DESIGN, CONSTRUCTION & PERFORMANCE TEST OF A TREADMIL BICYCLE

A Project

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September, 2025

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September, 2025

APPROVAL

This is to certify that the project work entitles, **"Design, Construction & Performance Test of a Treadmil Bicycle"** has been carried out by **Ashikur Rahman ID: ME2201026028, Md. Golam Rabbani ID: ME2102024569, Tanvir Ahmed Utshow ID: ME2201026223, Ekramul Khan ID: ME2201026278 and Mohammed Shahadat Hossen ID: ME2002021149** thereby declared that the work presented here is original work done by us and has not been published or submitted elsewhere for the requirement of a degree of **Bachelor of Science (B.Sc.) in Mechanical Engineering** in the year of 2025 Program in the Department of Mechanical Engineering, Sonargaon University has been carried out under by supervisor. Any work done by other and cited within this project has given due acknowledgement and listed in the reference section.

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DECLARATION

We do hereby solemnly declare that, the work presented here in this project report has been carried out by us and has not been previously submitted to any University Organization for award of any degree or certificate

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ABSTRACT

This project introduces an innovative concept of a Treadmill Bicycle integrated with Timer and Speed Measurement using a Microcontroller, designed to promote sustainable mobility and fitness in a unique way. The system combines the functionality of a treadmill with a bicycle, where the rider walks or runs on the treadmill surface to generate motion and propel the bicycle forward. Unlike conventional cycles that rely on pedaling, this design emphasizes walking or jogging, making it suitable for health-conscious users who wish to exercise while traveling.

A microcontroller is embedded into the system to measure speed, distance, and time through sensors. The collected data is displayed on an LCD, allowing the rider to monitor performance in real time. This integration not only motivates physical activity but also enhances safety and efficiency by providing accurate travel metrics. The Treadmill Bicycle presents a futuristic alternative to eco-friendly transport while encouraging healthy lifestyles, energy efficiency, and creative engineering innovation..

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CHAPTER 1
INTRODUCTION

1.1 Introduction

The treadmill bicycle is completely a new way of moving which is designed mostly for runners. Basically, using a treadmill is similar to running, hiking or walking. Think about the last time you were riding a bike over a few obstacles such as train tracks, potholes, speed bumps etc. The possibilities are you stood up on the pedals to improve your balance when crossing the obstacle. Basically, the treadmill bicycle will provide the rider a well-balanced position the entire time. Since it uses no fuel it a very conventional option for people in their busy schedule to take care of their health completely. People with a busy schedule will also be able to take care of their health and physical fitness. Above all, it is not a conventional treadmill to make use of only in closed rooms, people using treadmill bicycles can roam around freely on roads as well. This project overcomes the drawback of the conventional treadmill which is stationary and moreover the jogger gets exposed to the natural atmosphere too. So this proposed methodology provides an ultimate solution by making use of the wheels and making the treadmill bicycle a walking cycle. The walking cycle has a simple mechanism, operated with free wheels, gear chain, bearing shaft and links arrangement. The conversion of the linear motion into rotary motion is done by the gear chain and free wheel mechanisms of the linkages, which involves very simple movements. The rotary motion is again converted into linear motion of the cycle through mechanical linkages (gear chain and free wheels) arrangement.

The conveyor system is either a continuous movement or intermittent which depends on the person's usage. So a basic free wheel mechanism with bearings is designed with time delay which can be used to halt the movement when necessary. This invention relates to improvements in transport devices, and it relates particularly to devices for transferring people, small in number like that of a bike or a cycle. The Walking Bicycle is the one, which combines walking and cycling into one activity. The Walking Bicycle combines the two activities into a linear motion, allowing you to propel yourself forward at desired speed, simply by walking on the belt provided. Usually, the operation of the walking cycle machine is controlled by the user itself by

simply walking on the treadmill belt and also balancing the cycle. The operating speed of the walking cycle differs on the amount of force applied by the user.

1.2 Problem Statement

In day-to-day life, the people mostly use cars, bikes, etc. to travel which results in increase in pollution and as we know pollution is a big problem nowadays. Pollution isn't good for our environment, and it's something we need to find solutions for.

Now, when people go to the gym to stay healthy, they use treadmills for jogging and running. The trouble with regular treadmills is that they stay in one place. Running on them can feel a bit dull because you're not moving through different surroundings, and you miss out on the fresh air outside. So, here's where the idea of a Treadmill Bicycle comes in. It's like combining a bicycle and a treadmill to create something cool and helpful. This special treadmill isn't stuck in one spot – it moves with you! Imagine riding a bike, but instead of moving on the road, you're also running on a treadmill. This way, you can travel from one place to another, just like with a bike, but without causing pollution. It's like getting two benefits in one – you're staying fit and reducing pollution at the same time. This Treadmill Bicycle is a smart solution. You get to enjoy the outdoors, breathe in fresh air, and stay healthy while you travel.

1.3 Objectives

We have some specific objectives for this project and they are pointed below:

- To provide a pollution-free mode of transportation using human power.
- To combine exercise and commuting into a single activity.
- To measure speed, distance, and time using a microcontroller for real-time monitoring.
- To study the system performance for future reference and improvement purpose.

1.4 Methodology

Methodology the method used in this study is as follows:

- First, develop the concept of the treadmill bicycle and plan its design and structure. At the same time, create a block diagram and circuit diagram to identify the necessary components.
- Gather all required components and program the microcontroller (Arduino) to accurately measure speed, time, and distance.
- Set up all components on a PCB or modular board, solder where needed, and assemble the blocks.

1.5 Work Flow Diagram

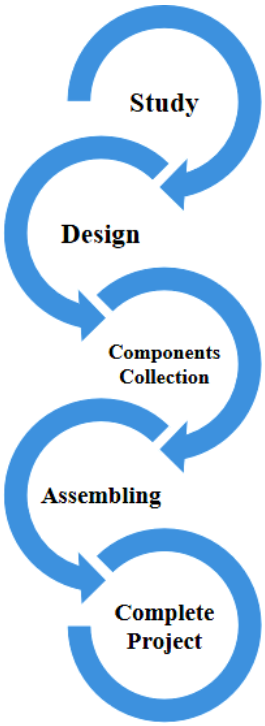


Figure 1.1: Working Flow Diagram

The Treadmill Bicycle with Timer and Speed Measurement using Microcontroller is an innovative system that combines exercise and eco-friendly transportation. Users can pedal on a treadmill-equipped bicycle while tracking speed, distance, and time via a microcontroller. The project development follows a systematic approach: study the concept, design the bicycle and electronics, collect components like sensors, Arduino,

and LCD, assemble the parts on a board, and finally run the complete project for testing. The diagram this step-by-step workflow, showing the iterative process from initial study to final project assembly, ensuring accurate performance and user safety.

