RENEWABLE POWER GENERATION VIA ANIMATE PRIME MOVERS

1. QURBAN ALI 2019-EE-353
2. HUZEIFA ALI 2019-EE-359
3. MUHAMMAD SHOAIB 2019-EE-369
4. TIPU HARIS ZAHEER CHATHA 2019-EE-371

Supervisor

Dr. Faizan Dastageer

Signature: _____

Department of Electrical, Electronics & Telecom Engineering

University of Engineering and Technology Lahore (FSD Campus)

May 2023

“Renewable Power Generation Via Animate Prime Movers”

A report submitted in partial fulfilment of the requirement for the degree of

B.Sc. Electrical Engineering

Internal Examiner	**External Examiner**

Chairman

Department of Electrical, Electronics & Telecom Engineering
University of Engineering and Technology Lahore (FSD Campus)
May 2023

DECLARATION

We solemnly declare that this report is written by us and is not copied from any online or printed material.

1. Qurban Ali _____
2. Huzeifa Ali _____
3. Muhammad Shoaib _____
4. Tipu Haris Zaheer Chatha _____

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

PROBLEM STATEMENT

Power Generation has been a major issue in Pakistan. Moreover, the electricity, that has been generated, is offering more costs, due to which bills of electricity have been increasing continuously. Other power-generating sources like coal, fuel, and natural gas, have been producing many harmful gases, that harm the environment and increase the temperature of the earth. Due to these harmful gases, the temperature of the earth increases and glaciers melt and we have to face the consequences.

To solve the above problem, we decided to convert the muscular energy, that has been tapped in muscles of animals into electrical energy, which is totally environment-friendly, green, and clean energy.

This project seeks to harness renewable energy from animate prime movers (such as cattle) by using the idea of ‘power generating carts’.

ABSTRACT

The project portion relates to the generation of power, specifically electricity, by animals, especially cattle. The project particularly relates to generating carts that can be used to produce power using animals. The device will be designed such that the energy of moving animals will be utilized to rotate the belt connected to the cart. DC generator would be attached to the belt to produce power which can either be stored in a battery or fed into the electrical system or can be used to power electrical equipment in a dairy operation. DC generator will give 12V in DC at 1450 rpm along with 300W power. There is an automation portion that will operate on a specific condition in the form of speaker command that will be an indication to the prime mover to move ahead. When this indication happens many times, we will stop the prime mover because this will be the maximum fatigue level of the prime mover. There are 3 different bulbs to show the different fatigue level. There is an inverter that will convert the DC into AC. There are both DC and AC loads. To constant the voltage level, there is a capacitor, connected to the DC generator.

REFERENCES

[1] Arlan R. Smith, “Bovine Treadmill” 14021 Country Way, McCall, ID (US) 83638

[2] W.Taylor, Macosquin (GB), “Animal Power Generator” Pub. No. 2011/0266091 A1, Appl. No. 12/921,394

[3] Li Chengyu, Zhang Hongjie, Wang Sen, “Equipment for Breeding Animals”, CN108157223B

[4] Faizan Dastgeer, Muhammad Sarmad Javed, Muhammad Umar Hussain, Nouman Ahmad, Mohammad Sameer, Muhammad Shahid Amin, “A Sustainable Power Solution for Cattle Farms: Prototype of Power Generating Treadmill for Large Animate Prime Movers”, published on 08.07.2022

[5] Applicant: T.C.CHANG, New Taipei City(TW), Inventor: T.CHANG, N.Taipei City(TW), “Livestock Power Generation System”, Appl. No.14/885,340, Pub. No. US 2016/0344260 A1

[6] BAYEN, A.Kumar [IN/IN]; c/o J.Bayen, D.Bijoynagar, Joyna, gar, Dist: South 24 Parganas, West Bengal (IN), “A System for Generating Electricity using Nonconventional Source” International application number PCT/IN20 19/050243

[7] H. T. Yang, Senior Member, IEEE, T. H.Tseng, T. H. Ai, Y. H. Wu, and S. H. Yeh, “A Grid-Connected Energy Conversion System for a Treadmill with Auto-transferring Modes between a Motor and a Generator”, IECON2015-Yokohama November 9-12, 2015

[8] Sahill, P.K. Sharma, N. Hari, N. Kumar, and D. Shahi, BVCOE, Delhi, India 4EEED, BVCOE, Delhi, India, “An Innovative Technique of Electricity Generation and Washing Machine Application using Treadmill”, 1st IEEE International Conference on Power Electronics. Intelligent Control and Energy Systems (ICPEICES-2016)

[9] Yingbo Yu, H.Aohua Qin, “The Design of Treadmill with Distributed Generation Function”

[10] Al-Barkat Mehedi, Masuma Akter, Asma-Ul-Husna, “Electricity Generation from Treadmill Using Piezoelectric Transducer”, Paper ID: ET 136

[11] Shamshad Ali, Syed Tariq Murtaza, A.K.Katiyar. “Design of Manual Treadmill with Electricity Generator for Energy Saving”

[12] A.gaikwad, A.Jadhav, P.Dhage, S.Borchate, “Design and Development of Treadmill to Generate Electricity by Using Mechanical Energy”, e-ISSN: 2395 -0056, p-ISSN: 2395-0072

[13] K.Titare, A.Ram, S.Nagrale, Prof. S.R.Zaveri4, “Design and Fabrication of Power Generating Manual Treadmill”, eISSN: 2395 -0056, p-ISSN: 2395-0072

[14] D.A.Gondane, Aniket M. Dighade, Priyanka V. Raut, “Treadmill Based Electricity Generator for Domestic Purpose”, eISSN: 2395 -0056, p-ISSN: 2395-0072

[15] Faiz F. Mustafa, O Hussein, Sadoon Radhi Daham, and, A.H.Sabry, “New Treadmill Design for Energy Harvesting”, ISSN: 1024- 1752, CODEN: JERDFO, Published Year 2020

CHAPTER 1

1.1: Introduction of renewable energy

Renewable energy has become an increasingly important topic in recent years due to the global concern about climate change and the environmental impacts of fossil fuels. Renewable energy refers to the energy that is generated from natural resources that are replenished over time, such as solar, wind, hydro, geothermal, and biomass.

Fig 1.1: Different Energy Sources

1.1.2: Renewable energy sources

Renewable energy resources are a category of energy sources that can be replenished naturally over time. These sources of energy include solar, wind, hydro, geothermal, and biomass energy. Unlike non-renewable energy sources, such as fossil fuels, renewable energy resources do not deplete over time and do not harm the environment as much. Renewable energy resources have enormous potential to meet the world's energy demand.

Fig 1.2: Renewable Energy Sources

The use of renewable energy sources has numerous benefits, both for the environment and for human health. Firstly, renewable energy sources do not emit harmful pollutants into the air or water, unlike fossil fuels.

1.1.3: Renewable energy and air pollution

This means that the use of renewable energy can reduce air pollution and improve the quality of life for people living in urban areas. Secondly, renewable energy is often more cost-effective than fossil fuels, especially as the cost of technologies such as solar and wind power continue to decline. Thirdly, renewable energy can provide a reliable source of power in areas that are not connected to a traditional electricity grid, such as remote communities and rural areas.

Fig 1.3: Fossil Energy

1.1.4: Green Energy Production

The need for renewable energy has become increasingly urgent as the world faces the impacts of climate change. The burning of fossil fuels has contributed significantly to the increase in global temperatures, leading to more extreme weather events such as droughts, floods, and hurricanes. Renewable energy can play a crucial role in mitigating the effects of climate change by reducing greenhouse gas emissions and slowing the rate of global warming.

Renewable energy sources can be used to generate electricity using various types of prime movers or generators. Animate prime movers are a category of renewable energy technologies that use living organisms to generate energy.

It produces no greenhouse gas emissions from fossil fuels and reduces air pollution, diversifying the energy supply and reducing dependence on imported fuels, and creating economic development and jobs in manufacturing, and installation is all the benefits of renewable energy.

Fig 1.4: Pollution Effect

Fig 1.5: Green Energy

1.2: Renewable energy production in many countries

In recent years, many countries have made significant investments in renewable energy. These investments have helped to reduce the cost of renewable energy technologies and increase their adoption, which has led to a significant increase in the use of renewable energy worldwide. However, there is still a long way to go before renewable energy can fully replace fossil fuels as the primary source of energy worldwide. Therefore, it is important that policymakers continue to support the growth of renewable energy and invest in research and development to improve renewable energy technologies and make them more efficient and cost-effective.

Fig 1.6: Wind Renewable Energy

1.3: Pakistan and Renewable energy

Pakistan is a developing country that is highly dependent on imported oil and gas to meet its energy need. However, the country has abundant renewable energy resources such as solar, wind, hydro, and biomass, which can help to reduce its reliance on fossil fuels and improve energy security.

In recent years, Pakistan has made significant efforts to develop its renewable energy sector. The government has set a target of achieving 30% of its electricity generation capacity from renewable sources by 2030. The country has made significant progress towards this goal, with renewable energy capacity increasing from 240 MW in 2013 to over 9,000 MW in 2021.

Fig 1.7: Solar Energy in Pakistan

1.4: Livestock Renewable Energy

Livestock renewable energy is a concept that involves using animate prime movers, such as cows or horses, to generate electricity. This approach is applicable to dairy farms and dairy animals where they move with a device on their backs that produces electricity. The concept has the potential to provide several benefits, including improved animal health, reduced energy costs, and reduced greenhouse gas emissions.

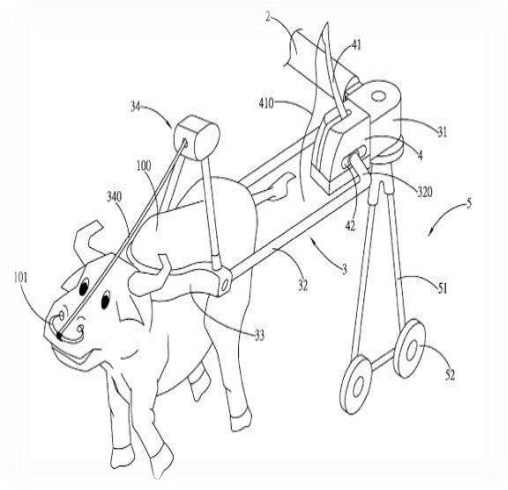

Fig 1.8: Patent picture showing Prime Mover Renewable Energy Production Device

One example of livestock renewable energy is the use of cow power. Cow power involves capturing the methane emissions from cow manure and using it to generate electricity. This approach not only produces electricity but also helps to reduce greenhouse gas emissions from dairy farms.

Another example of livestock renewable energy is the use of cow generators. These generators are installed on the backs of cows and use the up and down motion of the cow's movement to generate electricity. The energy generated can then be used to power the farm or sold back to the grid.

