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Train Collision Avoidance System

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ABSTRACT

The Train Collision Avoidance and Track Crack Detection System is an innovative safety solution aimed at reducing train accidents caused by collisions and track faults. This project integrates ultrasonic sensors and infrared (IR) sensors to enhance railway safety. The system operates in two main functionalities: collision avoidance and track crack detection. The collision avoidance system employs ultrasonic sensors to measure the distance between the train and objects or other trains on the same track. If the distance falls below a predetermined safety threshold, the system triggers an alert and automatically halts the train to prevent collisions. The ultrasonic sensor calculates the distance based on the time delay of reflected ultrasonic waves, ensuring accurate real-time object detection. Simultaneously, the track crack detection system uses IR sensors to monitor the railway track for cracks or discontinuities. Under normal conditions, IR signals are reflected uniformly by the track surface. If a crack is detected, the reflection pattern changes, prompting the system to raise an alarm.

INTRODUCTION

Pakistan Railways was also Called the Pakistan Western Railway from Railways provide the lowest priced and many Convenient manners of passengers for space and suburban visitors. It also plays a significant part in the maturation and growth of businesses. Railways Assist in providing raw materials and other amenities to the mill sites and Finished products to the marketplace. So, safety and reliability should be highly considered in the case of a railway. As it is playing a vital role in the growth of the economy, so the importance of having a modern and improved railway system is increasing day by day.

However, the present scenario of the railway is quite different. Railway mishap has become a common issue nowadays. This becomes daily news losing many lives by train accidents. In today's world, transport, being among the drivers of electricity, its sustainability and safety are issues of major significance. Railways offer the least expensive and most convenient way of passengers for the local and distance visitors. Additionally, it has a vital part in the maturation and growth of businesses. Railways aid in providing raw materials and other amenities to the mill websites and finished products to the marketplace.

So, safety and reliability should be highly considered in the case of a railway. As it is playing a vital role in the growth of the economy, so the importance of having a modern and improved railway system is increasing day by day. However, the present scenario of the railway is quite different. Railway mishap has become a common issue nowadays.

EXISTING SYSTEM

- **Manual Supervision:** Current railway systems rely heavily on manual monitoring and control.
- **Human Error:** High risk of accidents due to human error, especially at railway crossings.
- **Delayed Response:** Manual systems can be slow in processing data and responding to emergencies.

DISADVANTAGES OF EXISTNG SYSTEM

- **High Risk of Accidents:** Due to human error and delayed responses.
- **Inefficiency:** Manual monitoring is time- consuming and less efficient.
- **Limited Coverage:** Difficult to manually monitor thousands of miles of railway tracks.

the user's muscle contraction. The magnitude of the EMG signal depends on various factors, such as placement on the hand, the type of electrode used, and the strength of the muscle contraction. The electrodes were placed on the arms with hand movements and positions as shown in Fig. 4. This study is intended to find position and movement that produce the best muscle contraction response.

Data acquisition or data collection was carried out on five subjects or study participants. They were male (one of whom was a subject with hand amputation) and one subject was female. Subjects have varied ages, three subjects have ages from 20 to 24 years at the time of data collection, one subject with transradial amputation has an age of over 35 years, while for female subject has an age of 22 years. Table II shows the list of subjects for EMG signal data acquisition.

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2.3.1 BLOCK DIAGRAM OF PROPOSED SYSTEM

HARDWARE COMPONENTS ARE

- Power Supply
- Arduino UNO
- Fire Sensor
- Temperature Sensor
- Current Sensor
- Voltage Sensor
- DC Motor Fan
- LCD
- Buzzer

POWERSUPPLY

In this project we have power supplies with +5V & -5V option normally +5V is enough for total circuit. Another (-5V) supply is used in case of OP amp circuit.

Transformer primary side has 230/50HZ AC voltage whereas at the secondary winding the voltage is step downed to 12/50 Hz and this voltage is rectified using two full wave rectifiers the rectified output is given to a filter circuit to fitter the unwanted ac in the signal. After that the output is again applied to a regulator LM7805 (toprovide+5v) regulator. WhereasLM7905 is for providing – 5Vregulation. Z (+12V circuit is used for stepper motors, Fan and Relay by using LM7812 regulator same process like above supplies).

