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Design and Implementation of an Arduino Uno-Based RPM Control System for a Treadmill

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Abstract

This research presents the design and development of an RPM (Revolutions Per Minute) controller for a treadmill using Arduino UNO. The treadmill is a medical device commonly used to evaluate cardiac performance under increasing levels of physical activity. Its primary function is to monitor how the heart responds to progressively intense exercise. In this design, the treadmill is powered by an AC motor, with RPM speed regulated through a timer and driven by a servo motor programmed via Arduino UNO. The system is designed to display RPM values of 550, 750, 950, and 1100 on the interface. This development aims to support more accurate and controlled cardiac stress testing through precise speed adjustments.

Keywords: Treadmill, motor AC, Arduino UNO, RPM

INTRODUCTION

Hospitals are an integral part of healthcare services. To ensure the delivery of high-quality services, hospitals must be supported by adequate resources, both in terms of quality and quantity. These resources include human resources (HR), equipment, facilities, and infrastructure. Moreover, hospitals are required to consistently maintain the readiness and functionality of medical equipment, as well as supporting facilities and infrastructure (Badar, 2022).

Hospitals consist of various specialized units, each equipped with numerous medical devices. One such unit is the cardiology clinic (cardiac outpatient department), which provides healthcare services aimed at diagnosing, treating, and preventing heart diseases. The cardiology clinic is equipped with several medical devices, one of which is the treadmill. Regular physical exercise can reduce blood glucose levels. One example of regular exercise is walking on a treadmill. The treadmill is equipped with a system that detects distance, speed, and time, allowing individuals to determine the distance, speed, and duration of their exercise (Sari, 2021).

The treadmill is a medical device used to evaluate the heart's performance during progressively increasing physical activity. Its primary function is to monitor how the heart responds to elevated levels of physical exertion. Although advancements in medical technology for diagnosing coronary heart disease have progressed rapidly, the treadmill exercise test (TET) remains the most widely utilized diagnostic method. Its popularity stems from ease of use, safety, relatively low cost, and quick administration time. Moreover, the TET serves as a preliminary screening tool before proceeding to more invasive and expensive procedures (Suchyar, 2018).

Fitness treadmills based on microcontroller technology are developed through two main stages: hardware system design and software development. The hardware design integrates various functional components, while the software is programmed to ensure the system performs as intended. The software is written in Basic language. This microcontroller-based fitness device operates effectively and can be controlled using push buttons. Upon activation, the soft rubber belt begins to move at a speed determined by the user. The speed results are then displayed on an LCD screen (Irawan, 2020).

One critical component of the treadmill is the RPM controller, which regulates the speed of the belt movement. The presence of an RPM controller allows users to adjust treadmill speed according to the specific requirements needed—whether for fitness purposes or cardiac diagnostics.

Arduino Uno is a microcontroller board based on the ATmega328. It features 14 digital input/output pins (6 of which can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. The Arduino Uno contains everything needed to support a microcontroller; simply connect it to a computer via USB or power it with a DC source from a battery or AC-to-DC adapter to get started. The Arduino Uno uses the ATmega16U2 programmed as a USB-to-serial converter, enabling serial communication with a computer via the USB port. (Kadir, 2022)

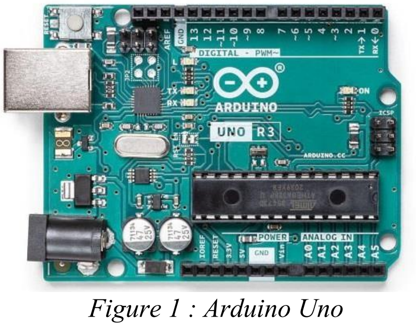


Figure 1 : Arduino Uno

RESEARCH METHODS

The research design serves as a guideline comprising procedures and techniques employed in structuring a study. It functions as a framework for developing strategies that yield a coherent research model. The design utilized in this study is illustrated in Figure 2.