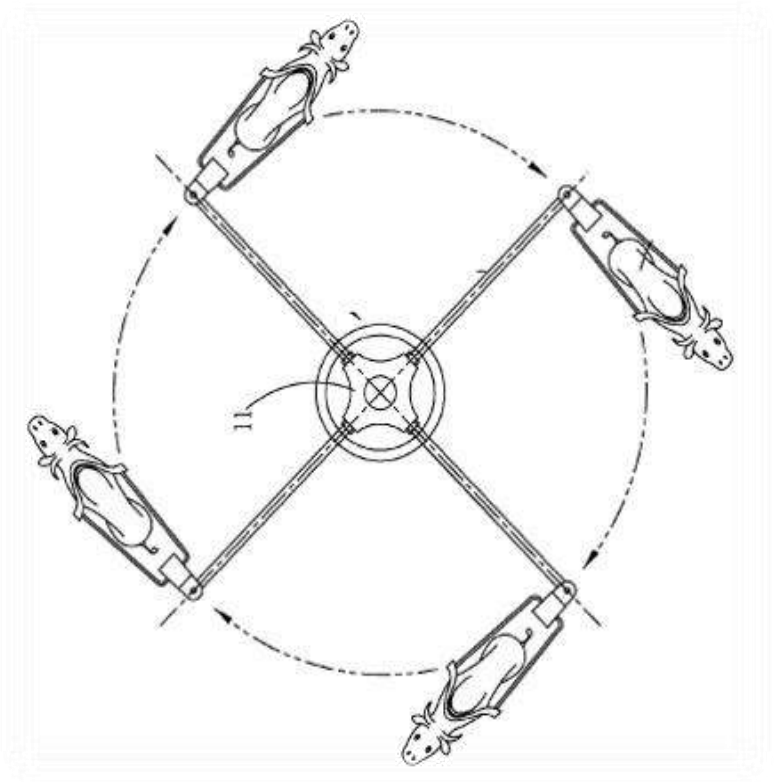

Fig 1.9: Showing Prime Mover Renewable Energy Production Device

There are also wearable devices that can be attached to animals to harness their movement and generate electricity. These devices are designed to produce electricity when the animal moves, such as when it walks or grazes. The energy generated can then be used to power the farm or other applications.

1.4.1: Positive Impact on Animal Health

In addition to providing renewable energy, these technologies can also have a positive impact on animal health. For example, wearable devices that harness the movement of animals can encourage them to move more, which can improve their health and well-being.

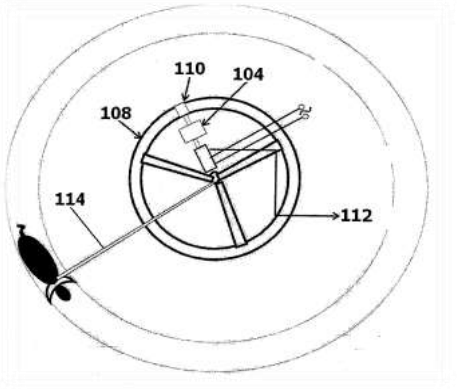

Fig 1.10: Showing Prime Mover Renewable Energy Production Device

1.5: Future of Sustainable Agriculture

While the use of livestock renewable energy is still in the early stages of development, there is significant potential for it to play a role in the future of sustainable agriculture. By harnessing the movement of animals and converting it into electricity, farmers can reduce their reliance on non-renewable energy sources, improve animal health, and reduce their environmental impact. As the technology continues to evolve and become more efficient, it is likely that we will see more widespread adoption of livestock renewable energy in the years to come.

1.6: Overview of renewable energy

Overall, while there are still challenges to overcome, such as financing and infrastructure issues, Pakistan has made significant progress in developing its renewable energy sector. With continued efforts and support, the country has the potential to become a leader in renewable energy in the region.

CHAPTER 2

2.1: Literature Review

Animate prime movers refer to renewable energy technologies that use living organisms to generate energy. These technologies utilize the muscular energy of animals for generating electrical energy. The use of animate prime movers has been studied extensively in the literature, and numerous research efforts have been made to explore the potential of these technologies for sustainable energy generation. This literature review summarizes past research efforts using animate prime movers.

2.1.2: Concept of using animate prime movers

The concept of using animate prime movers, such as cows or horses, to generate electricity is not a new idea. In fact, it has been around for centuries, with early examples of animal-powered machines dating back to the middle-ages. However, in recent years, there has been renewed interest in the concept of livestock renewable energy, driven by the need to reduce greenhouse gas emissions and increase the use of renewable energy sources.

2.2: Research in livestock renewable energy

Another area of research in livestock renewable energy is the use of wearable devices that harness the movement of animals to generate electricity. Several studies have shown that wearable devices can be an effective way to generate electricity from animal movement. For example, a study published in the Journal of Renewable and Sustainable Energy found that wearable devices attached to cows could generate up to 3 watts of power per cow, which could be used to power sensors or other devices on the farm.

2.3: Research patents

The article [1] describes a running treadmill for dairy cows that provides exercise benefits and generates electric power. The device is equipped with an ID chip system to record cow health parameters and a hoof abrasion system. However, the inventor did not achieve the objective of electric power generation due to the absence of a generator. Softer side barriers are recommended to prevent injury to the bovines.

The article [2] presents an animal power generator using a treadmill-like device. The device includes an entry end, feed end, sidebars, a belt around the roller, a generator, and brakes. Multiple treadmills can be used in parallel for increased electricity generation. The device has a detector to sense an animal presence, a feed box, and small belt carrier rollers or ball bearings. The generator type is not specified, but AC generators are more advantageous than DC. Using treadmills in parallel may cause issues with varying animal speeds. To generate electricity on a farm, each treadmill must be used separately.

In the article [3], the inventors introduced a breeding device for animals to improve their body quality and disease resistance. The device consists of a feeder, clean bedding, cultivation unit,

conveyor belt, and control unit with lighting and speaker reminding devices. However, the control unit's functions and safety concerns regarding the lighting and speaker reminding devices require further clarification. Additionally, the inventors did not address the cooling process after drying the conveyor belt.

The article [4] presents a method of generating renewable power by running living beings on a treadmill. A small treadmill was designed to determine the produced power, which was then implemented on a larger iron frame. The power generated by human beings was 53W and could run two loads. Adding electronic devices and entry/leaving gates can improve the device's functionality. The proposed treadmill device needs a flushing system for equine and ID chips carried by equine for animal detection.

The article [5] proposes using livestock movement to generate electricity by using equiangular levers to rotate a power generation system. An urging and stopping device is used to control the movement of the livestock, and a speed indicator is used to detect slow movement and command whipping to increase speed.

The article [6] proposes a renewable energy device consisting of six power units that use gears and free wheels to generate electricity using livestock. The movement of the livestock in a circular position rotates the main shaft, which generates electricity. The device uses a synchronous generator with a converter and transformer and each power unit requires six horses, totaling 36 horses for large power production.

The article [7] presents a grid-connected energy conversion system for a treadmill that can convert kinetic energy into electrical energy. The system operates in two modes, motor and generator, and uses a three-phase AC-DC power converter and a single-phase DC-AC power converter. A PI controller is used to remove the steady-state error, and experimental results show the system's feasibility and effectiveness.

The article [8] proposed a treadmill model with a washing machine application for generating renewable energy with no pollution. The treadmill consisted of a walking belt, wheels, a shaft, and a gearbox that connected to a DC generator. A specially designed washing machine was coupled to the treadmill via a shaft and a gearbox. A boost converter was used to convert lower voltage to higher voltage. The running person on the treadmill rotated the wheel, which caused the washing tub to rotate via the gearbox shaft, generating electricity with the DC generator that could be used for home appliances.

2.4: Patents related to animal-producing energy

The patent [9] proposes a treadmill that converts human kinetic energy into electrical energy using a permanent magnet synchronous generator, a drive board, and a master control board. The AC current generated by the generator is rectified to DC current and stored in a battery. The system uses a PWM module to adjust electromagnetic damping, and the software is designed using C language and the Keil5 development environment.

This patent [10] proposes generating clean electric energy using Piezoelectric Transducer on a treadmill. The inventor used crystalline piezoelectric components to convert human-weight

deformations into electrical charges. The setup included piezoelectric transducers, an AC-DC rectifier, Capacitor, Battery, Connecting wire, and Cork pieces. The setup generated maximum power at maximum load using multiple Piezoelectric Transducers.

This patent [11] proposed a treadmill with a generator to generate electricity by converting human walking/running effort into electrical energy. The device consists of a flywheel, rollers, working belt, upright support, U-shaped handrail, electricity generator, V-pulley, and V-belt. The flywheel runs at 200 RPM and rotates the rollers to generate electricity. The diameter of the flywheel is larger than the diameter of the V-pulley to produce more power. This design not only generates power but also provides health benefits from exercise on the treadmill.

Fig 2.1: Horse Running on a Treadmill for energy production

In the patent [12], the inventor designed a treadmill with a generator to generate electricity using mechanical energy. The treadmill was coupled with a shaft, bearing, and generator. The electricity was used to power electrical instruments and LED bulbs.

This patent [13] proposed a treadmill-based electricity generator that used a roller and gear to convert mechanical energy into electrical energy. The device consisted of a roller, shaft, bearing, AC motor (as a generator), moving belt, and rectifier circuit. The roller reduced friction and the gear attached to the main shaft converted mechanical energy to electrical energy. The inventor used bearings to rotate freely and produce more power. The generator produced AC current that was converted to DC using a bridge rectifier.

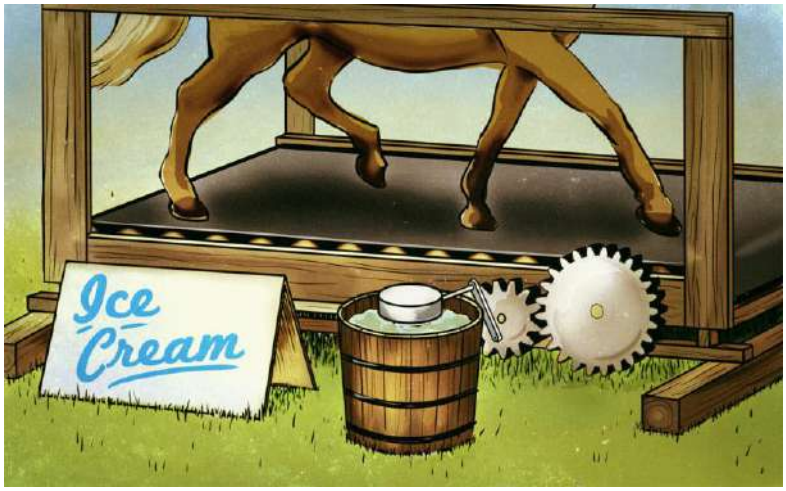

Fig 2.2: Horse running on treadmill

The inventor of the patent [14] proposed a treadmill-based electricity generator using an electromagnetic dynamo generator coupled to a front axle flywheel. The DC generator was directly coupled to the gearbox through a shaft that was connected to the moving belt of the treadmill. The generator was coupled with a boost converter to increase DC voltage up to 220V, and a controller was used to maintain a constant voltage regardless of changes in belt speed. The inventor produced 140W of electric power by rotating the main shaft of the treadmill.

