonomous Lawnmower".

[14] P. Patil, A. Bhosale, S. Jagtap, "Design and implementation of automatic lawn cutter,"

[15] Ray Jarvis, "A tele-autonomous heavy-duty robotic lawnmower," proc.2001 Australian conference on Robotics and Automation Sydney, Nov 14-15, 2001.

[16] H. Singh, J. Singh Mehta, "Design and analysis of wireless remote controlled lawn mower," SSRG International Journal of Mechanical Engineering, April
2015.

[17] S. Sujendran, P. Vanitha, "Smart Lawn Mower for Grass Trimming," IJSR, vol 3, Issue 3, March 2014