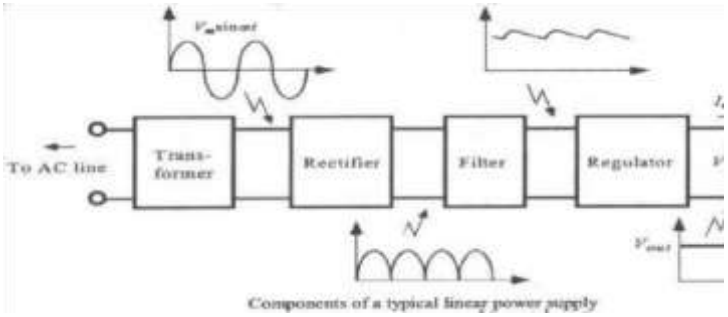


Fig 4.1 RPS

TRANSFORMER

Transformers are used to convert electricity from one voltage to another with minimal loss of power. They only work with AC (alternating current) because they require a changing magnetic field to be created in their core. Transformers can increase voltage (step-up) as well as reduce voltage (step-down). Alternating current flowing in the primary (input) coil creates a continually changing magnetic field in them on core. This field also passes through the secondary (output) coil and the changing strength of the magnetic field induces an alternating voltage in the secondary coil. If the secondary coils connected to a load the induced voltage will make an induced current flow. The correct term for the induced voltage is 'induced electromotive force' which is usually abbreviated to induced e.m.f.

RECTIFIERS

The purpose of a rectifier is to convert an AC wave form into a DC wave form(OR) Rectifier converts AC current or voltages into DC current or voltage. There are two different rectification circuits, known as 'half-wave' and 'full-wave' rectifiers. Both use components called diodes to convert AC into DC.

FILTERS

A filter circuit is a device which removes the ac component of rectifier output but allows the dc component to the load. The most commonly used filter circuits are capacitor filter, choke input filter and capacitor input filter or pi-filter. We used capacitor filter here.

The capacitor filter circuit is extremely popular because of its low cost, small size, little weight and good characteristics. For small load currents this type of filter is preferred. It is commonly used in transistor radio battery eliminators.

The capacitor filter works on the principle of charging and discharging of a capacitor. When the rectifier output is applied to the capacitor, it charges up to the peak value of the rectified voltage. During the non-conduction period of the rectifier, the capacitor discharges slowly through the load, thus maintaining a steady DC output.

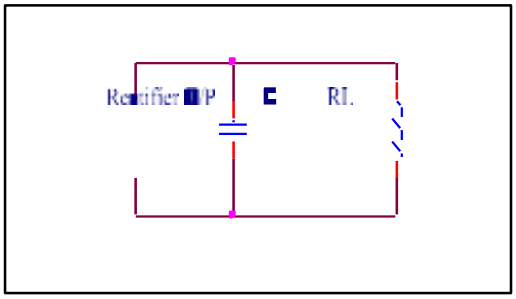


Fig 4.1.1 Capacitor

ARDUINO UNO

INTRODUCTION

The Arduino is a family of microcontroller boards to simplify electronic design, prototyping and experimenting for artists, hackers, hobbyists, but also many professionals. People use it as brains for their robots, to build new digital music instruments, or to build a system that lets your house plants tweet you when they're dry. Arduino's (we use the standard Arduino Uno) are built around an ATmega microcontroller — essentially a complete computer with CPU, RAM, Flash memory, and input/output pins, all on a single chip. Unlike, say, a Raspberry Pi, it's designed to attach all kinds of sensors, LEDs, small motors and speakers, servos, etc. directly to these pins, which can read in or output digital or analog voltages between 0 and 5 volts. The Arduino connects to your computer via USB, where you program it in a simple language (C/C++, similar to Java) from inside the free Arduino IDE by uploading your compiled code to the board. Once programmed, the Arduino can run with the USB link back to your computer, or stand-alone without it — no keyboard or screen needed, just power.

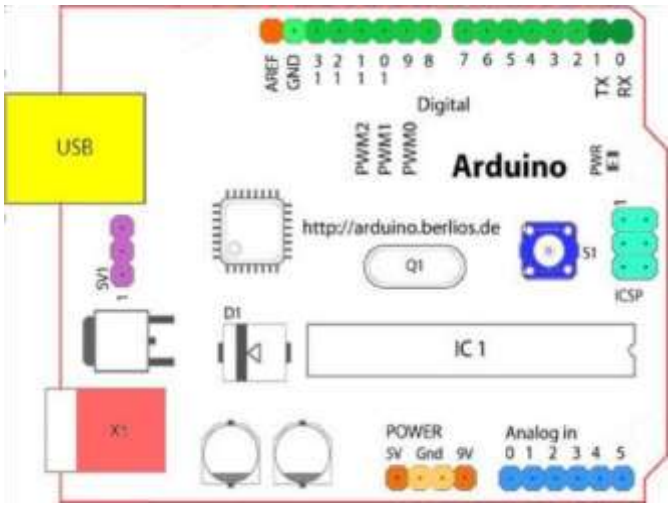


Fig4.2 Structure of Arduino Board

Looking at the board from the top down, this is an outline of what you will see (parts of the board you might interact with in the course of normal use are highlighted)