The inventor of the patent [15] used a manual treadmill to generate electrical power without harming the environment. The device used a gear system, wheels, inverter, voltage regulator, and DC generator to convert the kinetic energy of running or walking on the treadmill into electric energy. The gear system was a highlight of the device, producing nearly 250W of power, and an inverter was used to convert the power into AC voltage for home appliances.

2.5: Web articles

The Economical Equine: How Horse Treadmills Became a (Very) Niche Thing - Modern Farmer

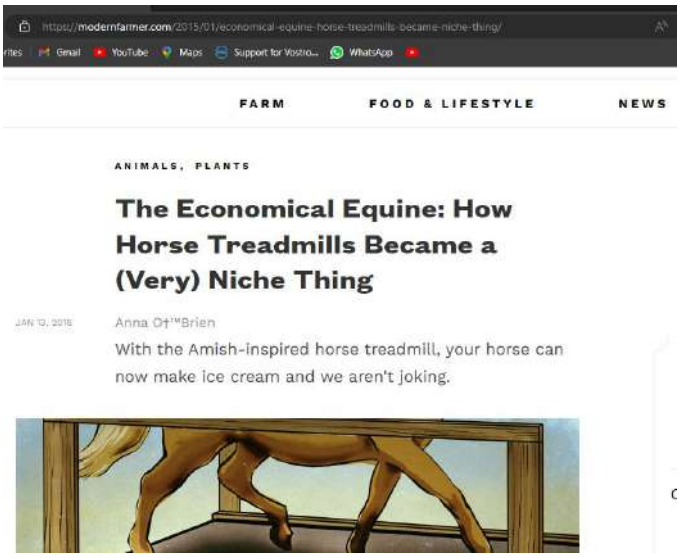

Fig 2.3: Website Screenshot of web-article

Cows on Treadmills Produce Electricity for Farms (inhabitat.com)

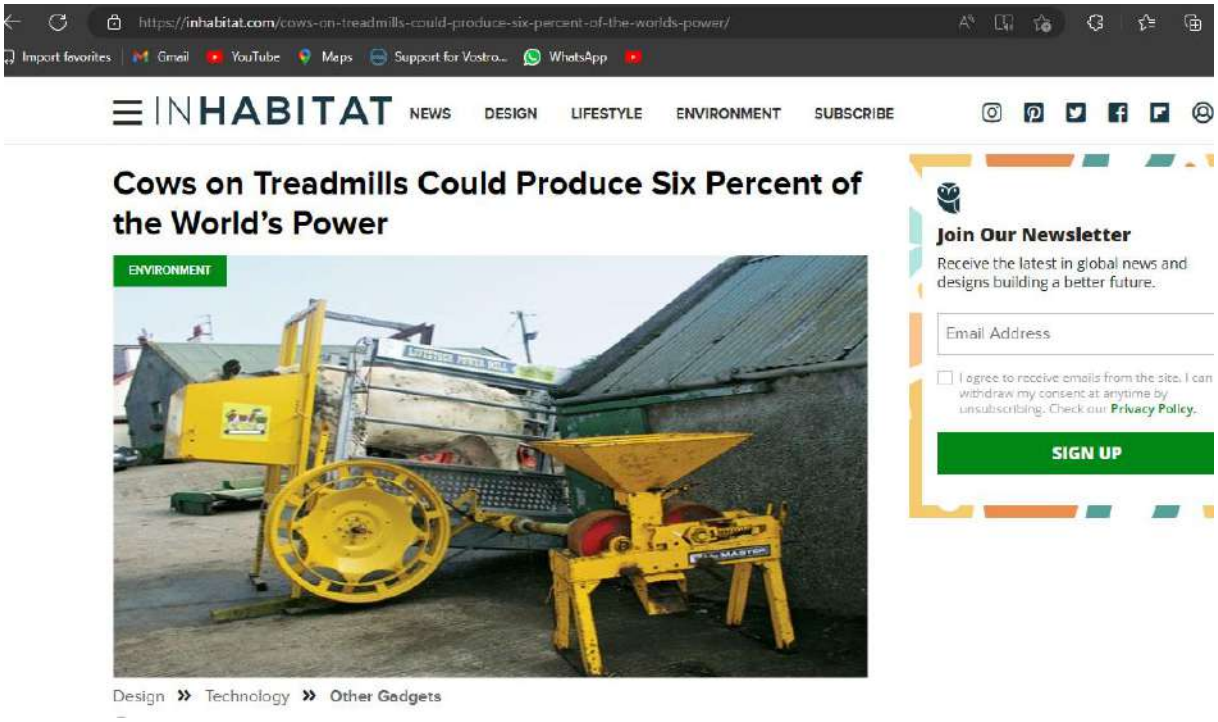

Fig 2.4: Website Screenshot of web-article

In conclusion, animate prime movers are an important category of renewable energy technologies that have been extensively studied in the literature. Past research efforts have explored the potential of renewable energy sing animate prime movers. These studies have investigated various aspects of energy generation using animate prime movers, including the design and optimization of energy systems, the impact of energy generation on the environment, and the potential for using renewable energy to support sustainable development.

2.6: References

[1] Arlan R. Smith, "Bovine Treadmill" 14021 Country Way, McCall, ID (US) 83638

[2] W.Taylor, Macosquin (GB), "Animal Power Generator" Pub. No. 2011/0266091 A1, Appl. No. 12/921,394

[3] Li Chengyu, Zhang Hongjie, Wang Sen, "Equipment for Breeding Animals", CN108157223B

[4] Faizan Dastgeer, Muhammad Sarmad Javed, Muhammad Umar Hussain, Nouman Ahmad, Mohammad Sameer, Muhammad Shahid Amin, "A Sustainable Power Solution for Cattle

Farms: Prototype of Power Generating Treadmill for Large Animate Prime Movers", published on 08.07.2022

[5] Applicant: T.C.CHANG, New Taipei City(TW), Inventor: T.CHANG, N.Taipei City(TW), "Livestock Power Generation System", Appl. No.14/885,340, Pub. No. US 2016/0344260 A1

[6] BAYEN, A.Kumar [IN/IN]; c/o J.Bayen, D.Bijoynagar, Joyna, gar, Dist: South 24 Parganas, West Bengal (IN), "A System for Generating Electricity using Nonconventional Source" International application number PCT/IN20 19/050243

[7] H. T. Yang, Senior Member, IEEE, T. H.Tseng, T. H. Ai, Y. H. Wu, and S. H. Yeh, "A Grid-Connected Energy Conversion System for a Treadmill with Auto-transferring Modes between a Motor and a Generator", IECON2015-Yokohama November 9-12, 2015

[8] Sahill, P.K. Sharma, N. Hari, N. Kumar, and D. Shahi, BVCOE, Delhi, India 4EEED, BVCOE, Delhi, India, "An Innovative Technique of Electricity Generation and Washing Machine Application using Treadmill", 1st IEEE International Conference on Power Electronics. Intelligent Control and Energy Systems (ICPEICES-2016)

[9] Yingbo Yu, H.Aohua Qin, "The Design of Treadmill with Distributed Generation Function"

[10] Al-Barkat Mehedi, Masuma Akter, Asma-Ul-Husna, "Electricity Generation from Treadmill Using Piezoelectric Transducer", Paper ID: ET 136

[11] Shamshad Ali, Syed Tariq Murtaza, A.K.Katiyar. "Design of Manual Treadmill with Electricity Generator for Energy Saving"

[12] A.gaikwad, A.Jadhav, P.Dhage, S.Borchate, "Design and Development of Treadmill to Generate Electricity by Using Mechanical Energy", e-ISSN: 2395 -0056, p-ISSN: 2395-0072

[13] K.Titare, A.Ram, S.Nagrale, Prof. S.R.Zaveri4, "Design and Fabrication of Power Generating Manual Treadmill", eISSN: 2395 -0056, p-ISSN: 2395-0072

[14] D.A.Gondane, Aniket M. Dighade, Priyanka V. Raut, "Treadmill Based Electricity Generator for Domestic Purpose", eISSN: 2395 -0056, p-ISSN: 2395-0072

[15] Faiz F. Mustafa, O Hussein, Sadoon Radhi Daham, and, A.H.Sabry, "New Treadmill Design for Energy Harvesting", ISSN: 1024- 1752, CODEN: JERDFO, Published Year 2020

CHAPTER 3

3 HARDWARE WORK

3.1 METHODOLOGY

The conceptual picture of the cart structure given by our supervisor is shown in the below-mentioned figure:

Figure 3-1: Showing the basic idea of the cart structure [12-9-22]

Figure 3.1 is used as a reference for our cart structure. The measurements for the height of the cart, the supporting pipes, and the wheels were selected considering our living prime mover (horse or calf).

In the first step, we implemented an external fence for the movement of animals. We use bamboo sticks for the fence and tighten the fence. We selected the wheels of a motorbike for the cart and connect them with the main axle along with the pulleys. Pulley size was calculated by assuming an animal's walk speed of 1m/s to achieve the machine's rated rpm (1450 rpm). We provided support on the main axle using appropriate iron brackets. In between the main axle and the top of the cart, we provided a separate axle with pulleys to complete the rpm of the DC generator.

3.1.1 Brief Working Explanation of machine

The prime mover moves in a pre-defined path, with a cart placed behind it. When animals moved, the corresponding main axle rotated, which moved the attached pulleys using belts. The pulleys of the main axle are connected with the pulleys of the separate axle. So, our generator is connected through the pulley to the pulley of the axle. In this way, we provide a prime-mover to DC machine which is environmental-friendly. At the speed of 1 m/s, we obtained DC 12V at 1450 rpm. We converted DC voltage into AC voltage using a suitable inverter.