1.6 Thesis Outline

- **Chapter 1: Introduction.** This chapter is all about Introduction, problem Statement, objectives, Methodology and Work flow Diagram .
- **Chapter 2: Literature Review-** Here briefly describe about literature review.
- **Chapter 3: Evaluation of the Developed System -** This chapter is discussed about instrument and software. Hardware and Software details and its working procedure.
- **Chapter 4: The Design Method and Process –** Here briefly discuss about project, Block Diagram, circuit Design, working principle ,Cost Analysis and Hardware Implementation etc.
- **Chapter 5: Result and Discussion**– This chapter is all about our project advantages, Disadvantage, application and this project conclusion.
- **Chapter 6: Conclusion**– In the final chapter, we have discussed the , Future Scope & conclusion of the project.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

This chapter is arranged on Literature Review. Here's a look at some of last year's literature, like our project. By reading them, we can overcome the mistakes of the previous project and make a more effective project.

2.2 Literature Review

Manish Debnath et al (2015) proposed an eco-friendly method of generating electricity. They proposed the feasibility of this method for the remote areas where the electricity is beyond the reach of common people. Their suggested treadmill can be easily operated by anyone as the small connected DC generators require very small torque. Their method can reduce a significant portion of our consumption of fossil fuel, spent for generating electricity [1].

Shamshad Ali et al (2015) designed simple and sustainable manual treadmill with Electricity. They suggested that this manual treadmill can manage a wide range of health problems and improve strength of muscles. They emphasised that this manual treadmill with Electricity Generator can reduce Green House Gases up to some extent [2].

Gopinath et al (2018) proposed a technique that can produce electricity with the assistance of electricity components that create use of the energy of human footsteps and storing of the charge by converter employed in the circuit for future applications. They suggested the need of constant increase of power to be met by putting in the systems in heavily packed places to overcome the energy crises however conjointly build up a healthy encompassing [3].

Ravindra Burkul et al (2018) developed a branch and bound approach to optimize the ‘Treadmill Electric Bicycle’ serving the purpose of exercise and to reduce the use of non renewable energy resources. They created a platform in which mechanical energy is converted into linear motion. Their proposed prototype can be a good promoted

area to use the energy being wasted on treadmills in fitness centres, not only to save energy but also to create a new idea of energy distribution i n electrical field which is a common need for everyone in future [4].

Gandhewar et al (2017) proposed a project creating a platform in which mechanical energy is converted into linear motion. This is highly fuel-saving technology based prototype was promised to utilize the energy being wasted on treadmills in fitness centers. They investigated its application as an indoor locomotive device infrastructure with large roof span i.e. malls, warehouse, open markets, large office spaces, etc [5].

Masuma Akter et al (2017) proposed the idea of utilizing the wastage energy from human locomotion. They investigated observed as millions of people move every day in cities, significant amount of electricity can be generated by installing feasible devices at places where public walk everyday like railway stations, shopping malls, roadways, densely populated public spots etc. Their piezoel ectric system can be a practical product for capturing footstep power [6].

Harsha et al (2018) developed a treadmill based human power generator using an electromagnetic dynamo generator coupled to a manual treadmill's flywheel. They investigated that a human power treadmill generator could help reduce energy consumption significantly in the gym environment. They emphasised application of the treadmill generator for a low-cost, quick to implement, simple to operate, and low maintenance solution in isolated areas such as rural countryside or developing countries. They discussed application of the treadmill as an educational tool to give people a physical perspective on quantities in energy, helping re alize the importance of energy conservation. They observed that in current era, the method of human power generation could be a solution that also helps mitigate the issue of obesity and overweight [7].

Manish Debnath et al (2015) proposed an eco-friendly method of generating electricity. They proposed the feasibility of this method for the remote areas where the electricity is beyond the reach of common people. Their suggested treadmill can be easily operated by anyone as the small connected DC generators require very small

torque. Their method can reduce a significant portion of our consumption of fossil fuel, spent for generating electricity [8].

Gopinath et al (2018) proposed a technique that can produce electricity with the assistance of electricity components that create use of the energy of human footsteps and storing of the charge by converter employed in the circuit for future applications. They suggested the need of constant increase of power to be met by putting in the systems in heavily packed places to overcome the energy crises however conjointly build up a healthy encompassing [9].

Stavar et al (2010) proposed the treadmill with utility to be not only in recreational or sport domains but in apparently totally different ones. Domains such as Virtual Reality, Walking Rehabilitation, Regenerative Medicine, may take the advantage of using special adapted treadmills. They described a practical application that tries to control the sense, speed and acceleration of a DC motor which has the role to actuate an adapted treadmill. The authors presented a novel concept of an adaptive treadmill control based on the user's undisturbed locomotion intention [10].

2.3 Summary

The above has been discussed in detail in the past few literature's which has given us a lot of motivation to do this project.

CHAPTER 3

HARDWARE AND SOFTWARE ANALYSIS

3.1 Introduction

In this section, we will discuss elaborately about " Treadmill Bicycle and Timer, Speed Measurement using micro-controller" and the component description, features, working procedure of our all equipment. The system hardware fabricates composed of micro-controller unit, power store unite, sensor unit and many more related components.

3.2 Hardware & Software

Hardware

- Battery
- Buck Converter
- Arduino Nano
- IR Sensor
- LCD Display
- Bearing
- Coupler
- Roller
- Conveyor Belt
- Chain Sprocket
- Gear & Pinion
- Wheel
- Frame

3.3 Arduino Nano

Arduino is open-source electronics prototyping platform based on flexible, easy-to- use hardware and software. It's intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments. Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling Lights, motors, and other actuators.

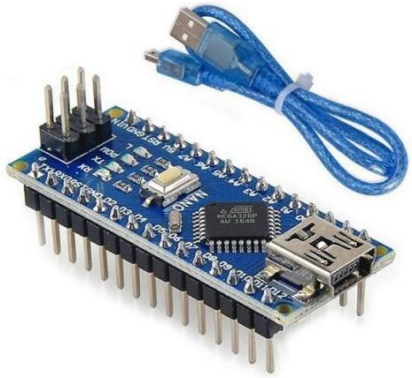


Figure 3.1: Arduino Nano [11]

The micro-controller on the board is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing). Arduino projects can be stand-alone or they can communicate with software on running on a computer (e.g. Flash, Processing, Maxims'). Arduino Nano is a surface mount breadboard embedded version with integrated USB. It is a small, complete, and breadboard friendly component. It has everything that Decimal/ Duemilanove has (electrically) with more analog input pins and onboard +5V AREF jumper. Physically, it is missing power jack. The Nano can automatically sense and switch to the higher potential source of power.

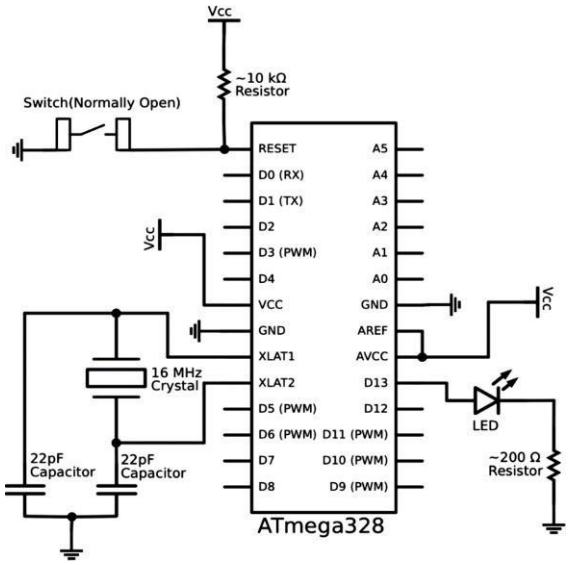


Figure 3.2: Arduino Nano Schematic Diagram [12]

Nano's got the breadboard-ability of the Boarding and the Minibus with smaller footprint than either, so users have more breadboard space. It's got a pin layout that works well with the Mini or the Basic Stamp (TX, RX, ATN, and GND on one top, power and ground on the other). This new version 3.0 comes with ATMEGA328 which offer more programming and data memory space. It has two layers. That make it easier to hack and more affordable. One of the best features of Arduino Nano is, it's easy to use, compact and also small.