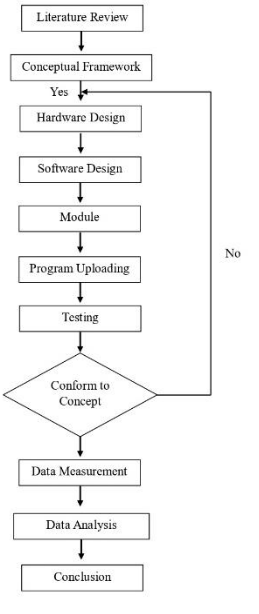


Figure 2 : Research Design Flowchart

The researcher conducted data collection through the following steps:
a. Measuring at predetermined measurement points.
b. Applying variations to test the output.
c. Presenting the measurement data and output results in a measurement table.
d. Analyzing the data obtained in step c.

e. Write conclusions based on the results of the data analysis.

The instrument used

The equipment used to support the implementation of the treadmill circuit design in this project is as follows:

Table 1 : Equipment Name and The function

Equipment Name	Function
Multimeter/Avo Meter	To measure voltage at each measurement point
Power *Supply*	To serve as a power source or to convert 12VDC to 5VDC for components
Tool Set	To serve as auxiliary tools for ensuring workplace safety

Materials

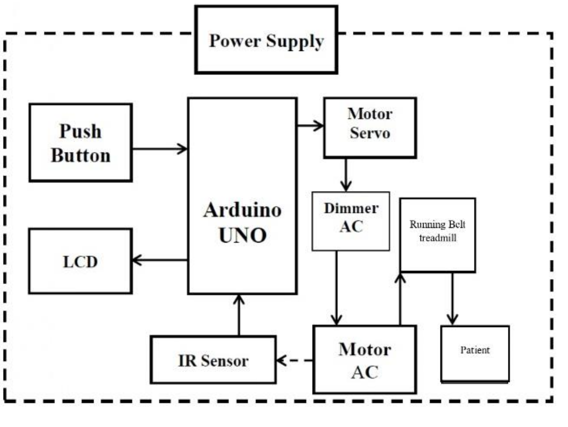
Several materials are used to support the implementation of the treadmill circuit construction. The materials used in the design are as follows:

Table 2 : The Components Used in This Design

No.	Component
1.	*Push Button*
2.	Motor AC
3.	*Liquid crystal Display* (LCD)
4	IR Sensor
5	Arduino UNO
6	*Power Supply*
7	*Dimmer AC*
8	Motor Servo
9	Running Belt treadmill

Block Diagram

The development of this treadmill device is designed based on the circuit block diagram shown in Figure 3.



Figur 3 : Design Block Diagram

Block Diagram Working Principle

When voltage is supplied to the device, the entire circuit becomes active. Once the display is powered on, the user initiates the process by pressing the start button. The Arduino microcontroller receives the command and activates the AC motor. This motor drives the carpet mechanism intended for patient use. Subsequently, the infrared (IR) sensor detects the resulting rotational speed in revolutions per minute (RPM), and the measurement is displayed on the screen for monitoring purposes.

Table 3: Functions of Each Block

Component	Function
Power Supply	Provides voltage to the entire circuit.
Arduino UNO	Controls the electronic circuit, stores the program, and manages the system.
Push Button	Functions as a pull-up/pull-down switch for RPM settings and as a start button.
Servo Motor	Controls the speed adjustment on the AC dimmer.
AC Dimmer	Regulates the speed of the AC motor.
AC Motor	Drives or rotates the treadmill belt.
IR Sensor	Detects the RPM of the treadmill.
LCD Display	Displays the RPM value.

RESULTS AND DISCUSSION

Mechanical Design

The treadmill frame was designed using PVC pipes and plywood, and then assembled according to the shape of a treadmill.

Figure 3 : Construction of the Treadmill Frame

Component Assembly

The components provided are assembled according to the design requirements.

Program Installation

After completing the component assembly, the program is uploaded to the Arduino Uno

Setting Circuit

The setting circuit is designed using two push buttons connected to the input pins of the Arduino UNO for controlling the start and stop functions of the RPM controller. Button S1 functions as the start switch, while S2 functions as the stop switch. These push buttons send signals to the Arduino through pin 2 and pin 3.