3.2 Conceptual Diagram

The concept for machine design is taken from the following source:

- **US Patent 0344260 A1'Livestock Generated Electricity', 2016**

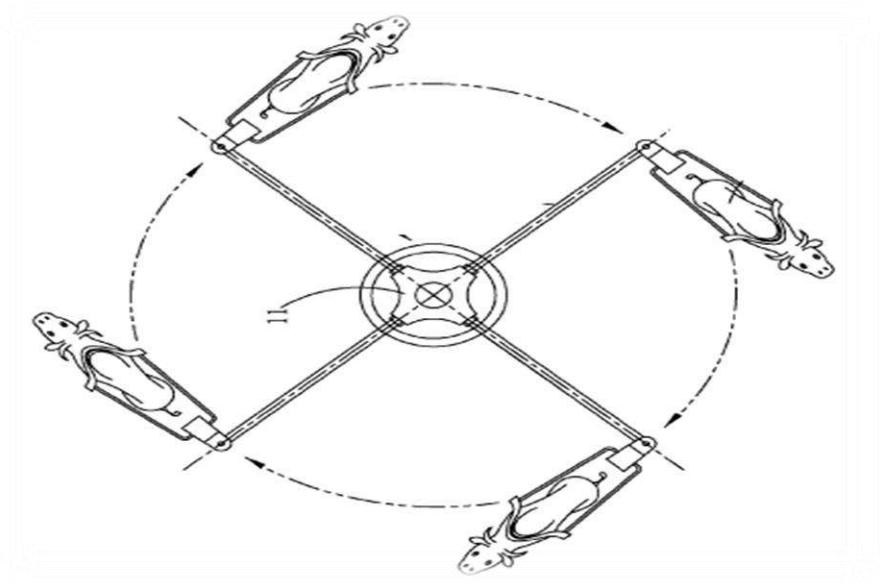

Figure 3-2: Showing the basic idea of the project

3.3 Prototype (September & October)

3.3.1 Construction of Cart

As we discussed above, after fencing for the proper movement of animals, we started working on the cart. First of all, we selected the main axle, so that it can bear the whole weight of the cart. The following pic shows the actual axle used in our prototype purchased from the market. [21-9-22]

Figure 3-3: Main axle of the prototype [21-9-22]

After the selection of the main axle, we decided on the appropriate wheels for a cart. At this point, we chose the wheels of the bike. Then we assembled both wheels and the main axle in the Engineering workshop as shown in the figures:

Figure 3-4: Wheels of bike [21-9-22]

Figure 3-5: Wheels with main axle [21-9-22]

Now, that was a time for main support on which cart frame has to be placed. We chose iron for this but it was broken. This hard iron broke because when we bent it for the desired shape by machine or gas cutter, it broke into pieces which was a problem in this duration. The cutting of iron in the welder shop is shown in the following figures:

Figure 3-6: Hard iron cutting by machine [22-9-22]

Figure 3-7: Hard iron cutting by gas cutter [22-9-22]

For this purpose, we use soft iron so that it can bend into any shape by machine for the proper working in an Iron cutting machine in the welder shop as shown in figure [26-9-22]:

Figure 3-8: Soft Iron cutting machine [26-9-22]

Figure 3-9: The actual support bent form of iron [26-9-22]

Figure 3-10: Supported Frame and Bracket [26-9-22]

In Figure 3-8, A bracket is used so that the main axle rotates along with the motion of the cart (that moves with the movement of animals). This bracket has a bearing that is perfect according to the size of the diameter.

After the selection of all requirements, that was time for the joining of all the components. So, we went to an Engineering workshop where all the tools were available. But there was a problem with the Hub size of the wheels not matching the main axle diameter. So, in the workshop, we make some changes in that hub according to the size of the axle by machine. After this whole procedure, a cart has been made in the Engineering workshop as shown in the figure on [27-9-22]:

Figure 3-11: Cart (wheels, axle, support) [27-9-22]

In Figure 3-11, we can see, the main axle has been fitted with a hub rather than a loose-fitting:

Figure 3-12: Showing fitness of hub with main axle [27-9-22]

Till [27-9-22], our cart frame was ready. Now we purchased T-Rods of Iron for the square shape of the top frame placed on the given support as shown in the figure:

Figure 3-13: T-Rod Iron for top square frame [28-9-22]

For proper movement of animals, there must be a pipe of iron or wooden piece on the head of animals so that the animal can tighten its grip on the cart. For this purpose, we chose a round iron piece as shown in the figure:

Figure 3-14: Round Iron pipe [28-2-22]

For our living prime mover, there must be a boundary so it cannot move to the left or right sides. For this problem, we selected long round pipes of iron that ranges from the top cart frame to the head of the prime mover. These long round pipes are attached to a round pipe of iron (Figure 3-14).

After this, we assembled the whole T-Rod Iron rod (Figure 3-13), round pipe of iron (Figure 3-14), and long round pipes at the Engineering workshop as shown in the figure:

Figure 3-15: Overall cart structure [29-2-22]

Figure 3-16: Another view of cart structure [29-2-22]

After the all of above work, that was the time for pulleys. We did calculations for the sizes of pulleys as shown below, to get complete rpm (1450 rpm). We perform multiple options for pulleys. In the end, the final decision was to take 4 pulleys. But here, we have to use another axle between the top of the frame and the main axle. That second axle has two pulleys. The smaller pulley is linked with a pulley of the main axle while the larger pulley is connected with the pulley of the DC Generator. In this way, according to calculations, we were able to achieve 1450 rpm at 1m/s speed of prime mover. According to the rating of the DC Generator, we will get 12V. The cart Structure with pulleys and a second axle is shown in the following:

Figure 3-17: Cart structure with pulleys [6-10-22]

Calculations for the size of the Pulley:

Average walk speed of horse = $1ms^{-1}$

$= (1 \times 3600) / 1000 \Rightarrow 3.6\ kmh^{-1}$

The actual diameter of the tyre = 24 inches or 0.6096 m

Circumference = 2 × pi × radius

radius = 0.6096/2 => 0.3048m

Circumference = 1.914 m

Rotational speed for linear speed of $1ms^{-1}$ = 1/ circumference

$W_1 = 0.523$ RPS

In RPM, $W_1 = 0.523 \times 60 = 31$ RPM

The Actual diameter of the Pulley $D_1 = 10$ inches

$W_1 = 31$ RPM

The diameter of generator pully = D_2 =1.25 inch

$$W_2 = 1450 \text{ RPM}$$

Let's take D_a = 2.5 inches

$$\frac{Wa}{W1} = \frac{\mathrm{D1}}{\mathrm{Da}}$$

$$Wa = \frac{\mathrm{D1}}{\mathrm{Da}} \times W1$$

$$Wa = \frac{10}{2.5} \times 31 => 124\ RPM$$

Since the Pulleys Da & Db are placed on the same axle, So

$$Wa = Wb = 124\ RPM$$

Similarly:

$$\frac{Wb}{W2} = \frac{\mathrm{D2}}{\mathrm{Db}}$$

$$Db = \frac{\mathrm{W2}}{\mathrm{Wb}} \times D2$$

$$Db = \frac{1450}{124} \times 1.25 => 14\ inches$$

After this work, we decided to use wooden boards to cover the space at top of the square frame and to place the DC Generator. Cutting of Wooden boards in woodcraft is shown in the following:

Figure 3-18: Cutting of wooden boards [11-10-22]

After that, we measure the length of the top square frame, so that we can place pieces of wood in wood crafts as shown in the figure:

Figure 3-19: Measurement of wood [11-10-22]

After using belts with pulleys and wooden boards, the cart structure is shown in the following:

Figure 3-20: Cart Structure with wooden boards & pulleys [13-10-22]

After completing the cart structure work, we placed the board with meters (Voltmeter, Ammeter)

, bulbs and capacitor on wooden board at top of the frame on our project site as shown in the following:

Figure 3-21: Fitting of Board with meters [18-10-22]

Then, we use Sandpaper to prevent the Cart frame from Rusting. After this, we color the whole cart as shown in the following:

Figure 3-22: Color on cart [20-10-22]

Figure 3-23: Color on cart [20-10-22]

When we move the cart by ourselves, the required rpm value was not achieved So, we increase the size of the pulley from 11 to 14 inches on the second axle. By using the updated pulley of 14 inches, we were able to get the required rpm.

CHAPTER 4

4 REARRANGEMENTS

4.1 INTRODUCTION

In this Chapter, we have discussed the cart. The main purpose is to achieve the desired rpm (1425) of the generator by applying multiple combinations of pulleys. After achieving the required rpm, readings were noted, that are used for automation.

4.2 Re-Calculation of the size of the pulley

At this stage, we were not able to get the required rpm. Consequently, the resulting DC voltages were not exactly 12V. For this purpose, we use 2 pulleys of 2.5 inches on the second axle along with 2 pulleys of 10 inches on the 1st axle for getting 1425 rpm as shown in the following figures:

Figure 4.1: Pulleys (2.5 inches) on 2nd axle [21-01-23]

Figure 4.2: Pulleys (10 inches) on 1st axle

By the above procedure, the speed was not still 1425rpm. Further, some were slipping between the pulleys and belts. To solve that problem, we placed pieces of wood under the generator. After testing with the calf, we do not get 12 V. There was a fluctuation in voltages and current. The load was not ON constantly.

After this, we decided to change the pulley of 14 inches with a large pulley to get the required rpm. For this purpose, we did a calculation, that is shown in the following:

By consulting with the DVM doctor, we chose the average walking speed of the calf, which was $0.9\ ms^{-1}$

Average walk speed of calf = 0.9 ms^{-1}

= (0.9 x 3600) / 1000 => 3.24 kmh^{-1}

The actual diameter of the tyre = 24 inches or 0.6096 m

Circumference = 2 × pi × radius

radius = 0.6096/2 => 0.3048m

Circumference = 1.914 m

Rotational speed for linear speed of 1ms^{-1} = 1/ circumference

W_1 = 0.470 RPS

In RPM, W_1 = 0.470 × 60 = 28.21 RPM

The Actual diameter of the Pulley D_1 = 10 inches

W_1 = 28.21 RPM

The diameter of generator pully = D_2 =1.25 inch

W_2 = 1450 RPM

Let's take D_a = 2.5 inches

$$\frac{Wa}{W1} = \frac{\mathrm{D1}}{\mathrm{Da}}$$

$$Wa = \frac{\mathrm{D1}}{\mathrm{Da}} \times W1$$

$$Wa = \frac{10}{2.5} \times 28.21 => 113.24\ RPM$$

Since the Pulleys Da & Db are placed on the same axle, So

$$Wa = Wb = 113.24\ RPM$$

Similarly:

$$\frac{Wb}{W2} = \frac{\mathrm{D2}}{\mathrm{Db}}$$

$$Db = \frac{\mathrm{W2}}{\mathrm{Wb}} \times D2$$

$$Db = \frac{1450}{113.24} \times 1.25 => 16\ inches$$

4.3 Cleaning and Repairing

By using the calculated value, we purchased the large pulley of 16 inches and attached that along with 14 inches pulley, which is shown in the following:

Figure 4.3: Pulleys (14 & 16 inches) on 2nd axle [25-01-23]

All the pulleys along with belts are clearly shown in the following:

Figure 4.5: Pulleys along with belts

Figure 4.6: Another view of Pulleys along with belts [02-02-23]

At this point, there was a slip between the pulleys and belts. The wood pieces that we placed before were not sufficient to solve this problem. Therefore, we decided to select the angles of iron, on which our generator will be placed, it can be moveable at any position, as shown in the following:

Figure 4.7: Support for generator [05-02-23]

For carrying DC power to a central point, at the input of the Inverter, we decided to use a steel pipe from which we will carry the wires carrying the DC current, which starts from the top of the cart and end near the central point. This Steel pipe is shown in the following:

4.4 DC Power Accumulation

Figure 4.8: Steel pipe [07-02-23]

The above steel pipe is connected with a round iron piece that is attached to the cart. The steel pipe is fixed in this round iron piece through nuts and bolts. It is shown in the following:

Figure 4.9: Round iron piece [10-02-23]

Figure 4.10: Another view of the round iron piece

The steel pipe [Figure 4.8] and round iron piece [Figure 4.9] are connected to the cart in the following:

Figure 4.11: Round iron piece with steel pipe

Till [February 27, 2023], the cart is almost complete as shown in the following:

Figure 4.12: Complete cart [20-02-23]

After all of the work, due to weather conditions, rusting of pulleys and iron pipes start. To protect the cart, we decided to color the cart once again as shown in the following:

Figure 4.13: Color on cart [22-02-23]

Figure 4.14: Color on the cart

To carry the wires carrying DC current, we used a wood piece at a central point along with 2 pulleys receiving positive & negative wires as shown in the following:

Figure 4.15: Central point support [24-02-23]

Till this point, corrosion began to start on the pulleys and metal parts of the cart. For this, we planned to clean every part of the cart to make it feasible to look and operate in working condition as shown in the following figures:

Figure 4.16: cleaning of rust by sandpaper [08-03-23]

Figure 4.17: cleaning of rust by sandpaper [08-03-23]

Dusting of whole cart was done along with cleaning by sandpaper as shown in the following:

Figure 4.18: Dusting [08-03-23]

Due to bad weather conditions, pulleys attached to the central point (the point, where power has been collected at the site), are rusted. So, we clean these pulleys with sand paper as shown in the following:

Fig 4.19: cleaning of pulleys by sandpaper [08-03-23]

Fig 4.20: cleaning of pulleys by sandpaper [08-03-23]

For professional work, we decided to use a board for generator output rather than direct connection of wires with the circuit as shown in the following:

Fig 4.21: Installation of the board of generator output [10-04-23]

When we run the cart with the horse, the angle of pipe [at the backside of cart] with the wooden pole in the center was not accurate. So, we decided to bend it at the specific angle for better results as shown in the following pictures:

Fig 4.22: Round pipe with straight angle [10-02-23]

Fig 4.23: Round pipe at new angle [10-04-23]

When the cart strike with bamboos on the site due to irregular movement of our prime mover, the whole training stopped because of this problem. To solve this, we use iron pipe in curved form so that, whenever, cart strike with bamboos, it slipped and move onward as shown in the following:

Fig 4.24: Iron pipe in curved form [11-04-23]

Due to rainy season. The pulleys on the site in central point began to rust. For this, we use a spray that removes the whole rust from this as shown in the following:

Fig 4.25: Spray on rusted pulleys [12-04-23]

Fig 4.26: Another view of Spray on rusted pulleys [12-04-23]

To carry the power from generator to central point, we use the copper wires to round the pulleys, so that path can become conductive as shown in the following:

Fig 4.27: Copper wire on the pulleys [12-04-23]

After connecting the wires from generator to pulleys in the central point, power has been transmitted as shown in the following:

Fig 4.28: connection of generator & pulleys [12-04-23]

Fig 4.29: Final cart [04-05-23]

CHAPTER 5

AUTOMATION

5.1: Need of automation in project

As our project aims to develop a relatively new power generation mechanism whose Novelty is the coupling with the healthy exercise. To develop a plan of stable power generation which has a focus on suitable exercise which provides health benefits to the animate Prime mover.

5.1.1: Developing Exercise and generation plan

To develope this Exercise/ Energy Generation Plan ,the physiological parameters such as fatigue level of the subject may need to be monitored; this parameter may be used as an indication of exhaustion which may be again subject to the weather condition, where an exhibition is reach early in hot/humid ambience and vice versa. So we have to design a mechanism of automation on the physiological parameters such as fatigue level and adjusting the power generation to animal physiological parameter.

5.2: Monitoring Voltage Level

We monitored the physiological parameters of the subject by monitoring the voltage level of the power generation cart.

If the fatigue level of the animal is normal then the subject can exercise with his full strength and generate 12 volt dc by moving on circular path. As fatigue level increases, the ultimate power generation will decrease. So in keeping view this scenario , we develop a mechanism of automation that will run to physiological parameters to generate power by animal exercise as much as it can .

5.3: Voltage level and Microcontroller

Sensor will Measure voltage level and send data to microcontroller and Microcontroller decides which load to be cut off according to the data send by sensor to microcontroller on the basis of adjust value of sensor as decides the power need to be increased or decreased.

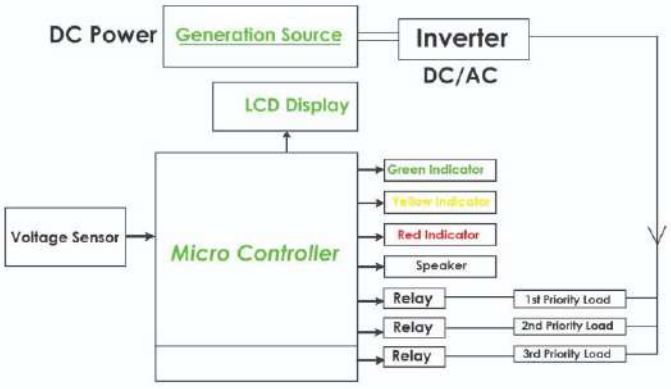

Fig.no 5.1: Lock diagram of Power generation Via Animate prime mover

04-01-2023

At normal fatigue level, the animal will move on the circular path with his full strength and generate 12 volt dc and this power supplied to all loads.

5.4: Movement/walking effect on animal

By moving on circular path, when fatigue level of the animal is increased and ultimately voltage level decreased wherein microcontroller decides that the voltage sensor values decreased from the adjusted normal value it will cut of 50% load from supplied power supply via relay.

For further increase in fatigue level the voltage level also further decreased and the remaining 50% load will cut-off.

To develop the circuit of automation physically, we made a circuit of our project on Proteus Design Suite. The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation.

5.5: Proteus circuit diagram

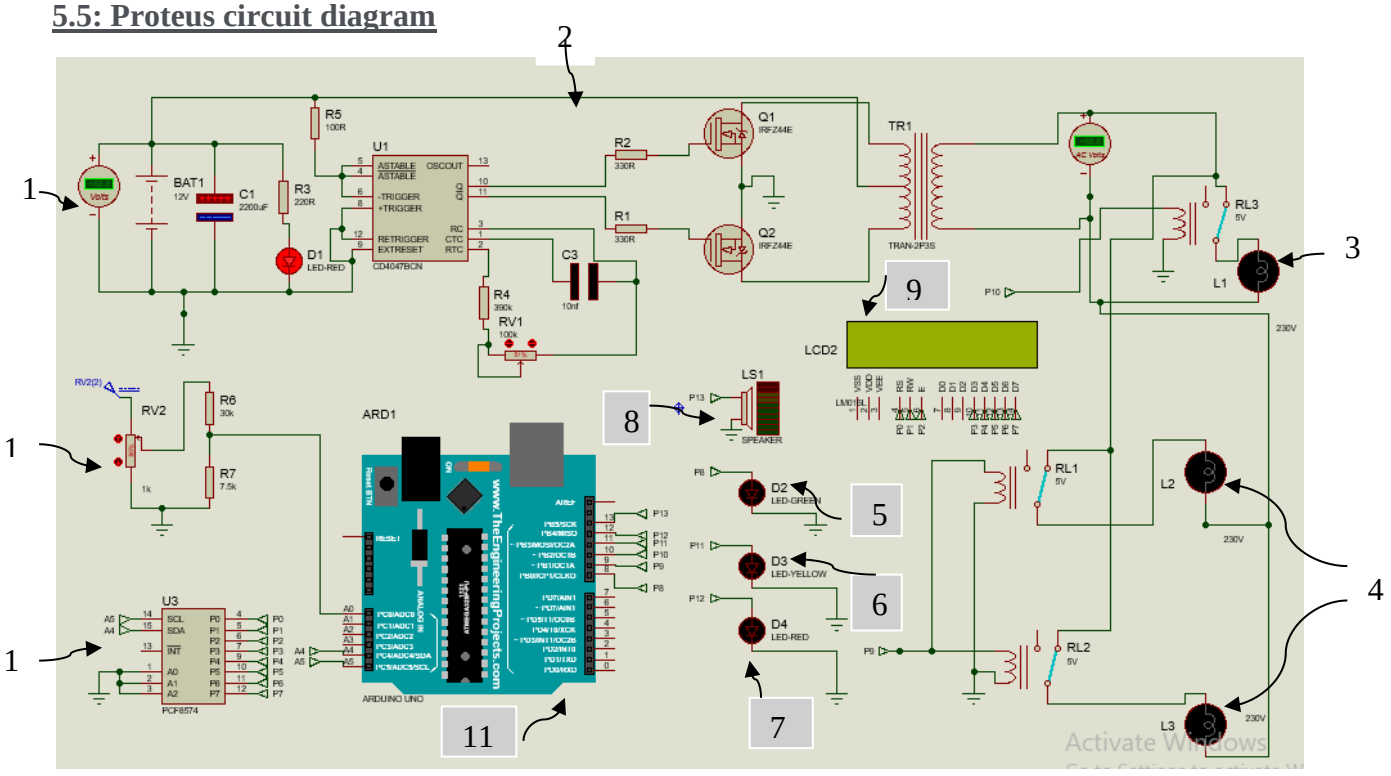

Fig no.5.2 Circuit diagram on PROTEOUS

11-01-2023

This is the circuit of our project on Proteus design Suite.

Here is the different blocks indicates different components used in the circuit diagram. Let us describe it one by one numerically.

1. The power generation cart set-up of our project.

2. 12 V DC to 230V AC inverter setup

3. 50% our critical load

4.50% our non-critical load

5. Green led indicates normal fatigue level of the animal

6. Yellow led indicates average fatigue level of the animal

7. Red led indicates below average fatigue level of the animal

8. Speaker that is used to boast up the speed as our animal is voiced trained and boast up its speed on certain voice

```
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 16, 2); // I2C address 0x27, 16 column and 2 rows
long volt;  // initialization
#define Switch1 2 // defining output pin for relay
#define Switch2 3 // defining output pin for relay
#define Switch3 4 // defining output pin for relay
#define Ledgreen 8 // defining output pin led
#define Ledyellow 9 // defining output pin led
#define Ledred 10 // defining output pin led
#define Ledblue 7 // defining output pin speaker MP3 module
#define Sensor A0 // defining input pin for sensing voltage
float vIN = 0; // initialization for input voltage
int a = 0; // initialization and declaration for check statment
void setup() {
  lcd.init(); // initialize the lcd
  lcd.backlight();
    pinMode(Sensor,INPUT); // declaring input
    pinMode(Switch1,OUTPUT); // declaring output
    pinMode(Switch2,OUTPUT); // declaring output
    pinMode(Switch3,OUTPUT); // declaring output
    pinMode(Ledgreen,OUTPUT); // declaring output
    pinMode(Ledyellow,OUTPUT); // declaring output
```

```
pinMode(Ledred,OUTPUT); // declaring output
pinMode(Ledblue,OUTPUT); // declaring output
a=0;
digitalWrite(Switch1,HIGH); //  To write a HIGH or a LOW value to a digital pin.
 digitalWrite(Switch2,HIGH); // To write a HIGH or a LOW value to a digital pin.
  digitalWrite(Switch3,HIGH);// To write a HIGH or a LOW value to a digital pin.
}
void loop() {
  int value = analogRead(Sensor); // read input voltage value
  vIN = value * (5.0/1023.0) * 100.46;
  lcd.setCursor(0, 0);         // move cursor to   (0, 0)
  lcd.print("Voltage :");        // print message at (0, 0)
  lcd.setCursor(10, 1);         // move cursor to   (2, 1)
  lcd.print(vIN); // print message at (2, 1)
  Serial.print("Voltage : ");
  Serial.println(vIN);
  delay(500);
if(a==0){
if(vIN>=12){  // if condition
  digitalWrite(Ledgreen,HIGH);
  digitalWrite(Ledyellow,LOW);
  digitalWrite(Ledblue,LOW);
  digitalWrite(Ledred,LOW);
  digitalWrite(Switch1,HIGH);
  digitalWrite(Switch2,HIGH);
  digitalWrite(Switch3,HIGH);
  }
if(vIN>=5 && vIN<=9){ // if condition
```

```
  digitalWrite(Ledgreen,LOW);
  digitalWrite(Ledyellow,HIGH);
digitalWrite(Ledblue,HIGH);
  digitalWrite(Ledred,LOW);
  digitalWrite(Switch1,HIGH);
  digitalWrite(Switch2,LOW);
  digitalWrite(Switch3,LOW);
  delay(500);
  digitalWrite(Ledblue,LOW);
  delay(30000);
  digitalWrite(Ledblue,HIGH);
  delay(500);
  digitalWrite(Ledblue,LOW);
  }
if(vIN>2 && vIN<5){ // if condition
  digitalWrite(Ledgreen,LOW);
  digitalWrite(Ledyellow,LOW);
  digitalWrite(Ledblue,LOW);
  digitalWrite(Ledred,HIGH);
  digitalWrite(Switch1,LOW);
  digitalWrite(Switch2,LOW);
  digitalWrite(Switch3,LOW);
  a=1;
  }}}
```