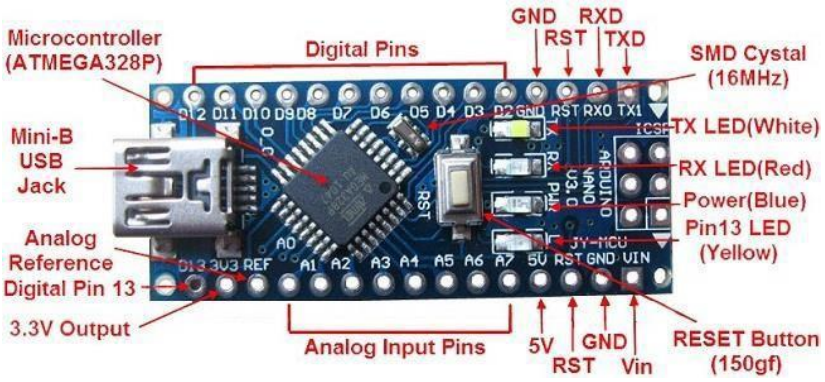


Figure 3.3: How Arduino Nano looks like [13]

3.3.1 Specifications

- Micro-controller: Atmel ATmega328
- Operating Voltage (logic level): 5 V
- Input Voltage (recommended): 7-12 V
- Input Voltage (limits): 6-20 V
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 8
- DC Current per I/O Pin: 40 mA
- Flash Memory: 32 KB (of which 2KB used by boot loader)
- SRAM : 2 KB
- EEPROM: 1 KB
- Clock Speed: 16 MHz
- Dimensions: 0.70" x 1.70"

3.3.2 Features

- Automatic reset during program download
- Power OK blue LED
- Green (TX), red (RX) and orange (L) LED
- Auto sensing/switching power input
- Small mini-B USB for programming and serial monitor
- ICSP header for direct program download
- Manual reset switch

Micro-controller IC ATmega328p

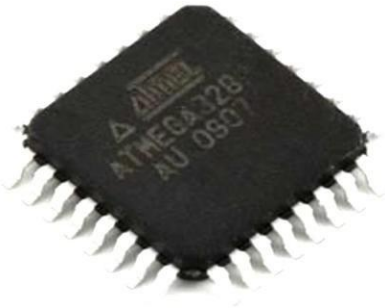


Figure 3.4: Micro-controller IC AT mega 328p [14]

The high-performance Microchip Pico Power 8-bit AVR RISC-based micro-controller combines 32KB ISP flash memory with read-while-write capabilities, 1024B EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, a 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts. By executing powerful instructions in a single clock cycle, the device achieves throughput's approaching 1 MIPS per MHz, balancing power consumption and processing speed.

3.4 IR Sensor

An infrared sensor is an electronics device that emits certain features around it and / or detects infrared radiation. Infrared sensors are capable of measuring the heat emitted by an object and detecting motion. In this project we will control the fan and light automatically through the closed loop system so the IR sensor for the system is definitely needed as a response. Here the fan will turn on and the light will turn on when the IR sensor detects an object and the fan and light will switch off automatically when an object leaves the house.



Figure 3.5: IR Sensor [15]

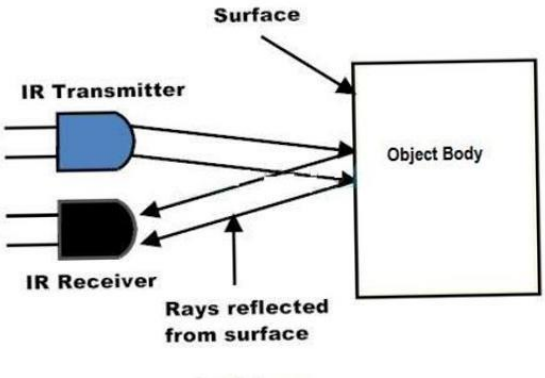


Figure 3.6: IR sensor reflection System [16]

3.4.1 Principles of operation

Sensor works with sense. When an object intersects the sensor light then the sensor detects something .Some infrared ray is deflected from the object and scene the length of this distance. In this sensor we can make a fixed length light and detect our exact object. If some object comes in front of this sensor then the sensor detects it and sends a signal in LED.

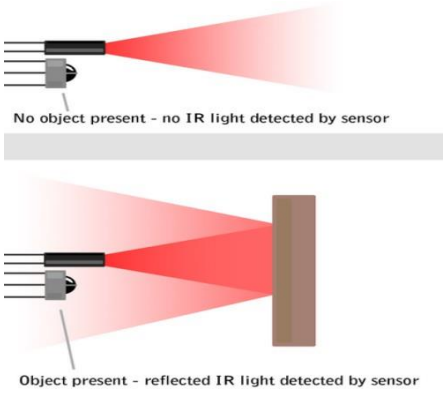


Figure 3.7: IR sensor Detection System [17]

3.5 Battery

Lithium batteries are primary batteries that have metallic lithium as an anode. These types of batteries are also referred to as lithium-metal batteries. They stand apart from other batteries in their high charge density and high cost per unit. Depending on the design and chemical compounds used, lithium cells can produce voltages from 1.5 V (comparable to a zinc–carbon or alkaline battery) to about 3.7 V.

Disposable primary lithium batteries must be distinguished from secondary lithium- ion or a lithium-polymer, which are rechargeable batteries. Lithium is especially useful, because its ions can be arranged to move between the anode and the cathode, using an intercalated lithium compound as the cathode material but without using lithium metal as the anode material. Pure lithium will instantly react with water, or even moisture in the air; the lithium in lithium ion batteries is in a less reactive compound.



Figure 3.8: 3.7V Battery [18]

Lithium batteries are widely used in portable consumer electronic devices. The term "lithium battery" refers to a family of different lithium-metal chemistries, comprising many types of cathodes and electrolytes but all with metallic lithium as the anode. The battery requires from 0.15 to 0.3 kg of lithium per kWh. As designed these primary systems use a charged cathode, that being an electro-active material with crystallographic vacancies that are filled gradually during discharge.

3.5.1 Product Specification

Table 3.1 : Specification of Material

Voltage	3.7 V
Product Type	Lithium-Ion
Battery Capacity	2200mAh
Weight	45 g
Model Number	ICR 18650

3.6 Buck Converter

A buck converter (step-down converter) is a DC-to-DC power converter which steps down voltage (while drawing less average current) from its input (supply) to its output (load). It is a class of switched-mode power supply (SMPS) typically containing at least two semiconductors (a diode and a transistor, although modern buck converters frequently replace the diode with a second transistor used for synchronous rectification) and at least one energy storage element, a capacitor, inductor, or the two in combination. To reduce voltage ripple, filters made of capacitors (sometimes in combination with inductors) are normally added to such a converter's output (load- side filter) and input (supply-side filter). It is called a buck converter because the voltage across the inductor “bucks” or opposes the supply voltage.