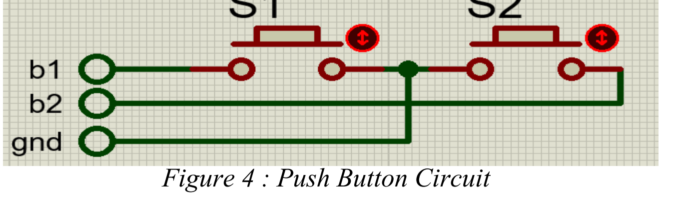


Figure 4 : Push Button Circuit

Arduino UNO Circuit

The microcontroller circuit is designed using the Arduino UNO, as shown in Figure 3.4. The Arduino functions as the main controller of the electronic system and stores the programmed

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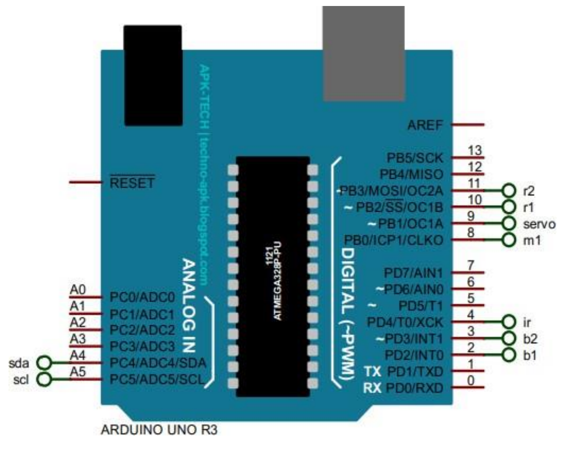
instructions. It receives input from the push buttons through pins 2 and 3. The Arduino then activates the servo motor through pin 9. The servo motor adjusts the speed by rotating the dimmer, which in turn drives the AC motor. The LCD displays the input data from the Arduino via pin A4 (SDA) and pin A5 (SCL). Pin 4 is used for the IR sensor, which measures the RPM of the motor. Pins 10 and 11 on the Arduino serve as inputs to the relay module.



Dimmer Circuit

The dimmer circuit, which includes a servo motor and a relay, is shown in Figure 3.5. This circuit functions to control the speed of the AC motor. The dimmer is operated by a servo motor connected to pin 9 of the Arduino, and a relay module serves as a driver for the AC motor powered from the main supply. The live wire from the dimmer is connected to the NO (Normally Open) terminal of the relay, while the neutral wire is connected to the neutral line of the main supply. The relay output is then connected to the motor, and the VCC of the relay is also connected to the motor.

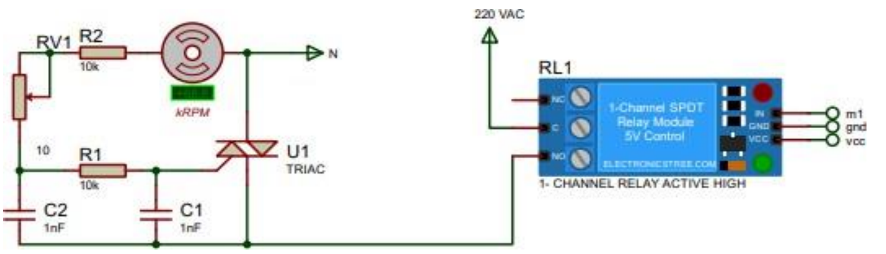


Figure 6 : Dimmer Circuit

RPM Reader Circuit

The RPM reader circuit is designed using an IR sensor, as illustrated in Figure 7. This circuit functions to detect the RPM output and send the data to the Arduino, which then displays it on the LCD screen. The IR sensor transmits rotational speed data to the Arduino microcontroller via digital pin 4. This data is then processed and forwarded to the LCD screen for visual display and real-time monitoring.

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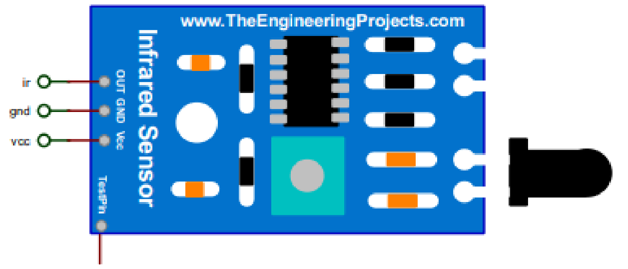

Figure 7 : RPM Reader Circuit

RPM Circuit Configuration

The RPM circuit is designed using relays and a motor, as illustrated in Figure 3.7. This circuit functions as the driving mechanism for the treadmill belt. The AC motor is activated when the push-button switch is pressed (*start*). Subsequently, the Arduino microcontroller engages the servo motor via digital pin 9, which regulates speed through a dimmer module. Following this, the Arduino activates the relay system via pins 10 and 11 to initiate motor operation.