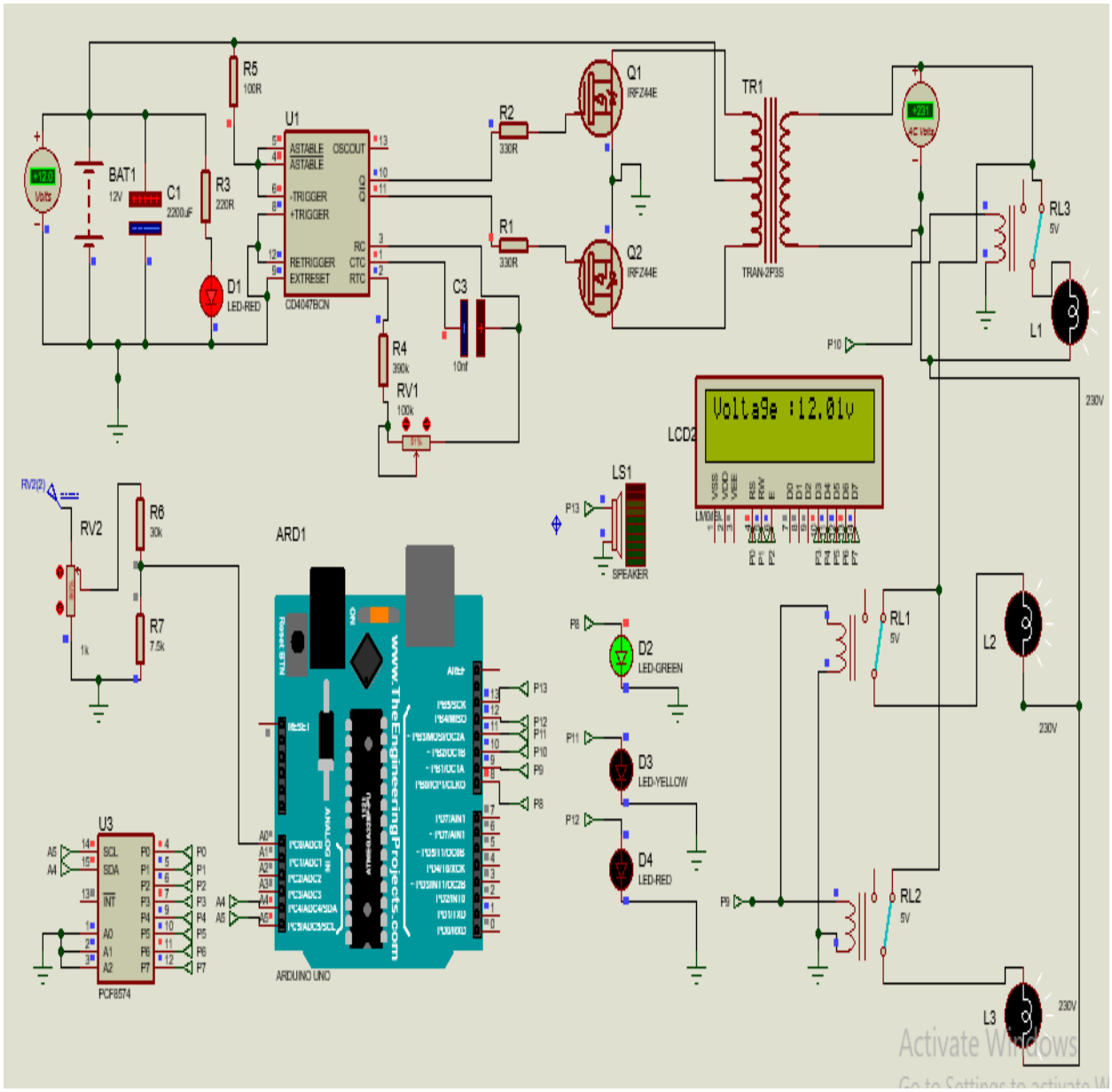

Fig no.5.3 Simulation 22-02-2023

5.7: Displays the information on an LCD display

The animal will exert all of his energy while moving around the circle, producing 12 volts of direct electrical power that will be supplied to power all loads. A voltage sensor will measure the generated voltage and communicate information to the microcontroller. The microcontroller determines that the voltage has been adjusted to its peak level, sends a signal to cause a green light to glow, indicating the animal's typical degree of tiredness, and displays the information on an LCD display. All of the relay's contacts are now set to be normally closed.

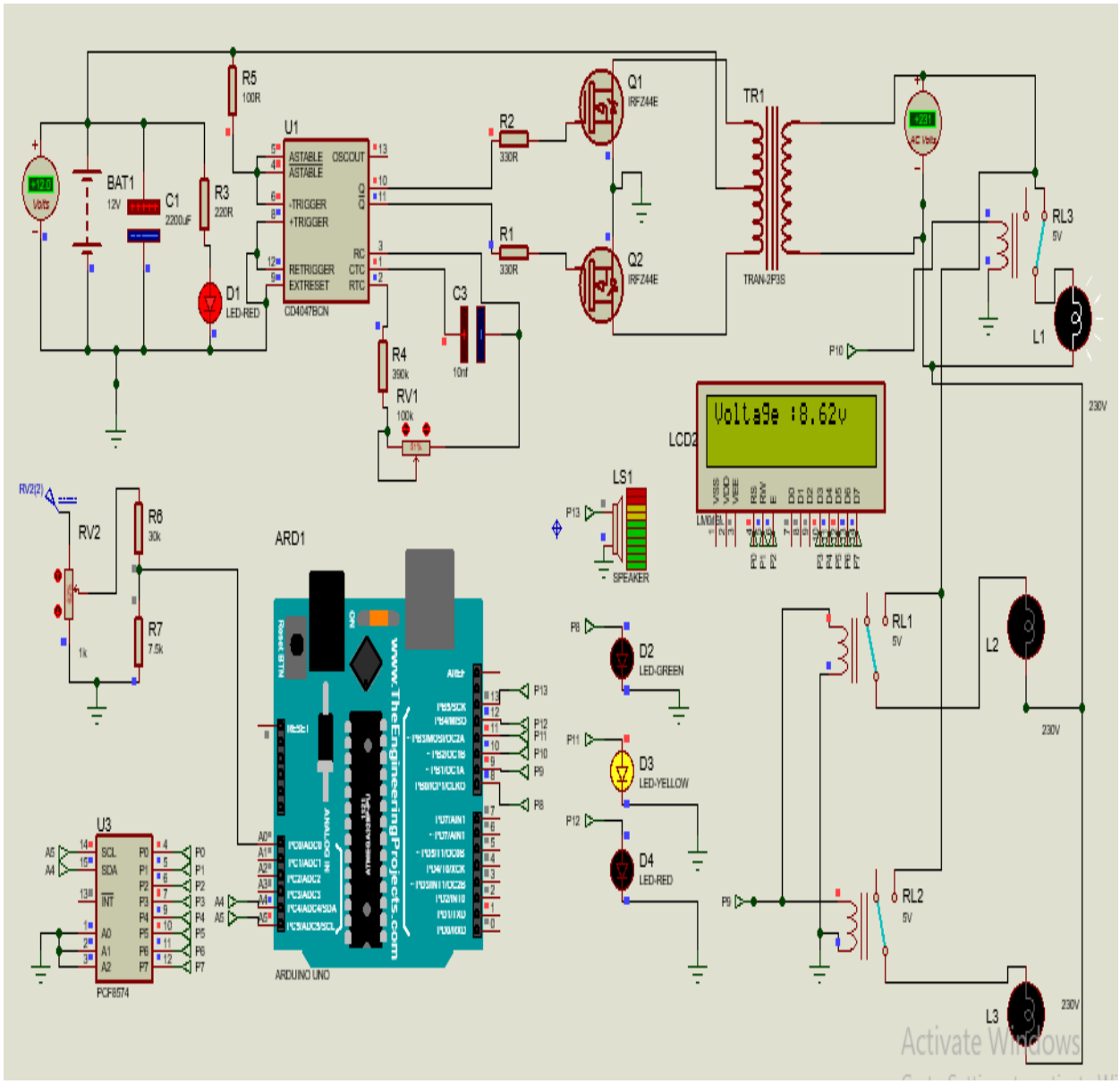

Fig no. 5.4: Simulation 22-02-2023

By following a circular motion as the animal's degree of exhaustion rises and finally the voltage drops, the microcontroller judges that the voltage sensor values have fallen below the set normal value and turns off 50% of the power supply through relays. The microcontroller sends a signal that causes a yellow light to shine, signifying the animal's increased usual level of fatigue, as soon as it deems that the voltage has been reduced to its set peak level. The speaker receives a signal from the microcontroller as well because our animal is voice-trained. Upon hearing the voice our animal has been trained to respond to, it will pace up its speed and regulate the voltage to a previous peak level.

