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Design and Implementation of Gesture Controlled Bicycle Indicator Gloves

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ABSTRACT

The Gesture Control Bicycle Indicator Gloves is an innovative solution designed to improve safety for cyclists. Cyclists often need to signal their turns or stops with hand gestures, but these signals can be difficult for motorists to see, especially at night or in low-visibility conditions. These smart gloves incorporate gesture-based control for turn indicators, making it easier for cyclists to communicate their movements to other road users. The gloves use motion sensors and LEDs to signal turns based on hand movements, improving visibility and safety. If an accident happens, a message and its location will be sent to the concerned member.

Keywords: Gesture Control, Cyclists, Motion Sensors

1. INTRODUCTION

Cyclists often face challenges in communicating their intended direction to other road users, especially in low-light or high-traffic conditions. Traditional hand signals, though widely recognized, can be unclear or go unnoticed by motorists, leading to safety risks. This problem is particularly pronounced during nighttime or adverse weather conditions when visibility is compromised. Cyclists lack an effective, safe, and universally visible means of signaling their intentions while riding. The current reliance on traditional hand signals is inadequate in ensuring visibility and understanding by other road users, increasing the risk of accidents.

Objectives of the Project Work is

To design and develop Gesture controlled bicycle indicator gloves for cyclist safety.

To lessen the number of accident and to promote innovation and technology.

To send a message to the concerned member along with its location when accident happens.

2. METHODOLOGY

Sensor Integration:

The gloves are embedded with accelerometer sensors to detect specific hand movements corresponding to turning gestures.

Signal Processing:

The motion data from the sensors is processed by a microcontroller, such as an Arduino or a smaller processor, to detect whether the gesture indicates a left or right turn.

LED Activation:

Upon detecting a turn gesture, the microcontroller activates the appropriate LED strip (on the left or right

glove) to signal the turn.

Power Supply:

The system is powered by a small, lightweight, rechargeable Li-ion battery mounted on the glove. This battery provides power for both the sensor and the LEDs.

Fig. 1 and 2 shows block diagram of transmitter and receiver part.