Figure 3.9: DC -DC Buck Converter [19]

DC-DC Buck Converter Step Down Module LM2596 Power Supply is a step-down(buck) switching regulator, capable of driving a 3-A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, and an adjustable output version. The LM2596 series operates at a switching frequency of 150kHz, thus allowing smaller sized filter components than what would be required with lower frequency switching regulators.

3.6.1 Specifications of DC-DC Buck Converter Step Down Module LM2596 Power Supply

- Conversion efficiency: 92%(highest)
- Switching frequency: 150KHz
- Output ripple: 30mA9maximum)
- Load Regulation: ± 0.5%
- Voltage Regulation: ± 0.5%
- Dynamic Response speed: 5% 200uS
- Input voltage:4.75-35V
- Output voltage:1.25-26V(Adjustable)
- Output current: Rated current is 2A, maximum 3A (Additional heat sink is required)
- Conversion Efficiency: Up to 92% (output voltage higher, the higher the efficiency)
- Switching Frequency: 150KHz
- Rectifier: Non-Synchronous Rectification
- Module Properties: Non-isolated step-down module (buck)

- Short Circuit Protection: Current limiting, since the recovery
- Operating Temperature: Industrial grade (-40 to +85) (output power 10W or less)

3.7 LCD Display

The LCD (liquid crystal display) screen is an electronic display module and looks for various applications. A 16x2 LCD display is a very basic module and it is very commonly used in various devices and circuits. These modules are preferred over seven sections and many other segments.



Figure 3.10: 16*2 LCD Display [20]

The reasons for having LCD are economic; Easily programmable, special and even custom characters (different in seven sections), there are no restrictions on displaying animations. A 16x2 LCD means it can display 16 characters per line and contains 2 lines. Each character on this LCD is displayed in a 5x7 pixel matrix.

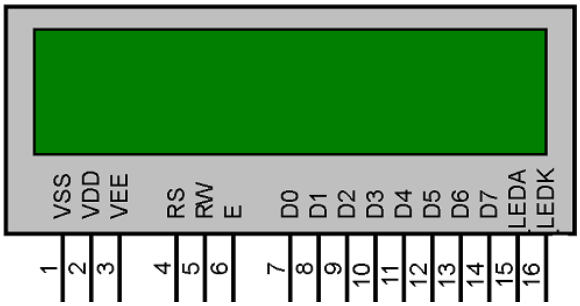


Figure 3.11: Pin out of 16*2 LCD Display [21]

This LCD contains two articles called Command and Data. The command register stores the command instructions on the LCD. The command is a command given to the LCD to perform a predefined task such as starting it, clearing its screen, locating the cursor, controlling the display, etc.

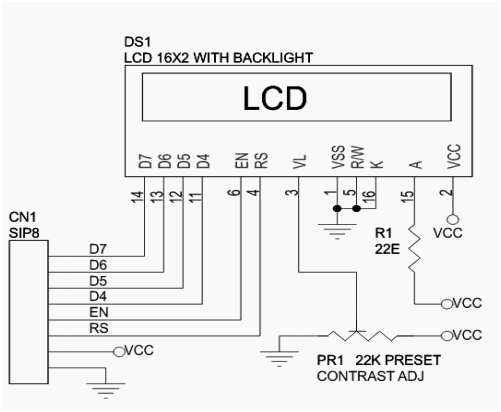


Figure 3.12 : 16*2 LCD Display interfacing with Arduino [22]

3.7.1 Feature

The features of this LCD mainly include the following.

- The operating voltage of this LCD is 4.7V-5.3V
- It includes two rows where each row can produce 16-characters.
- The utilization of current is 1mA with no backlight
- Every character can be built with a 5×8 pixel box
- The alphanumeric LCDs alphabets & numbers
- Is display can work on two modes like 4-bit & 8-bit
- These are obtainable in Blue & Green Backlight
- It displays a few custom generated characters

3.8 Gear & Pinion

A gear and pinion system is a mechanical arrangement used to transmit motion and power between rotating shafts. The pinion is the smaller gear, while the gear is the larger one in the pair. When they mesh together, rotational motion and torque are transferred efficiently. This system is widely used in machinery, automobiles, industrial equipment, and power transmission devices due to its ability to control speed, direction, and mechanical advantage. Gear and pinion mechanisms are valued for their precision, reliability, and ability to handle high loads in compact designs.



Figure 3.13: Gear & Pinion

3.8.1 Specification

- Drive system: Motor → pinion sprocket → chain → large sprocket on roller shaft
- Recommended ratio: 1:2

3.9 Chain Sprocket

Chain drive is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a vehicle, particularly bicycles and motorcycles. It is also used in a wide variety of machines besides vehicles. Most often, the power is conveyed by a roller chain, known as the drive chain or transmission chain, passing over a sprocket gear, with the teeth of the gear meshing with the holes in the links of the chain. The gear is turned, and this pulls the chain putting mechanical force into the system. Another type of drive chain is the Morse chain, invented by the Morse Chain Company of Ithaca, New York, United States. This has inverted teeth. Sometimes the power is output by simply rotating the chain, which can be used to lift or drag objects. In other situations, a second gear is placed and the power is recovered by attaching shafts or hubs to this gear.

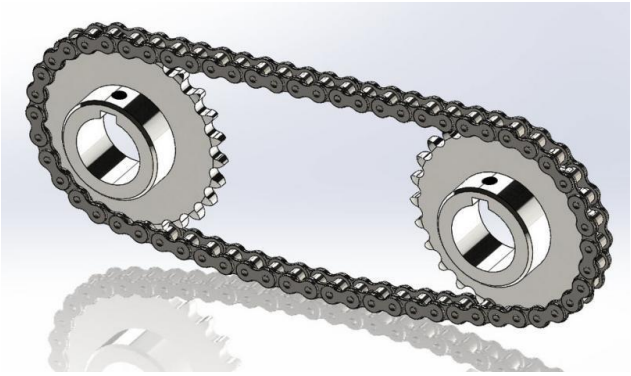


Figure 3.14: Chain Sprocket

Though drive chains are often simple oval loops, they can also go around corners by placing more than two gears along the chain; gears that do not put power into the system or transmit it out are generally known as idler-wheels. By varying the diameter of the input and output gears with respect to each other, the gear ratio can be altered. For example, when the bicycle pedals' gear rotate once, it causes the gear that drives the wheels to rotate more than one revolution. Duplex chains are another type of chain which are essentially two chains joined side by side which allow for more power and torque to be transmitted.

3.10 Ball Bearing

A bearing is a machine element that constrains relative motion to only the desired motion, and reduces friction between moving parts. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may prevent a motion by controlling the vectors of normal forces that bear on the moving parts. Most bearings facilitate the desired motion by minimizing friction. Bearings are classified broadly according to the type of operation, the motions allowed, or to the directions of the loads (forces) applied to the parts. Rotary bearings hold rotating components such as shafts or axles within mechanical systems, and transfer axial and radial loads from the source of the load to the structure supporting it. The simplest form of bearing, the plain bearing, consists of a shaft rotating in a hole. Lubrication is often used to reduce friction. In the ball bearing and roller bearing, to prevent sliding friction, rolling elements such as rollers or balls with a circular cross-section are located between the races or journals of the bearing assembly. A wide variety of bearing designs exists to allow the demands of the application to be correctly met for maximum efficiency, reliability, durability and performance.