Fig4.2 ArduinoBoard Starting clockwise from the top centre:

- Analog Reference pin (orange)
- Digital Ground (light green)
- Digital Pins 2-13 (green) Digital Pins 0- 1/Serial In/Out - TX/RX (dark green) -

These pins cannot be used for digital i/o (Digital Read and Digital Write) if you are also using serial communication (e.g.Serial begin).

- Reset Button - S1 (dark blue)
- In-circuit Serial Programmer (blue-green)
- Analog In Pins 0-5 (light blue)
- Power and Ground Pins (power: orange, grounds: light orange)
- External Power Supply In (9- 12VDC) - X1 (pink)
- Toggles External Power and USB Power (place jumper on two pins closest to desired supply) - SV1 (purple)
- USB (used for uploading sketches to the board and for serial communication between the board and the computer; can be used to power the board) (yellow)

DIGITAL PINS

In addition to the specific functions listed below, the digital pins on an Arduino board can be used for general purpose input and output via the pin Mode(), Digital Read(), and Digital Write() commands. Each pin has an internal pull-up resistor which can be turned on and off using digital Write () (w/ a value of HIGH or LOW, respectively) when the pin is configured as an input. The maximum current per pin is 40mA.

Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. On the Arduino Diecimila, these pins are connected to the corresponding pins of the FTDI USB-to-TTL Serial chip. On the Arduino BT, they are connected to the corresponding pins of the WT11Bluetooth module. On the Arduino Mini and LilyPad Arduino, they are intended for use with an external TTL serial module (e.g. the Mini- USB Adapter).

External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attach Interrupt () function for details.

PWM: 3, 5, 6, 9, 10, and 11 Provide 8-bit PWM output with the analog Write () function. On boards with an ATmega8, PWM output is available only on pins 9, 10, and 11.

BT Reset: 7. (Arduino BT-only) Connected to the reset line of the blue tooth module.

SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13

(SCK). These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language.

LED: 13. On the Diecimila and LilyPad, there is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

ANALOG PINS

In addition to the specific functions listed below, the analog input pins support 10-bit analog-to-digital conversion (ADC) using the analog Read () function. Most of the analog inputs can also be used as digital pins: analog input 0 as digital pin 14 through analog input 5

as digital pin 19. Analog inputs 6 and 7 (present on the Mini and BT) cannot be used as digital pins.

I^2C: 4 (SDA) and 5 (SCL).

Support I^2C (TWI) communication using the
Wire library (documentation on the Wiring website).

POWER PINS

VIN (sometimes labelled "9V"): The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin. Also note that the Lily Pad has no VIN pin and accepts only a regulated input.

5V: The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an onboard regulator, or be supplied by USB or another regulated 5V supply.

3V3 (Diecimila-only): A 3.3-volt supply generated by the on-board FTDI chip.

GND: Ground pins.

OTHER PINS

AREF: Reference voltage for the analog inputs. Used with analog Reference().