2.1 TRANSMITTER

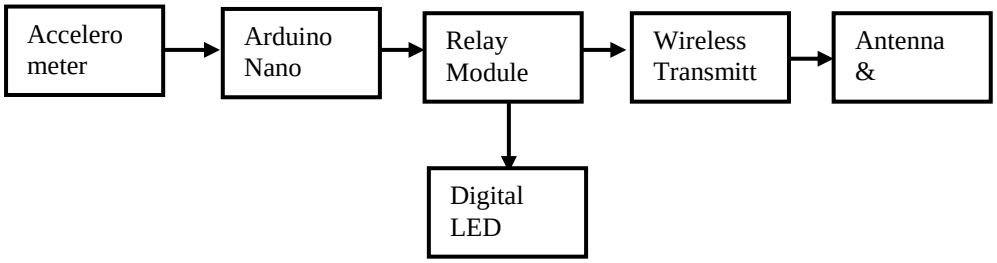

Fig.1 Block diagram of transmitter

2.2 RECEIVER

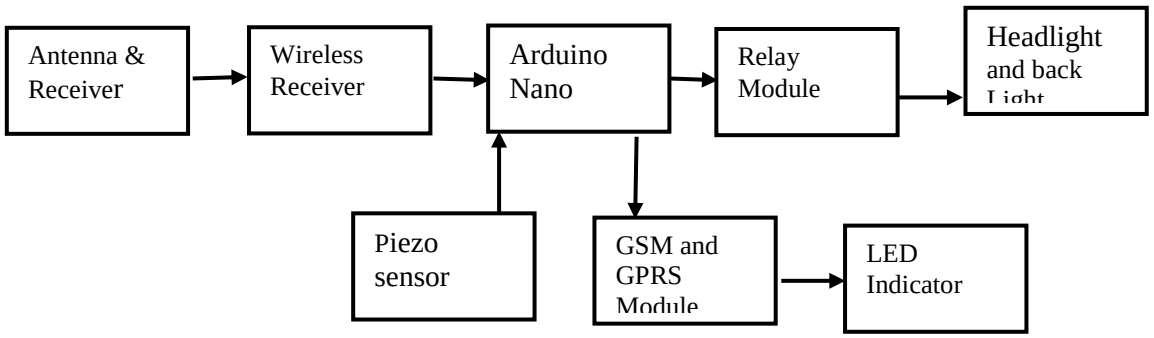

Fig.2 Block diagram of receiver

2.3 WORKING

The Gesture Control Bicycle Indicator Gloves function by detecting specific hand movements through sensors embedded in the gloves. Accelerometers or gyroscope sensors detect when the cyclist makes a left or right turn gesture. When the cyclist raises their hand to indicate a turn, the sensors detect the motion, and the corresponding LED lights on the gloves light up to signal the direction (left or right). The gloves are powered by a small rechargeable battery and feature LED strips on the back of the hands that flash to signal turns. The system is entirely wireless, eliminating the need for the cyclist to manually activate lights. Fig. 3 and 4 shows the circuit diagram of transmitter and receiver part