Figure 3.15: Ball Bearing

The purpose of Bearing is to reduce rotational friction and support radial and axial loads Types of bearings There are at least 6 common types of bearing, each of which operates on different principles:- Plain bearing, consisting of a shaft rotating in a hole. There are several specific styles: bushing, journal bearing, sleeve bearing, rifle bearing, and composite bearing. Rolling-element bearing, in which rolling elements placed between the turning and stationary races prevent sliding friction. There are two main types Ball bearing, in which the rolling elements are spherical balls Roller bearing, in which the rolling elements are cylindrical, taper and spherical rollers Jewel bearing, a plain bearing in which one of the bearing surfaces is made of an ultra hard glassy jewel material such as sapphire to reduce friction and wear Fluid bearing, a noncontact bearing in which the load is supported by a gas or liquid, Magnetic bearing, in which the load is supported by a magnetic field Flexure bearing, in which the motion is supported by a load element which bends.

3.8.1 Specification

Outer Dia : 22 mm

Inner Dia : 8mm

3.11 Roller



Figure 3.16: Rollers & Pillow Block

A roller is a cylindrical mechanical component designed to rotate around its axis and facilitate smooth motion or support in various systems. It is commonly used to reduce friction, guide movement, and transfer loads efficiently. Rollers are widely applied in machines, conveyors, bicycles, treadmills, and industrial equipment to ensure stability and durability. They can be made from metal, rubber, or composite materials depending on the application, and their design allows for easy rotation with minimal resistance. By providing continuous rolling support, rollers enhance performance, reduce wear and tear, and improve the overall efficiency of mechanical operations.

3.11.1 Specification

- Length: 600 mm
- Outer diameter (OD): 150 mm
- Material: MS tube (3–4 mm thickness) or stainless steel if corrosion is an issue
  Cover/Belt: PVC conveyor belt or rubber sheet (1.5–3 mm thick)

3.12 Wheel



Figure 3.17: Wheel

A wheel is a circular mechanical component that rotates around an axle and is primarily used to enable movement, reduce friction, and carry loads efficiently. It plays a vital role in transportation systems such as bicycles, cars, and carts, as well as in machinery and industrial equipment. Wheels can be made of materials like metal, rubber, or composites depending on their purpose. Their design allows smooth rolling motion, stability, and energy efficiency, making them one of the most fundamental inventions in engineering. By converting rotational motion into forward movement, wheels significantly enhance mobility and mechanical performance.

3.12.1 Specification

- Front wheel: Bicycle wheel, 26″ rim (660 mm dia)
- Rear support (if needed): 50–75 mm dia swivel casters
- Axles: M12 bolts + locknuts

3.13 Frame



Figure 3.18: Frame

A frame is the fundamental structural component that provides support, shape, and stability to a system or device. It acts as the backbone on which other parts and components are mounted or assembled. Frames are commonly used in bicycles, vehicles, machines, and construction, ensuring strength and durability while withstanding loads and stresses. They are typically made of materials like steel, aluminum, or composite alloys, chosen for their strength-to-weight ratio. The design of a frame not only determines stability and safety but also affects overall performance and efficiency. In essence, the frame holds everything together and maintains structural integrity.

3.13.1 Specification

- Material: Mild Steel (MS) rectangular tube or channel
- Main rails: 40 × 40 × 3 mm rectangular steel tube
- Cross members: 25 × 25 × 3 mm or 40 × 20 × 3 mm tube
- Overall length: ~1100 mm
- Width (inside roller span): ~600 mm

3.14 Conveyor Belt



Figure 3.19: Conveyor Belt

The conveyor belt in the Treadmill Bicycle is made of rubber and plays a key role in turning the movement from walking/running into forward motion. It's designed to feel like jogging or running outdoors and can handle the impact of your feet as you walk or run. The belt is strong and lasts a long time, giving you a smooth and consistent workout experience. By using the conveyor belt, the Treadmill Bicycle not only improves your heart health but also lets you do different types of exercises for a full- body workout.

3.14.1 Specification

- Type: Flat PVC or Rubber conveyor belt
- Length: ~1800–2000 mm (depending on roller center distance + wrap allowance)
- Width: 600 mm (to match roller length)
- Thickness: 2–3 mm (PVC) or 4–6 mm (rubber)

3.15 Coupler



Figure 3.20: Coupler

A coupler is a mechanical device used to connect two shafts or components together so that motion and power can be transmitted between them. It ensures alignment, smooth transfer of torque, and reduces vibration or misalignment problems. Couplers are widely used in engines, pumps, generators, and bicycles where rotational energy needs to be transferred. They can be rigid or flexible, depending on the application, and are usually made of strong materials like steel or aluminum. In short, a coupler plays a crucial role in linking mechanical parts to work as a single system.

3.15.1 Specification

- Type: Flexible jaw-type or rigid coupler (depends on alignment accuracy)
- Material: Aluminum alloy or Mild Steel
- Length: ~40–60 mm
- Outer Diameter: 30–40 mm

SOFTWARE

3.16 Arduino Software

The digital micro-controller unit named as Arduino Nano can be programmed with the Arduino software IDE. There is no any requirement for installing other software rather than Arduino. Firstly, Select "Arduino Nano from the Tools, Board menu (according to the micro controller on our board). The IC used named as ATmega328 on the Arduino Nano comes pre burned with a boot loader that allows us to upload new code to it without the use of an external hardware programmer. Communication is using the original STK500 protocol (reference, C header files). We can also bypass the boot loader and programs the micro controller through the ICSP (In Circuit Serial Programming) header. The ATmega16U2 (or 8U2 in the rev1 and rev2 boards) firmware source code is available. The ATmega16U2/8U2 is loaded with a DFU boot loader, which can be activated by:

On Rev1 boards: connecting the solder jumper on the back of the board (near the map of Italy) and then resetting the 8U2. On Rev2 or later boards: there is a resistor that pulling the 8U2/16U2 HWB line to ground, making it easier to put into DFU mode. The Arduino Nano is one of the latest digital micro controller units and has a number of facilities for communicating with a computer, another Arduino, or other micro-controllers. The ATmega328 provides UART TTL at (5V) with serial communication, which is available on digital pins 0 -(RX) for receive the data and pin no.1 (TX) for transmit the data. An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, an .in file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board.

The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial Communication on pins 0 and 1). A Software Serial library allows for serial communication on any of the Nano's digital pins. The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus. Arduino programs are written in C or C++ and the program code written for Arduino is called sketch. The Arduino IDE uses the GNU tool chain and AVR Lab to compile programs.