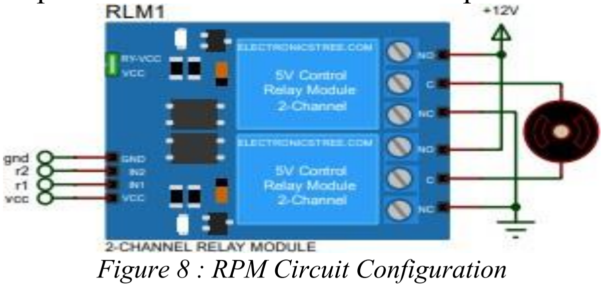

Figure 8 : RPM Circuit Configuration

Display Circuit Configuration

The display circuit is configured using a 16x2 LCD module, as shown in Figure 9. This circuit serves to receive output data from the programmed microcontroller, specifically to display RPM values. The LCD obtains data from the Arduino and renders the output using pin A4 (*SDA*) and pin A5 (*SCL*).

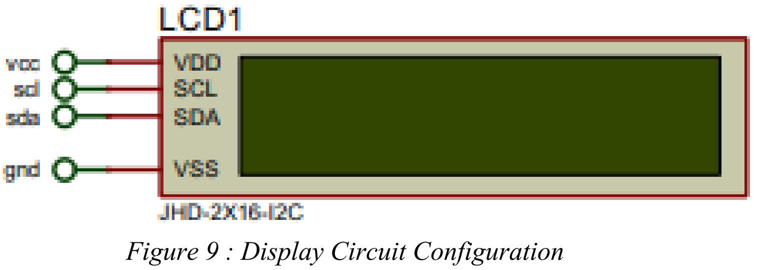

Figure 9 : Display Circuit Configuration

Software Design

The electronic hardware system built around the Arduino UNO cannot function without complementary software support. Improper software implementation may result in hardware malfunction or deviation from intended behavior. Therefore, precision and accuracy are essential in software design to ensure reliable system performance.

Supporting Program and Development Tools

The software is developed using C++ programming language, which is utilized to convey command instructions to the Arduino UNO microcontroller. Prior to coding, a flowchart is constructed to outline the procedures necessary for implementing the desired system behavior. This includes the definition of input and output parameters (port initialization) and the data processing operations as designed.

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RPM Control Flowchart

The RPM control system of the Arduino UNO–based treadmill is depicted in Figure 9.

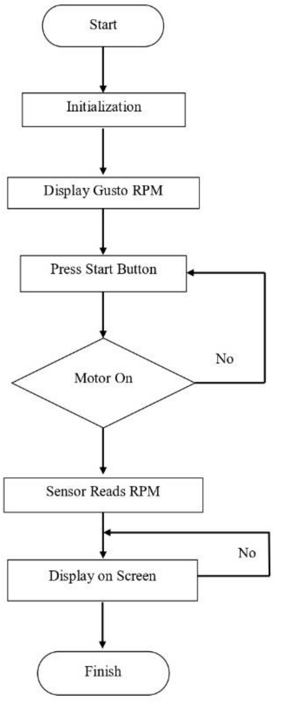

Figure 10 : RPM Control Flowchart

System Initialization and Operation Flow:

Upon initial power-up, the device performs an automatic initialization process to configure the relevant input and output pins. The display then shows the text "GUSTO RPM" as a system status indicator. Once the user presses the start button, the motor is triggered and begins operation automatically. The sensor reads the rotational speed (RPM) of the motor, transmits the data

RPM Testing Procedure

The RPM testing was conducted according to the following steps:

1. Power on the device by connecting the power supply cable to the mains.
2. Press the start button on the treadmill unit.
3. Wait until the RPM value appears on the display screen.
4. Direct the tachometer toward the rotating pipe connected to the belt mechanism to measure RPM.
5. Record the RPM readings obtained via the tachometer. The results are presented in the corresponding data table

Table 3 : Measurement Results

No	Stage	Setting RPM (r/m)	RPM Measurement Results Using Tachometer (r/m) Test to-			Means	RPM Deviation (r/m)	Accuracy Percentage Calculation (%)
			1	2	3			
1	Stage I	550	522	535	560	539	11	