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2.3.1 TRANSMITTER CIRCUIT

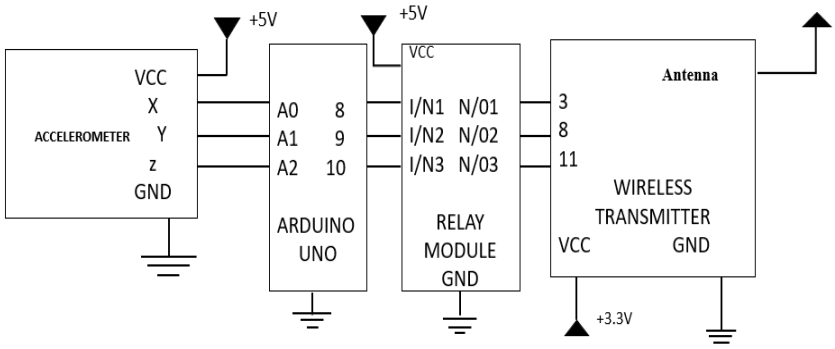

Fig.3 Circuit diagram of transmitter

2.3.2 RECEIVER CIRCUIT

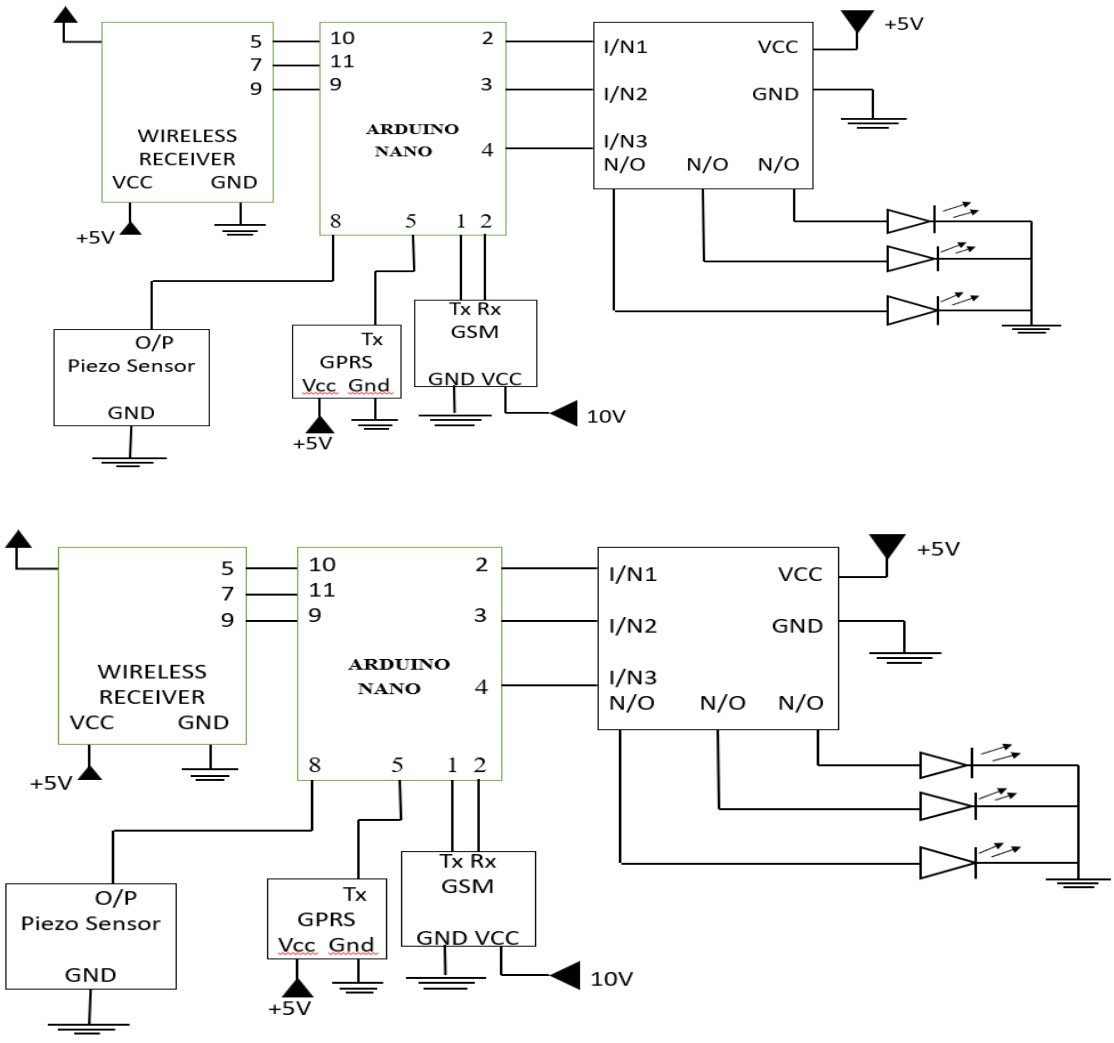

Fig.4 Circuit diagram of receiver

The circuit setup describes a gesture-controlled bicycle indicator system using an Arduino-based setup. It

includes a transmitter circuit and a receiver circuit. When the cyclist tilts their hand in a particular direction, the accelerometer detects the gesture. The Arduino UNO processes the accelerometer data and sends a signal via the wireless transmitter. The wireless receiver receives the signal and activates the appropriate LED indicator (left or right) on the bicycle.This setup enables gesture-controlled turn signals for cyclists, improving safety and visibility on the road.

2.3.3 Transmitter Circuit:

1. Accelerometer: An accelerometer module detects the tilt or movement of the user's hand (gesture). The X, Y, and Z axes from the accelerometer are connected to analog pins (A0, A1, A2) of the Arduino UNO.

2. Arduino UNO:The Arduino processes the analog signals from the accelerometer. Based on the tilt direction, it determines which indicator (left or right) should be activated.

3. Relay Module:The Arduino sends digital signals to the relay module via pins 8, 9, and 10. The relay module acts as a switch, controlling the signals sent to the wireless transmitter.

4. Wireless Transmitter:The relay module activates the wireless transmitter module, which transmits the signal corresponding to the gesture detected. The antenna improves the range of the transmitted signal.

2.3.4 Receiver Circuit:

1. Wireless Receiver:The receiver module receives the transmitted signals and forwards them to the Arduino Nano.

2. Arduino Nano: The Arduino Nano processes the signals from the wireless receiver.

It activates the appropriate pins (2, 3, 4) to control the indicator system.

3. Relay Module: The relay module is controlled by the Arduino Nano. It switches the connected LEDs (left, right indicators) based on the received signal.

4. Piezo Sensor:A piezo sensor can be used for additional feedback (e.g., buzzer sound) when the indicators are activated.5. GSM Module:This module (optional) may be included for sending notifications or alerts via SMS.

6. Indicator LEDs:LEDs (connected via the relay) light up to indicate left or right turns based on the user's hand gestures.

2.4 Hardware Design

2.4.1 Accelerometer (ADXL345) : An accelerometer measures acceleration forces, which may be static (like gravity) or dynamic (caused by movement or vibrations). Function in Project: Commonly used to detect orientation, tilt, or movement. Ideal for gesture-based control or motion detection.

Specifications:

Voltage: 3.3V or 5V (depending on model)

Communication Protocol: I2C or SPI

Pins: VCC, GND, SDA, SCL (or MISO, MOSI, SCK if using SPI)

2.4.2 Arduino Nano: A small, compact version of the Arduino development board, suitable for basic I/O and sensor interfacing. Function in Project: Acts as the main controller, processing data from sensors, managing signals, and executing code.