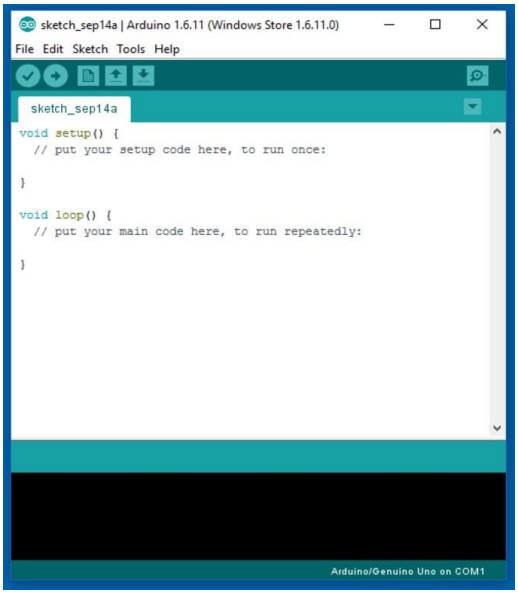


Figure 3.21: Arduino Software Interface IDE [23]

Writing Sketches

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension. ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom righthand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

Libraries

Libraries provide extra functionality for use in sketches, e.g. working with hardware or manipulating data. To use a library in a sketch, select it from the Sketch > Import Library menu. This will insert one or more #include statements at the top of the sketch and compile the library with your sketch. Because libraries are uploaded to the board with your sketch, they increase the amount of space it takes up. If a sketch no longer needs a library, simply delete its #include statements from the top of your code.

There is a list of libraries in the reference. Some libraries are included with the Arduino software. Others can be downloaded from a variety of sources or through the Library Manager. Starting with version 1.0.5 of the IDE, you do can import a library from a zip file and use it in an open sketch. See these instructions for installing a third-party library.

Third-Party Hardware

Support for third-party hardware can be added to the hardware directory of your sketchbook directory. Platforms installed there may include board definitions (which appear in the board menu), core libraries, boot-loaders, and programmer definitions. To install, create the hardware directory, then unzip the third-party platform into its own sub-directory. (Don't use "Arduino" as the sub-directory name or you'll override the built-in Arduino platform.) To uninstall, simply delete its directory.

4.17 Easy EDA

Easy EDA is a web-based EDA tool suite that enables hardware engineers to design, simulate, share-publicly and privately-and discuss schematics, simulations and printed circuit boards. Other features include the creation of a bill of materials, Gerber files and pick and place files and documentary outputs in PDF, PNG and SVG formats. Easy EDA allows the creation and editing of schematic diagrams, SPICE simulation of mixed analogue and digital circuits and the creation and editing of printed circuit board layouts and, optionally, the manufacture of printed circuit boards.

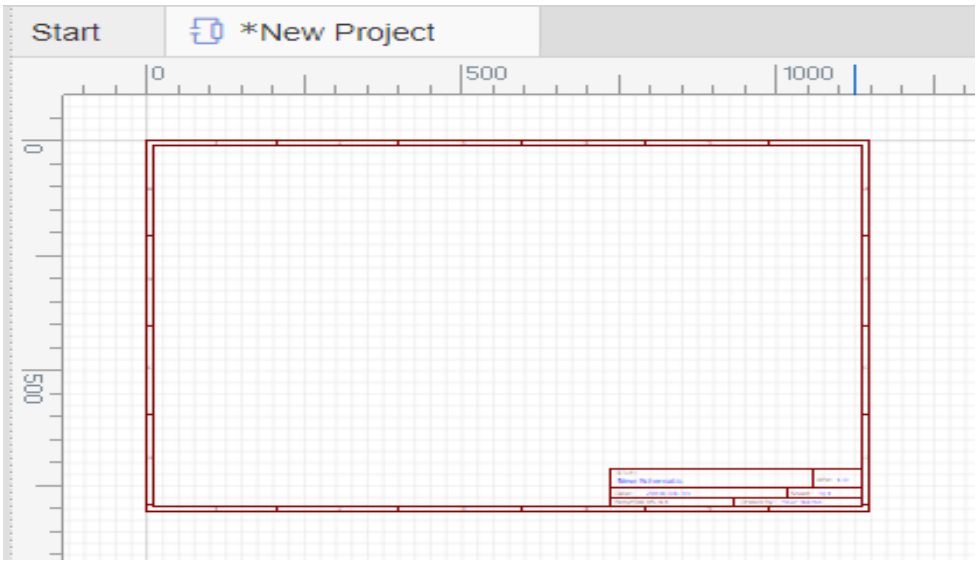


Figure 3.22: Easy EDA Software Interface [24]

Subscription-free membership is offered for public plus a limited number of private projects. The number of private projects can be increased by contributing high quality public projects, schematic symbols, and PCB footprints and/or by paying a monthly subscription.Registered users can download Gerber files from the tool free of charge; but for a fee, Easy EDA offers a PCB fabrication service. This service is also able to accept Gerber file inputs from third party tools.

CHAPTER 4

SYSTEM ARCHITECTURE

4.1 Introduction

The project Objectives, Methods,Problem Statement, Literature review, Hardware and Software Analysis and other details were all clarified in the preceding chapter. The block diagram, Proposed Design, circuit diagram, Working principle,Hardware Implementation and final project instrument cost analysis will all be covered in this chapter.

4.2 Block Diagram

Here is the block diagram of the ‘’Treadmill Bicycle and Timer, Speed Measurement using micro-controller’’ with all the essential components. All of the components are shown in below as a block in this diagram.Here we use Arduino Nano Micro-controller of our project. Other equipment's are attached with this micro-controller and work together for perform as our desire outcome.

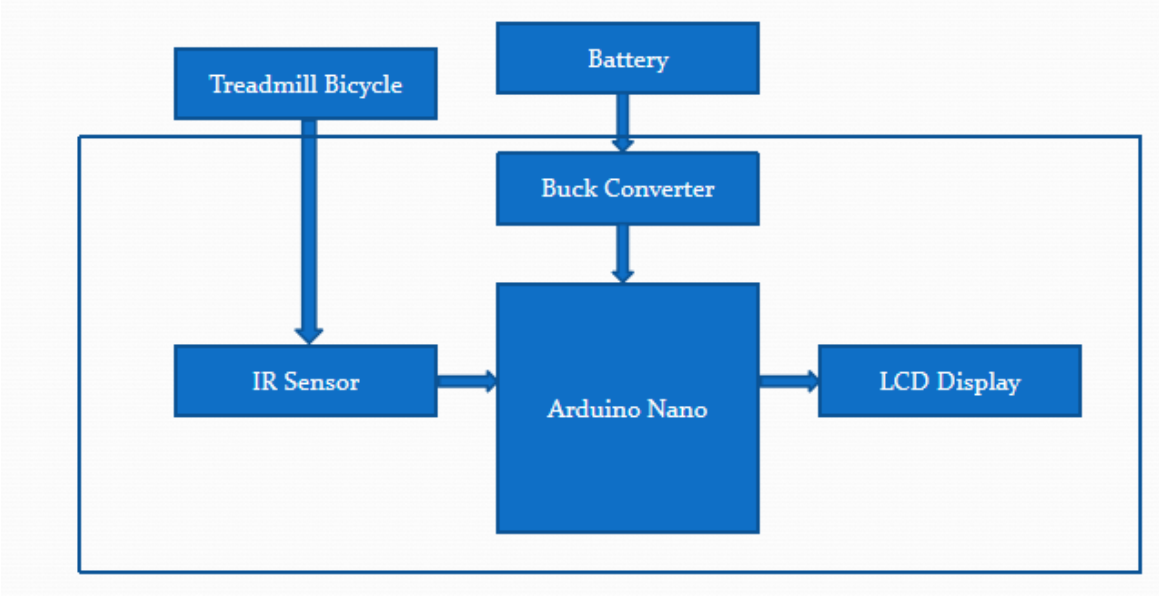


Figure 4.1: Block Diagram of Our Project

4.3 Circuit Design

The schematic diagram here is representing the electrical circuit and the components of our System. Here we connect equipment with he smart wire connection.