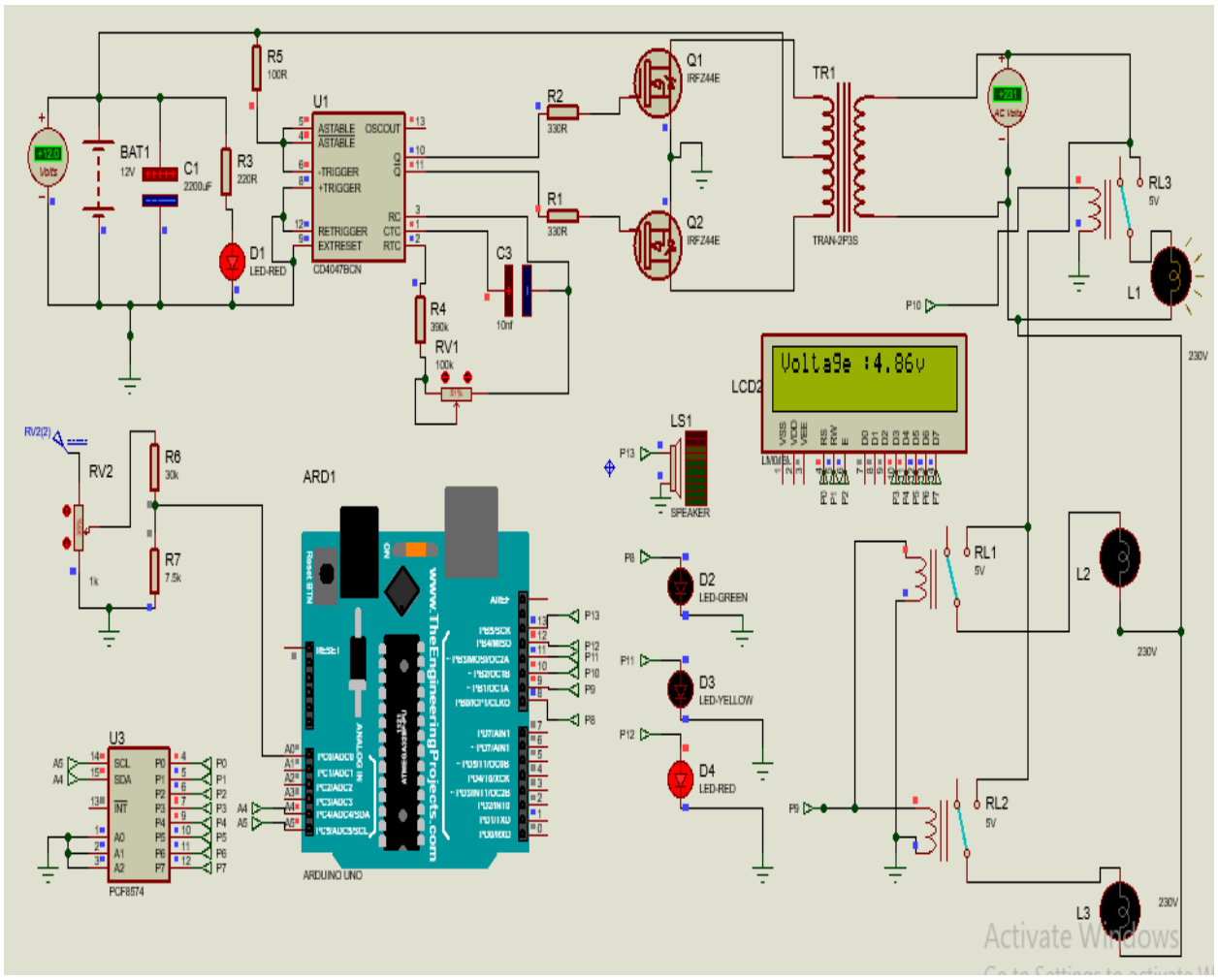

Fig no. 5.5 Simulation 22-02-2023

As the voltage level observed by the sensor decreases further, the microcontroller decides to cut-off the remaining 50% load by sending a signal to relay to open its contact and glow a red led.

5.8: Hardware Implementation

After successfully running the simulation of our designs on PROTEOUS, we proceed to wire-board assembly.

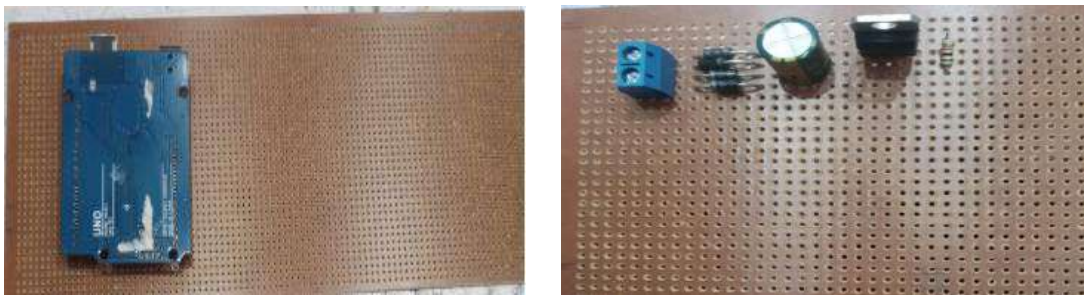

Fig no.5.6: Assembling on PCB Sheet 01-03-2023

First of all, to power up the Arduino UNO, we designed the 12v to 5v circuit using full wave bridge rectifier.

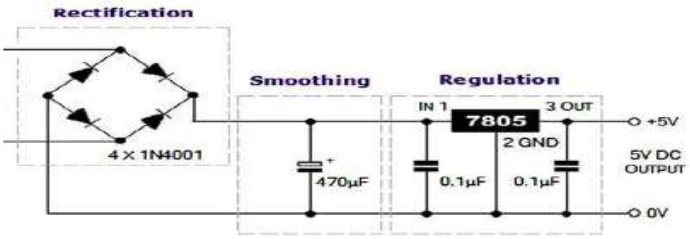

Fig no. 5.7: circuit diagram of 12v to 5V Dc power supply using 7805 IC

Fig no. 5.8: 12v to 5V Dc power supply using 7805 IC

01-03-2023

Three led indicators that is Green, yellow and red are connected with Arduino UNO to indicate the voltage level and fatigue level of the subject.

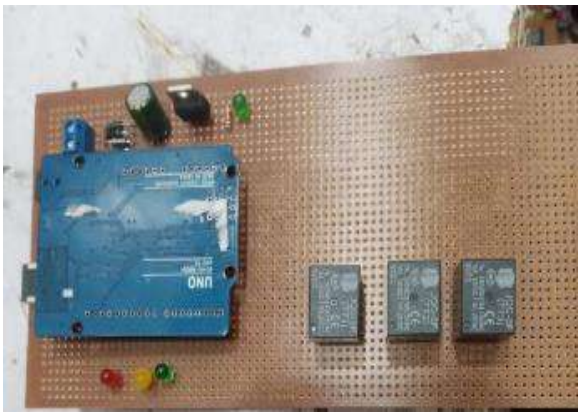

Fig no. 5.9: Assembling of relays with Arduino Uno 08-03-2023

To switch the load, three relays are also linked to the microcontroller, which cuts off the load based on the set coding.

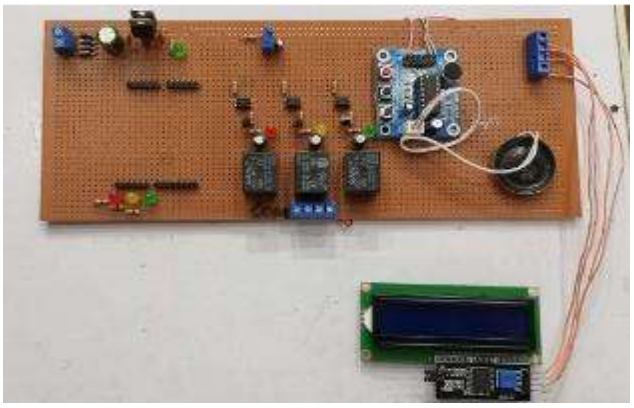

Fig no. 5.10: Assembling of opto-coupler relays circuit and speaker with Arduino Uno

22-03-2023

5.9: Microcontroller Problem

The microcontroller burned out the first time when we tried the circuit in response to the high current employed by the relays and led indication. Because the microcontroller can only deliver 40mA of current and the relay requires 90mA of current to operate, that is why the microcontroller burnt.

We utilized an opt coupler and BJT to run the relay at the necessary drew current in order to fix this issue. In opt coupler circuit, there isn't a direct or wired connection between the controller and the relay since it works on the opto-isolation concept. The controller will also continue to be protected from any high voltages and currents that may harm it because there is no hardwire linkage Additionally, LED operates at 2V operating voltage and 20mA operational current. Therefore, we used a 100 ohm resistor with the led to restrict the current.

To show the produced DC voltage, microcontroller has been connected to an LCD display.

As our animal is voice trained which respond to the certain voice command and boast up the speed to regulate the voltage. For this purpose, we used the above mentioned ISD 1820 module

which can record the voice up to 20 Second. But the sound pitch is very low to hear. To resolve this issue, we used an amplifier PAM 8403.

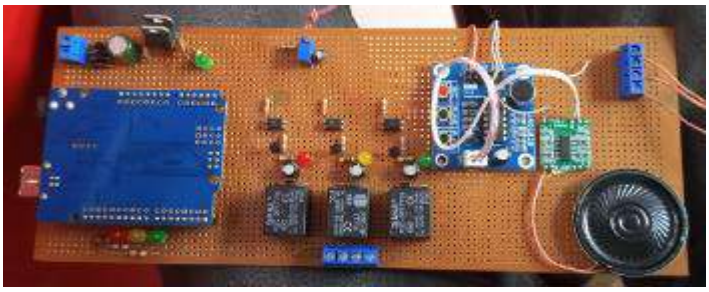

Fig no. 5.11: Amplifier module PAM 8403 with ISD 1820

29-03-2023

But still PAM 8403 is unable to provide hearable sound.

Fig no 5.12: MP3 device

5.10: 8ohm speaker use

To resolve the problem of sound we used a MP3 module with a large 8ohm speaker that is operated digitally with arduino. To operate MP3 digitally with microcontroller, we extract the wire from play button of MP3 which manually on and off the MP3. Now MP3 will operate digitally on receiving signal from arduino. For that purpose, we make a circuit using opto-coupler to provide a impluse signal to play the MP3 digitally. That sigal short the extracted wire from play button of MP3 and play it untill microcontroller sent a second impluse sigal which off the MP3 again by shorting the wires.

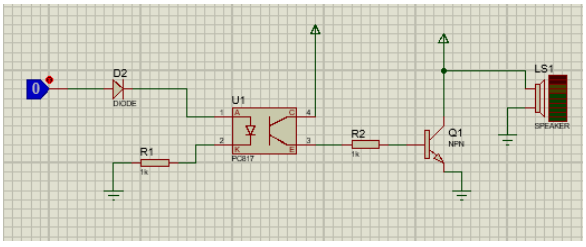

Fig no. 5.13: Opto-coupler circuit to connect speaker 05-04-2023

5.11: Opto-coupler circuit

This circuit shows that when logic is low means microcontroller is not sending any signal. Tha is why speaker is off.

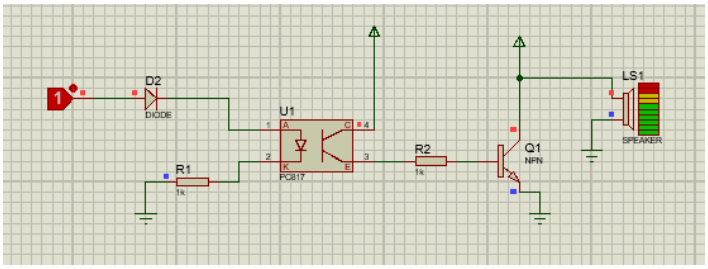

Fig no. 5.14: Opto-coupler circuit to connect speaker 05-04-2023

This circuit shows that when logic is high means microcontroller is sending a impluse signal to opto-copuler to close the contact of MP3 so that speaker will on.