Reset: (Diecimila-only) Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

PIN DIAGRAM

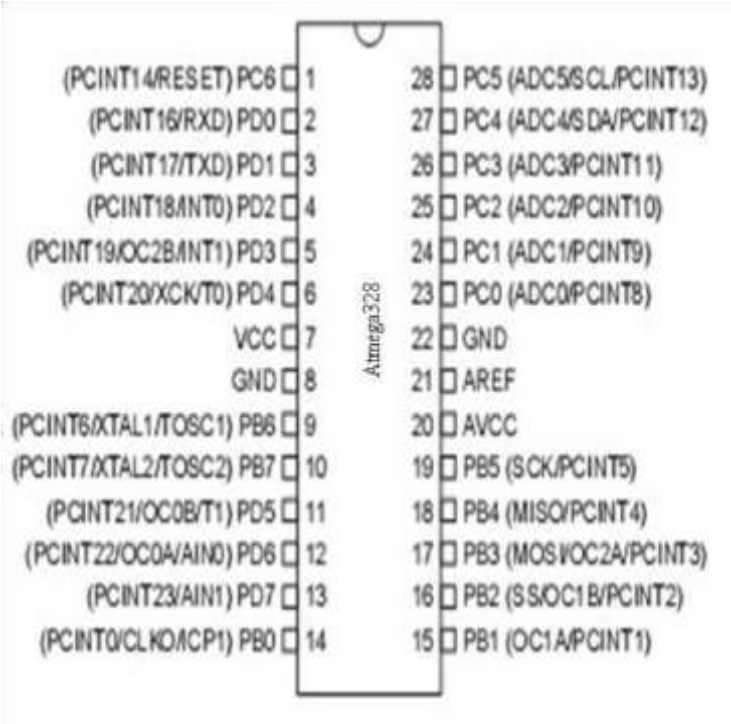


Fig4.2.1 Pin Configuration of Atmega328

PIN DESCRIPTION VCC:

Digital supply voltage

GND:

Ground

Port A (PA7-PA0):

Port A serves as the analog inputs to the A/D Converter. Port A also serves as an 8-bit bi- directional I/O port, if the A/D Converter is not used. Port pins can provide internal pull- up resistors (selected for each bit). The Port A output buffers have symmetrical drive characteristics with both high sink and source capability. When pins PA0 to PA7 are used as inputs and are externally pulled low, they will source current if the internal pull-up resistorsn are activated. The Port A pins are tri- stated when a reset condition becomes active, even if the clock is not running.

Port B (PB7-PB0):

Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running. Port B also serves the functionsof various special features of the ATmega32.

Port C (PC7-PC0):

Port C is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port C output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running. If the JTAG interface is enabled, the pull-up resistors on pins PC5 (TDI), PC3 (TMS) and PC2 (TCK) will be activated even if a reset occurs. The TD0 pin is tri-stated unless TAP states that shift out data are entered.

Port C also serves the functions of the JTAG interface.

Port D (PD7-PD0):

Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated. The Port D pins are tri-stated when a reset condition becomes active, even if the clock is not running. Port D also serves the functions of various special features of the ATmega32.

ULTRASONIC SENSOR

Ultrasonic is an excellent way of figuring out what's in the immediate vicinity of your Arduino. The basics of using ultrasound are like this: you shoot out a sound, wait to hear it echo back, and if you have your timing right, you'll know if anything is out there and how far away it is. This is called echolocation and it's how bats and dolphins find objects in the dark and underwater, though they use lower frequencies than you can use with your Arduino.

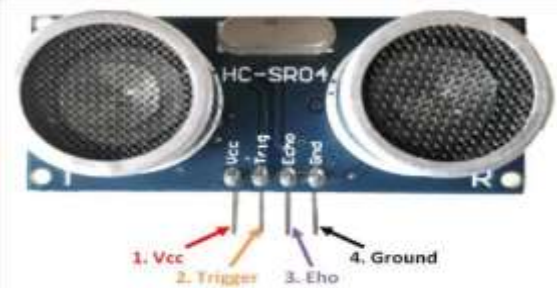


Fig 4.3 Ultrasonic Sensor

PRINCIPLE

Ultrasonic sensors can measure distance and detect the presence of an object without making physical contact. They do so by producing and monitoring an ultrasonic echo. Depending on the sensor and object properties, the effective range in air is between a few centimeters up to several meters. The ultrasonic sensor (or transducer) generates and emits ultrasonic pulses that are reflected back towards the sensor by an object that is within the field of view of the sensor.

IR SENSOR

An infrared sensor is an electronic device, that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. These types of sensors measure only infrared radiation, rather than emitting it that is called a passive IR sensor. Usually, in the infrared spectrum, all the objects radiate some form of thermal radiation. change in proportion to the magnitude of the IR light received.

WORKING PRINCIPLE

The working principle of an infrared sensor is similar to the object detection sensor. This sensor includes an IR LED & an IR Photodiode, so by combining these two can be formed as a photo- coupler otherwise optocoupler. The physics laws used in this sensor are planks radiation, Stephan Boltzmann &weins displacement.

IR LED is one kind of transmitter that emits IR radiations. This LED looks similar to a standard LED and the radiation which is generated by this is not visible to the human eye. Infrared receivers mainly detect the radiation using an infrared transmitter. These infrared receivers are available in photodiodes form. IR Photodiodes are dissimilar as compared with usual photodiodes because they detect simply IR radiation. Different kinds of infrared receivers mainly exist depending on the voltage, wavelength, package, etc.