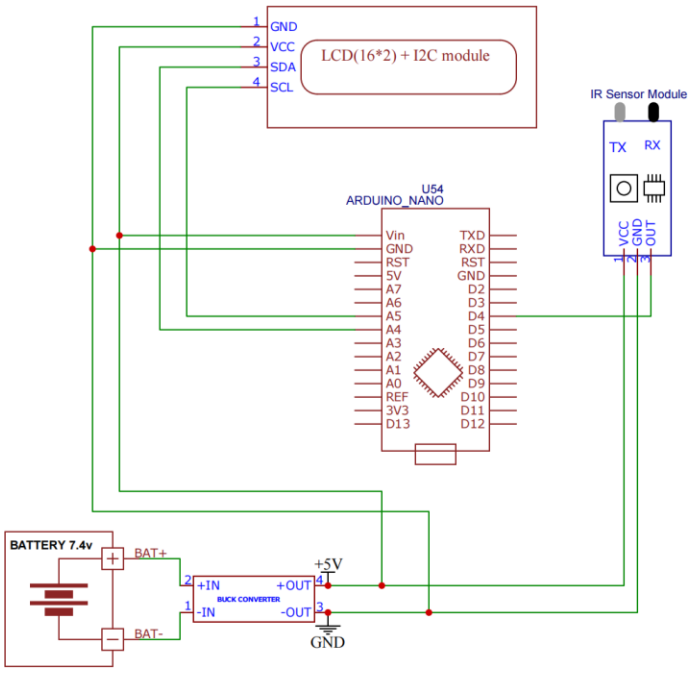


Figure 4.2: Circuit Diagram of our system

4.4 Working Principle

The Treadmill Bicycle with Timer and Speed Measurement using Microcontroller works by combining a treadmill belt system with a bicycle frame, where an IR sensor is used to measure speed. As the treadmill belt and roller rotate during pedaling or running, the IR sensor detects the interruptions caused by a reflective or opaque mark placed on the wheel or roller. Each detection is counted as one rotation, and the signal is sent to the microcontroller. The microcontroller processes these pulses to calculate the speed, distance, and elapsed time. The results are then displayed on an LCD in real time. The power supply ensures stable operation, while the mechanical frame and rollers provide smooth motion. Thus, the system allows outdoor exercise and eco-friendly travel with accurate performance monitoring.

4.5 Cost Analysis

Table 4.1 :List of Component with Price

Sl. no	Particulars	Specification	Qty.	Unit Price (Taka)	Total Price (Taka)
1	Arduino nano	ATmega328P	1	600	600
2	Battery	3.7V	2	100	200
3	IR Sensor		1	250	250
4	Buck Converter	LM2596	1	250	250
5	LCD Display	16*2	1	400	400
6	Roller			2000	2000
7	Conveyor belt			1000	1000
8	Rack and Pinion			800	800
9	Ball Bearing		6	100	600
10	Treadmill Bicycle		1	15000	15000
11	Others				1000
				Total	22100/=

4.6 Hardware Implementation



Figure 4.3: Bearing



Figure 4.4: Roller



Figure 4.5: Conveyor belt



Figure 4.6: Rack & Pinion mechanism



Figure 4.7: Coupler

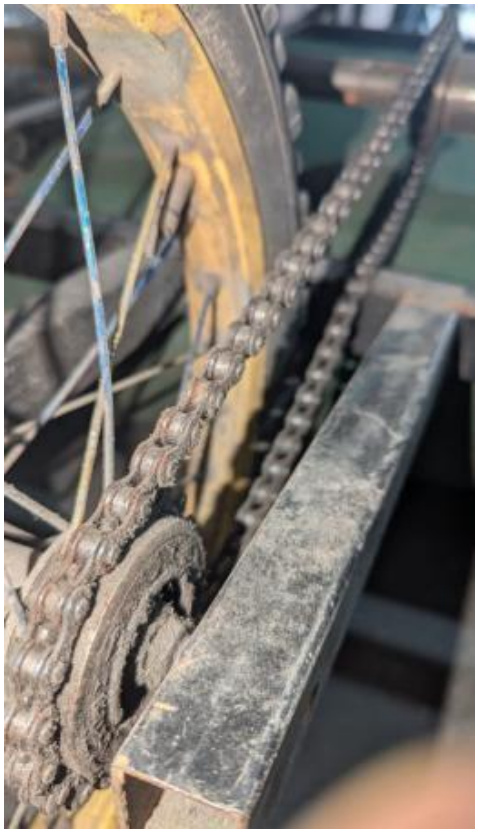


Figure 4.8 : Chain Sproket



Figure 4.9 : Project Progress Image

CHAPTER 5
RESULT AND DISCUSSION

5.1 Project Outcome

After finally completing this project, we ran it & we observed the output of this project. We can see that it is working well as expected. After making our project we observe it very careful. It works as we desire. Our project give output perfectly and all equipment are work perfectly. We check how much it works and we get perfect output from this project.

The IR sensor successfully detected wheel/roller rotations and provided accurate pulse counts.

- The microcontroller processed the sensor data effectively to calculate speed, distance, and time.
- Real-time results were displayed clearly on the LCD without delay.
- The system showed good stability and consistency during continuous operation.
- Speed measurement accuracy remained reliable after multiple test runs.
- The treadmill bicycle proved useful as both a fitness tool and an eco-friendly transportation concept.

5.1.1 Performance Test and Data Acquisition

Performance of the constructed Treadmill Bicycle was conducted on various road conditions. Average speed of the treadmill bicycle on various road conditions were calculated by measuring the length of the road using measuring tape. Then the time was measured by a stop watch to travel the measured distance on a particular road surface. This procedure was done several times on a specific road for more accurate result. Among all the collected data, the average value was calculated.

(a) Data on Asphalt Road:

Table 5.1.1.1: Observation-01 for Average Speed Measurement on Asphalt Road.

Exp. No.	Distance Travelled(m)	Time Required(S)	Velosity(m/s)	Avg. Speed(m/s)
01	8.5	10	0.85	0.86
02	17.5	20	0.87	
03	25.8	30	0.86	
04	35	40	0.87	

Table 5.1.1.2: Observation-02 For Average Speed Measurement on Asphalt Road.

Exp. No.	Distance Travelled(m)	Time Required(S)	Velosity(m/s)	Avg. Speed(m/s)
01	8.8	10	0.88	0.88
02	18.0	20	0.90	
03	26.5	30	0.88	
04	35.5	40	0.89	

Table 5.1.1.3: Observation-03 For Average Speed Measurement on Asphalt Road.