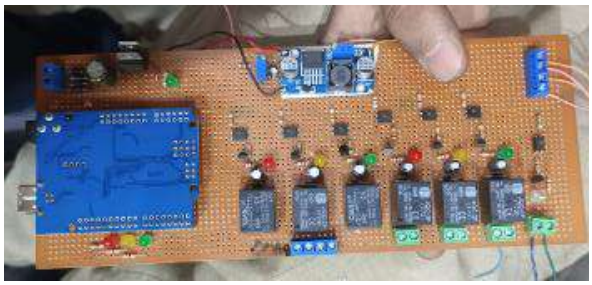

Fig no. 5.15:Installing opto-coupler circuit and relays to on and off Leds 10-04-2023

Also, the three led indicators, green, yellow, and red, are linked to an Arduino uno to indicate the voltage and exhaustion levels of the animal. now instead of these leds, three further relays have been coupled to the microcontroller through an optocoupler circuit to depict these indicators with 12V DC lights.

5.12: 7805 voltage regulator IC use

As we make use of a 7805 voltage regulator IC to power the circuit from a 12V to 5V source. In voltage regulator 7805 IC, a large amount of energy is exhausted in the form of heat. This is because there is a high difference between the input and output voltage which is converted in heat within the regulator IC. We built a 12V to 5V boost converter in parallel with a 12V to 5V supply using a 7805 IC to alleviate the strain caused by the six relays on the 7805 IC. Currently, three relays operate on a 12V to 5V supply, with the remaining relays receiving power from a DC-DC boost.

But the circuit of opto-coupler is not properly working in our case to on and off the MP3 module with speaker.

5.13: Relay circuit to connect speaker

In order to fix this issue, we use a realy in bewteen speaker and transistor to close the contact of MP3 module.

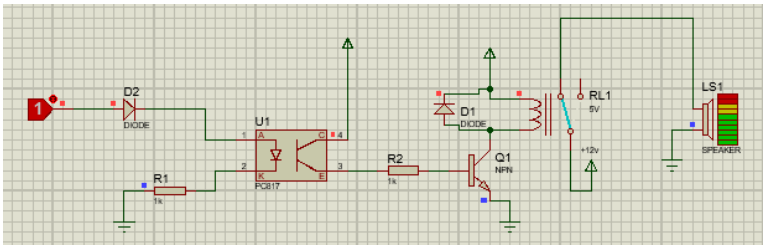

Fig no. 5.16: Opto-coupler relay circuit to connect speaker 16-04-2023

This circuit demonstrates how the microcontroller sends an impluse signal to the opto-coupler to drive the relay, turning on the speaker, when the logic is high.

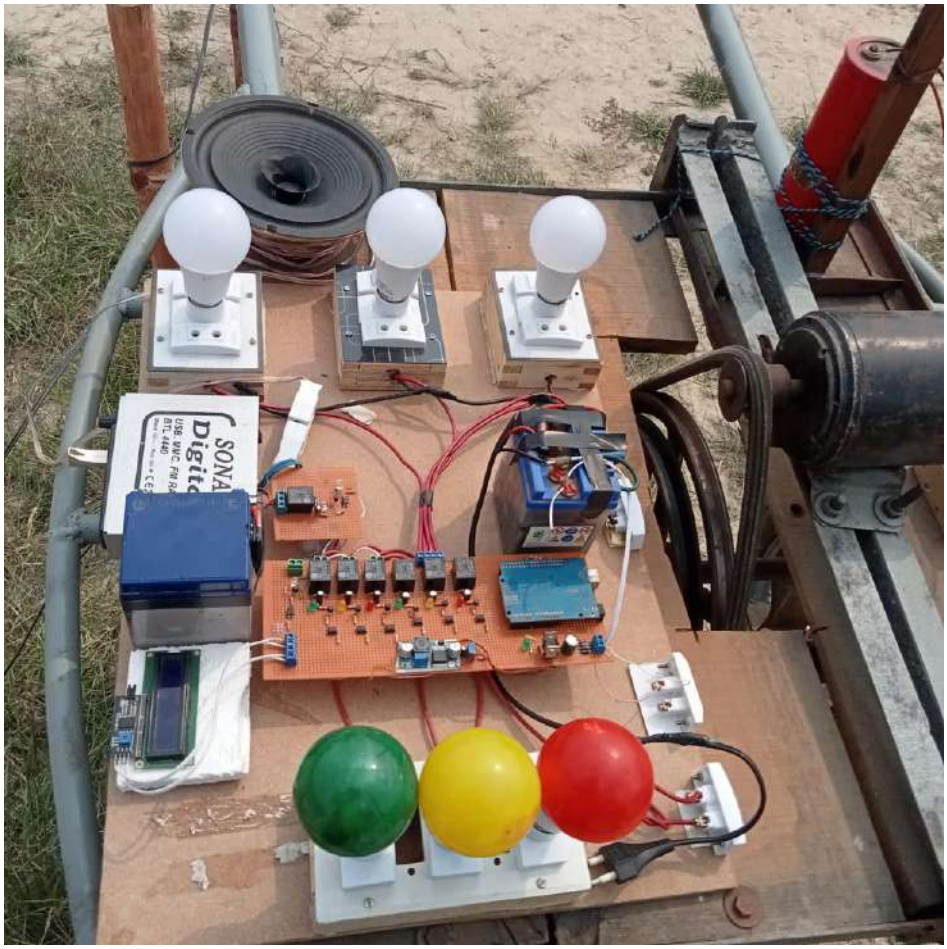

Fig no. 5.17: Complete Circuit of Automation 16-04-2023

Results:

Following are the results of our design work:

Phase	Pulley Size (inches)	Voltages (Volts)	Desired RPM
1st	10	7	1450
2nd	12	8.5	1450
3rd	14	10	1450
4th	16	12	1450

Table 6.1: Showing Pulley Size

In the 1st phase, we used a single pulley of 10 inches, and after multiple readings, the output voltages were about 7 volts. Since, we needed 12 Volts, that has to be converted into 220 AC. So, we decided to redesign the project.

In the 2nd phase, we decided to increase the size of the pulley from 10 to 12, but this time, the result was not satisfactory, and we again redesigned the project.

In the 3rd phase, we increased the pulley size from 12 to 14, the output voltages were 10V, and the machine was not able to rotate at 1450rpm speed, because of the small size of the pulley.

In the 4th phase, we decided to choose a large size pulley of about 14 inches along with two more pulleys of 2.5 inches on the second axle to support the machine to rotate at 1450 rpm. Finally, we got 12V at 1450 rpm.

It should be noted that all of the sizes of pulleys were chosen after certain calculations by assuming the multiple walking speeds of our prime-mover. The speed was selected after consulting with our Co-advisor [DVM specialist].

According to all of the readings shown by Voltmeter & Ammeter, DC voltages were more than 12V but when connected in AC form after inverter, there were some fluctuations as the loads were not completely ran. The following table shows the data taken by voltmeter and ammeter:

Load	**Capacity**	**Current (Ampere)**	**Voltages (Volts)**
AC (3)	39W	0.056	220
DC (3)	36W	1	12

The DC load was completely run without any fluctuation, however, there was some fluctuation in the AC bulb because the capacitor was not able to smooth the AC voltages accurately.

Further, our automation panel was complete and it was working accurately and independently. But we cannot take the results with the actual generation.

CHAPTER 6

CONCLUSION & FUTURE WORK

6.1) Conclusion

Our project is completed as per the instructions of our supervisor, we checked all the multiple combinations of pulleys to get the specified results by considering the calculations, we performed our project with two animals including a calf and a horse.

The output voltages with the calf were less than the horse's because the walking speed of the calf is less than the horse.

The prime mover moves in a pre-defined path, with a cart placed behind it. When animals moved, the corresponding main axle rotated, which moved the attached pulleys using belts. The pulleys of the main axle are connected with the pulleys of the separate axle. So, our generator is connected through the pulley to the pulley of the axle. In this way, we provide a prime-mover to DC machine which is environmental-friendly. At the speed of 1 m/s, we obtained DC 12V at 1450 rpm.

We converted DC voltage into AC voltage using a suitable inverter. At the start, DC voltages were observed at multiple points. Since voltages were fluctuating. So, by using the capacitor, we constant the DC voltages before the inverter. Now, we convert DC 12V to 230V AC.

In the end, the automation board operates properly and we got satisfying results but cannot record the video due to some hurdles. So, we perform the automation in the lab by supplying voltages 12V and varying the voltages with a potentiometer and got the results that were required.

6.2) Future Work

Following are the suggestions for further work on the power-generating cart:

- Power Generation has been a major issue in Pakistan. Moreover, the electricity, that has been generated, is offering more costs, due to which bills of electricity have been increasing continuously. The electricity, that has been generated, also produces many harmful gases, that harm the environment. Due to these harmful gases, glaciers melt and we have to face the consequences. To solve the above problem, we decided to convert the muscular energy of animals into electrical energy, which is totally environment-friendly, green, and clean energy. Power-generating carts be coupled in dairy farms to reduce bills of electricity which is beneficial from an electricity point-of-view as well the physical health of animals.
- If the generated power in a farm is exceeding, then the owner can transmit the excess power to utilities and this can be the concept of a Smart grid system because there is a two-way power flow, where they can receive as well as transmit the power. So, in this way, the Power generating cart can be coupled with the grid and the user can earn credit from the utility.
- Since the output power is DC, we have to convert this power into AC by using a suitable inverter. So here, we can also use a power storage device to store electrical power for use in peak hours.
- Chains & gear systems used in bikes can be used instead of using the belts for better movement and convenience of working. In this way, there will be more smooth movement of pulleys along with the motion of animals.
- Can add sensors to monitor the physical health of the animal. Currently, we have used the manual method, by stethoscope to check the physical condition of animals. We have not added the sensors because they are very expensive.
- There can be more work on automation to make itself a power-generating cart to eliminate the need for humans. Currently, automation is just to show the fatigue level by indicators of pre-defined colors and to trip the load on changing supply. In the future, the system can be fully automated.
- Prime-mover (animal) can be already trained to improve the working style. Currently, our animal is not much trained to get the readings from this independently.
- Use digital voltmeters at multiple points to verify whether the generations still exist or not. In this way, there will be no difficulty in finding the error place.
- This time, we cannot check the physical condition of animals multiple times. In the future, this can be added to the record to collect this data in various routines.
- Take the readings after pre-defined intervals. In this way, we can have multiple amounts of data and we can use this.
- Capacitor should be such that, it maintains the fluctuating voltage level due to irregular movement of our prime-mover.
- The site on which we were working was not smooth enough for free movement of animals. So, in the future, the site will be smoothened to get the readings accurately.