Sensor

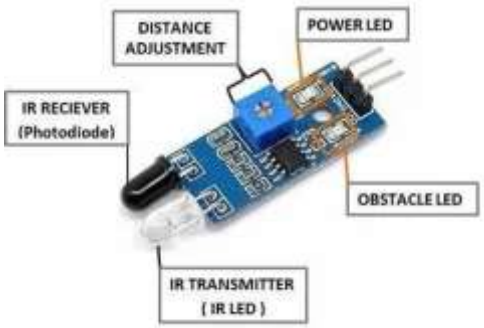


Fig4.4 IR

Once it is used as the combination of an IR transmitter & receiver, then the receiver's These types of radiations are invisible to our eyes, which can be detected by an infrared sensor. The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode that is sensitive to IR light of the same wavelength as that emitted by the IR LED. When IR light falls on the photodiode, the resistances and the output voltages will wavelength must equal the transmitter. Here, the transmitter is IR LED whereas the receiver is IR photodiode. The infrared photodiode is responsive to the infrared light that is generated through an infrared LED. The resistance of photodiode & the change

in output voltage is in proportion to the infrared light obtained. This is the IR sensor's fundamental working principle.

Once the infrared transmitter generates emission, then it arrives at the object & some of the emission will reflect back toward the infrared receiver. The sensor output can be decided by the IR receiver depending on the intensity of the response.

ESP32 CAM

The ESP32-CAM is a development board with an ESP32-S chip, an OV2640 camera, micro SD card slot and several GPIOs to connect peripherals. It allows you

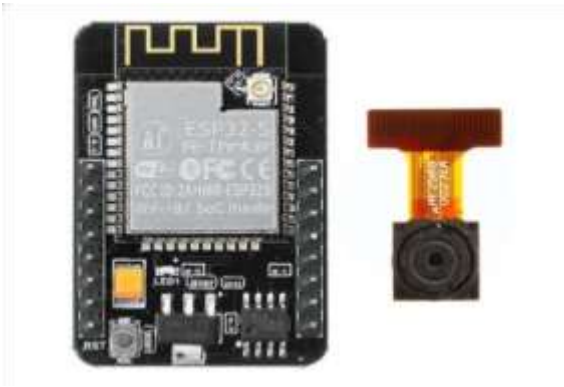


Fig 4.5 ESP32 CAM

to set up a video streaming web server, build a surveillance camera, take

FEATURES :

- Product Name: ESP32-CAM. WiFi+Bluetooth module: ESP-32S.
- Camera Module: OV2640 2MP.
- Flash Light: LED Built-in on Board.
- Operating Voltage: 3.3/5 Vdc.
- Onboard TF card slot, supports up to 4G TF card for data storage .
- RAM: Internal 512KB + External 4MB PSRAM.
- Power consumption:
  Flash off: 180mA@5V.
  Flash on and brightness max: 310mA@5V.
  Deep-Sleep: as low as 6mA@5V. Modern-Sleep: as low as 20mA@5V. Light-Sleep: as low as 6.7mA@5V
- Dimensions: 40.5mm x 27mm x 4.5mm.

MAIL (SMTP PROTOCOL)

SMTP (Simple Mail Transfer Protocol)

SMTP is a standard electronic-mail protocol that handles the sending of mail from one SMTP to another SMTP server. To accomplish the transport, the SMTP server has its own MX (mail exchanger) record in the DNS database that corresponds to the domain for which it is configured to receive mail.

When equipped for two-way communication, mail clients are configured with the address of a POP3 server to receive mail and the address of an SMTP server to send mail.

SMTP uses TCP for communication and operates on port 25. Simple Mail Transfer Protocol (SMTP) is

the application-layer protocol used for transmitting e-mail messages. SMTP is capable of receiving e-mail messages, but it's limited in its capabilities. The most common implementations of SMTP are in conjunction with either POP3 or IMAP4. For example, users download an e-mail message from a POP3 server, and then transmit messages via an SMTP server

SERVO MOTOR :

Servomotors are designed to operate control surfaces on hobby RC planes. So, they do not rotate continuously. Rather they are designed to rotate through 180 degrees with precise position control. If you want to use them as the main drive motor for a mobile robot you need to modify them so that they will rotate continuously. This is not a difficult thing to do. I will not cover it here but if you want to do it there are many sites on the web that cover this**.**