Exp. No.	Distance Travelled(m)	Time Required(S)	Velosity(m/s)	Avg. Speed(m/s)
01	8.3	10	0.83	0.83
02	16.8	20	0.84	
03	25.0	30	0.83	
04	33.5	40	0.84	

From the above observations the total Average Speed is = $\frac{0.86+0.88+0.83}{3}$ = 0.85 m/s

(b) <u>Data on Concrete Road:</u>

Table 5.1.1.4: Observation-01 for Average Speed Measurement on Concrete Road.

Exp. No.	Distance Travelled(m)	Time Required(S)	Velosity(m/s)	Avg. Speed(m/s)
01	8.2	10	0.82	0.82
02	16.2	20	0.81	
03	24.5	30	0.81	
04	32.8	40	0.82	

Table 5.5: Observation-02 For Average Speed Measurement on Concrete Road.

Exp. No.	Distance Travelled(m)	Time Required(S)	Velosity(m/s)	Avg. Speed(m/s)
01	7.9	10	0.79	0.79
02	15.9	20	0.79	
03	23.8	30	0.79	
04	31.5	40	0.78	

Table 5.1.1.6: Observation-03 For Average Speed Measurement on Concrete Road.

Exp. No.	Distance Travelled(m)	Time Required(S)	Velosity(m/s)	Avg. Speed(m/s)
01	8.0	10	0.80	0.82
02	16.5	20	0.82	
03	24.8	30	0.82	
4	33.0	40	0.82	

From the above observations the total Average Speed is = $\frac{0.82+0.79+0.82}{3}$ = 0.81 m/s

(c) <u>Data on Brick Road:</u>

Table 5.1.1.7: Observation-01 for Average Speed Measurement on Brick Road.

Exp. No.	Distance Travelled(m)	Time Required(S)	Velosity(m/s)	Avg. Speed(m/s)
01	7.5	10	0.75	0.74
02	14.8	20	0.74	
03	22.3	30	0.74	
04	29.5	40	0.73	

Table 5.1.1.8: Observation-02 For Average Speed Measurement on Brick Road.

Exp. No.	Distance Travelled(m)	Time Required(S)	Velosity(m/s)	Avg. Speed(m/s)
01	7.2	10	0.72	0.70
02	14.0	20	0.70	
03	21.0	30	0.70	
04	28.2	40	0.70	

Table 5.1.1.9: Observation-03 For Average Speed Measurement on Brick Road.

Exp. No.	Distance Travelled(m)	Time Required(S)	Velosity(m/s)	Avg. Speed(m/s)
01	7.8	10	0.78	0.78
02	15.8	20	0.79	
03	23.5	30	0.78	
04	31.4	40	0.78	

From the above observations the total Average Speed is = $\frac{0.74+0.70+0.78}{3}$ = 0.74 m/s

Therefore, From the results of performance test it is shown that the average speed varies with the road surface.

5.1.2 Results

Analyzing the data from the table 5.1, 5.2, 5.3,5.4,5.5,5.6,5.7,5.8 and 5.9 it has been observed that the average speed of the treadmill bicycle varies with the road surface. The maximum average speed is found on the asphalt road and it was 0.85 m/s . On the other hand, the minimum average speed was found on the brick road and it was 0.74 m/s . The average speed on the concrete road was 0.81 m/s.

5.2 Advantages

There are certainly many advantages of our project and some of the major ones have been given below:

- Reduces dependency on fuel-based vehicles, helping to lower air pollution.
- Provides a cost-effective alternative for short-distance travel.
- Improves cardiovascular health by combining exercise with commuting.
- Can be used in both urban and rural areas with simple road conditions.
- Requires minimal maintenance compared to motor-driven vehicles.
- Encourages green technology awareness among users.
- Acts as a dual-purpose machine
- Increases user motivation by providing real-time performance monitoring.
- Supports a sustainable lifestyle through clean and renewable energy use.

5.3 Disadvantages

This project has some disadvantages. There are –

- Cannot be used for long-distance travel compared to fuel vehicles.
- Performance depends entirely on human effort and stamina.
- Speed is limited, making it unsuitable for highway or fast transport.
- Carrying heavy loads or multiple passengers is not possible.
- Initial design and fabrication may require special materials and cost

5.4 Limitation

- The system does not operate smoothly when a person stands on it due to weight imbalance.
- Excessive load on the treadmill bicycle causes difficulty in rotation and smooth motion.
- The mechanical structure is not strong enough to handle high weight or heavy users.
- Friction between rollers and belt increases under load, reducing efficiency.
- Stability and durability need improvement for real-world practical use.

5.5 Application

Our project has many application areas and actually we need to use it in many places to verified the exact person which have the proper access. Some of the application areas of the project has been pointed out below:

- Fitness tool
- Eco-friendly transport
- Short-distance travel
- Educational projects
- Gyms / Fitness centers
- Exercise machine

5.6 Environmental Acceptation

- Promotes eco-friendly transportation by reducing dependency on fuel-based vehicles.
- Minimizes air pollution and greenhouse gas emissions in short-distance travel.
- Encourages sustainable mobility solutions aligned with green technology trends.
- Operates without fossil fuels, supporting renewable and clean energy practices.
- Reduces noise pollution compared to motorized vehicles.
- Serves as a prototype for future green urban transport systems.
- Supports a circular economy concept by combining fitness, energy efficiency, and sustainability.

5.7 Discussion

While working on our project, we did face some difficulties as it is a very complex system but the end results, we came up with were quite satisfactory. We have put the whole system through several tasks to validate our work and also have taken necessary notes for future improvements. Some future recommendations that we have involves improvement in system design and wiring, adding features for more efficient.

The Treadmill Bicycle with Timer and Speed Measurement is an innovative device combining exercise and transportation. Using an Arduino Nano, it monitors speed, time, and performance efficiently. It promotes daily fitness, eco-friendly commuting, and health monitoring. The project serves educational purposes, demonstrating green technology and sustainable practices. Additionally, it can be applied in gyms, physiotherapy, and awareness campaigns, acting as a prototype for future eco-conscious vehicles.

CHAPTER 6
CONCLUSION

6.1 Conclusion

In conclusion, the Treadmill Bicycle with Timer and Speed Measurement using Arduino Nano successfully integrates fitness, transportation, and technology into a single system. The project demonstrates how a microcontroller-based system can efficiently monitor speed, time, and performance while promoting health and physical activity. It serves as an eco-friendly alternative for short-distance travel, reducing pollution and encouraging sustainable practices. Moreover, it provides valuable insights for educational purposes, showcasing renewable and green technology applications. The device is versatile, suitable for gyms, rehabilitation centers, physiotherapy sessions, and awareness campaigns, offering controlled exercise for users of different age groups and health conditions. By combining exercise with real-time monitoring, the project not only encourages regular physical activity but also acts as a prototype for future green vehicles in urban mobility. Overall, this project highlights the potential of technology-driven fitness solutions and sustainable innovations.

6.2 Future Scope

We are thinking about adding many features to our project in the future to get more desirable out comes. Some of the steps that we are thinking about taking are given below:

- Improve the mechanical frame to support higher weight and ensure stability.
- Use stronger rollers and belts to reduce friction and allow smoother operation.
- Design the system to work both indoors and outdoors with better portability.
- Develop lightweight, durable materials to make the systemIntegration with IoT and mobile apps for real-time fitness tracking.
- Development of solar-powered versions for fully eco-friendly operation.

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