								98
2	Stage II	750	783	795	755	777	27	97
3	Stage III	950	933	960	948	947	2	99
4	Stage IV	1115	1120	1110	1126	1118	3	98

Referring to Table 4.1, the RPM values displayed by the system were compared against measurements obtained using a tachometer across four operational stages:

Stage I: The displayed RPM value was 550 r/m. The measured values across three trials were:

- Trial I: 522 r/m
- Trial II: 535 r/m
- Trial III: 560 r/m

Stage II: The displayed RPM value was 750 r/m. The measured values obtained were:

- Trial I: 783 r/m
- Trial II: 795 r/m
- Trial III: 755 r/m

Stage III: The displayed RPM value was 950 r/m. The measured results were:

- Trial I: 933 r/m
- Trial II: 960 r/m
- Trial III: 948 r/m

Stage IV: The displayed RPM value was 1115 r/m. The measured RPMs recorded were:

- Trial I: 1120 r/m
- Trial II: 1110 r/m
- Trial III: 1126 r/m

CONCLUSION

The observed discrepancy between the designed RPM values and the actual measurements can be attributed to several factors:

1. Precision limitations of the measuring instruments used.
2. Design constraints that did not account for component tolerance values within the circuit.

It is concluded that the RPM deviation between the display and tachometer readings did not exceed 10% across the specified target values.

Following a comprehensive research process—from literature review through module development, including both hardware and software construction controlled via the Arduino UNO—the author presents the following conclusions:

1. The Arduino UNO–based RPM control system for the treadmill operates effectively.
2. The deviation between display readings and tachometer measurements indicates an average accuracy of approximately 98%.

REFERENCES

Badar, M. (2022). Manajemen Kualitas Pelayanan Rumah Sakit Umum Daerah. Kaizen. Jurnal Kesehatan Masyarakat Andalas, 186-190

Dayanty, n. j. (2024). Home Blood Pressure Monitoring dan Health Education pada Manajemen Hipertensi Kehamilan. OKSITOSIN Jurnal Ilmiah Kebidanan, 25-30.

Irawan, D. (2020). Simulasi Alat Treadmill Elektrik Untuk Kebugaran Dan Dengan Teknik Pwm Berbasis Mikrokontroler. Program study elektronika fakultas teknil Uiversitas Negeri Yogyakarta, vol 3, no 2

Jost, D. (2019). Sistem Keamanan Pada Perlintasan Kereta Api Mengunakan Sensor Infrared Berbasis Mikrokontroller Arduino Uno. The S1 Computer Engineering Study Program, Faculty of Engineering and Computer Science vol 2, no 1.

Kadir, A. (2022). Sistem Pengontrol Irigasi Otomatis Menggunakan Mikrokontroler Arduino Uno. Universitas Teknokrat Indonesia.vol 1, no 1 kushartanty, w. (2022). Pengaruh Latihan Fartlek Dengan Treadmill Dan Lari Di Lapangan Terhadap Daya Tahan Kardiorespirasi. Pendidikan Jasmani Kesehatan dan Rekreasi, Fakultas Ilmu Keolahragaan, Universitas Negeri Yogyakarta, Indonesia, vol 1, no 1.

Rifali, M. (2021). Sistem Cerdas Deteksi Sinyal Elektrokardiogram (EKG) untuk Klasifikasi. Program Studi Teknik Elektronika Fakultas Teknik Universitas Negeri Yogyakarta, 49-55.

Rizsa, Y. (2021). Pengaruh Treadmill Terhadap Penurunan Kadar Gula Darah Pada Pasien Diabetes Melitus Tipe Ii Riwayat Penyakit Jantung Koroner Di Rumah Sakit Sentra Medika Cibinong 2021.

Sari, P. (2021). Riset Aktivitas Fisik Dan Hubungannya Dengan Kejadian Diabetes Melitus.

Suchyar, Y. (2018). Pengaruh Latihan Treadmill TerhadapPeningkatan Volume Oksigen Maksimal (VO2Max) Pada Anggota Row Of Power in Motion (RPM) Body Fitness Center. Skripsi thesis, Universitas Muhammadiyah Surakarta

Triwulan, A. (2021). Power Supply Cookbook, Marty Brown

Yapinus, P. (2018). Prototype Sistem Otomatisasi Pengendalian Treadmill. Sistem Komputer, Universitas Kristen Maranatha vol 3 no 11