Fig 4.7 Servo Motor

ADVANTAGES AND APPLICATIONS

ADVANTAGES

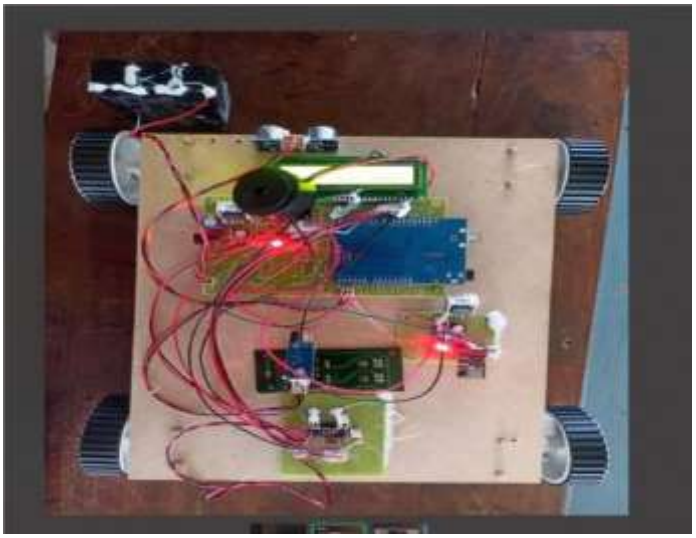
- **Enhanced Safety:** Reduced risk of accidents due to automation and real- time monitoring.
- **Increased Efficiency:** Faster data processing and response times.
- **Wider Coverage:** Ability to monitor extensive railway networks remotely.
- **Reliability:** Less dependency on human intervention, reducing the chance of errors.

APPLICATIONS

1. Automatic crack checking
2. The vehicle draws power from the battery the optical sensor is used to detect the crack in the railway track, suppose any crack in the track, the vehicle automatically stop and active the FM transmitter circuit.
3. Cordless identification to the station master
4. This unit can also be used to intimate the nearest railway station.

The FM receiver circuit is fixed in the room of the station master.

RESULT:



ADVANTAGES:

1. **Restoration of Functionality**

Allows individuals to regain basic hand functions such as gripping, holding, and manipulating objects. Advanced prosthetics even support fine motor skills like writing or typing.

2. **Improved Quality of Life**

Enhances independence and self-sufficiency in daily activities.Reduces reliance on caregivers or assistance.

3. **Psychological and Social Benefits**

Boosts confidence and social integration.Helps reduce the emotional trauma or stigma associated with limb loss.

4. **Customizability and Adaptability**

Modern prosthetics can be customized for the user's specific needs (e.g., sports, cooking, playing instruments). Can be upgraded with new tech (like sensors or AI-based control).

5. **Integration with Smart Technology**

Some prosthetic hands use myoelectric sensors to read muscle signals for more natural movement.Integration with apps or feedback systems helps improve control and training.

APPLICATIONS:

1. **Medical Rehabilitation**

- Used in post-amputation recovery to restore limb function and support therapy.

2. **Occupational Use**

- Designed for users in physically demanding jobs (e.g., mechanics, technicians) where grip strength and tool use are essential.

3. **Military and Veteran Rehabilitation**

- Help wounded soldiers return to normal or professional life after limb loss due to injury.

4. **Sports and Athletics**

- Specialized prosthetics allow amputees to participate in athletics, from cycling to rock climbing.

5. **Assistive Technology**

- Serve as assistive devices for individuals with congenital limb deficiencies or developmental issues.

6. Research and Development

- Used in biomechanics and neuroscience research to study brain-machine interfaces and motor control.

CONCLUSION:

A Before summing up, we can say accidents occurring in the railway transportation system cost a huge number of lives. So, an advanced and dependable system is needed to avert these types of accidents and also find out the possibilities of their occurrence. The proposed model is a simple prototype that will work as an independent inspector for the railway network. This system is highly reliable and cost-effective in any traffic area, sub urban area, and the routes. Furthermore, this is small in size and low power consumption, which is, in fact, a simple solution to all the problems of a railway mishap in one system. This system will work all the modules at a time to reduce accidents.

FUTURE SCOPE

The output from a piezo vibration sensor was fluctuating, and it was giving a small value against very high vibration. The overall demonstration gives expected outcomes through the vibration of the train was insufficient so that it cannot detect from a desired distance by the vibration sensor. On the other hand, the FSR, Servo Motor, HC- SR04Sonar, was very much compatible. In a demonstration, GPS could not be able to distinguish the different locations of trains as it was a minimal setup.

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