Specifications:

Microcontroller: ATmega328

Operating Voltage: 5V

Digital I/O Pins: 14 (6 of which can provide PWM output)

Analog Input Pins: 8

Communication Protocols: UART, I2C, SPI

SPECIFICATION

Microcontroller : ATmega328

Operating Voltage :5V

Input Voltage (recommended): 7-12V

Input Voltage (limits): 6-20V

Digital I/O Pins : 14 (of which 6 provide PWM output)

Analog Input Pins: 6

DC Current per I/O Pin: 40 mA

DC Current for 3.3V Pin:50 mA

32 KB of which 0.5 KB used by

SRAM : 2 KB

EEPROM :1 KB

Clock Speed :16 MHz

2.4.3 Relay Module 5V:A relay module allows low-power digital signals from a microcontroller to control higher-power devices (such as motors or lights) by isolating them from the control circuit.Used to switch on/off high-power devices or circuits from the Arduino Nano's control signals.

Specifications:

Input Voltage: 5V

Channels: Single or multiple channels, often with optocoupler isolation for protection.

Max Load: Varies, typically around 10A at 250V AC or 30V DC per channel.

2.4.4 Wireless Transmitter and Receiver (Robodo 4CH): Wireless modules with a transmitter and receiver, allowing remote control over short distances.Allows remote control of devices, such as turning indicators on/off or triggering specific functions.

Specifications

Frequency: Typically 433MHz or 2.4GHz

Channels: 4 channels in your case, enabling four different signals.

Range: Depends on the environment, usually 50–100 meters in open space.

2.4.5 LED: A light-emitting diode (LED) is a small, efficient light source. LEDs are often used as indicators.

Function in Project: Visual indicators, often for status or feedback (e.g., showing successful operation, errors, or specific alerts).

Specifications:

Operating Voltage:Typically, 2V–3.3V for a single LED

Current: Typically, around 10-20mA per LED; resistors are often used to limit current.

2.4.6 GPS Module (NEO-6M V2): A GPS module receives data from GPS satellites to determine precise geographical coordinates. Provides real-time location data, which can be used for tracking or navigation purposes.

Specification

Voltage: 3.3V or 5V

Communication Protocol: UART (TX, RX)

Accuracy: Usually within 2-3 meters

Example: NEO-6M is popular, with onboard EEPROM for saving settings.

2.4.7 GSM Module (SIM900A): A GSM module allows for cellular communication, enabling SMS, voice calls, and data over a cellular network. Useful for sending data (e.g., location or alerts) via SMS or enabling remote control commands via SMS.

Specifications:

Voltage: 5V

Communication Protocol: UART (TX, RX)

SIM Support: Standard SIM card slot

Example: SIM900A is commonly used for IoT applications that require remote communication.

2.4.8 Piezo Sensor: A piezo sensor detects vibrations, shocks, or impacts by generating an electrical charge when physically stressed. Can detect specific impact or vibration-based events (e.g., as a knock sensor or to detect collisions).

Specifications:

Voltage Output: Depends on the force applied; typically generates a small voltage pulse.

Sensitivity: Sensitive to physical stress, ideal for detecting light taps or strong impacts

BATTERY:

Used for power supply

Specifications:

Voltage: 3.7V

Current: 2600mAh

3.0 ADVANTAGES

Increased Safety: Enhances the cyclist's visibility, especially at night, reducing the risk of accidents.

Hands-Free Operation: The system operates automatically based on gestures, removing the need for manual switches or buttons.

Lightweight and Comfortable: Designed to be worn like normal gloves, with minimal additional bulk.

Rechargeable Power Supply: The battery-powered system can be recharged, eliminating the need for disposable batteries.

If an accident happens, a message is sent to the concerned member along with the location

Disadvantages

Battery Dependency: The gloves rely on battery power, which may run out during long rides if not charged.

4.0 APPLICATIONS

Cycling Safety

Motorcycle Indicators

Pedestrian Safety

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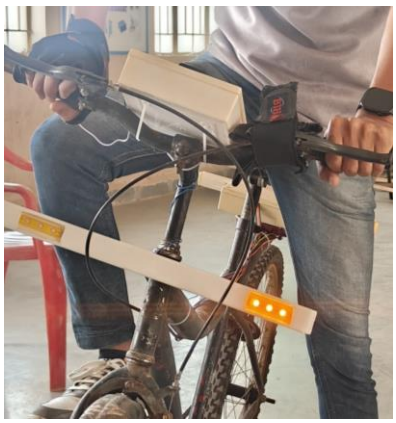
Accident alert generation

Fig. 5 shows the hardware implementation part of the project with transmitter and receiver circuit mounted on bicycle.

Front View **Rear View**



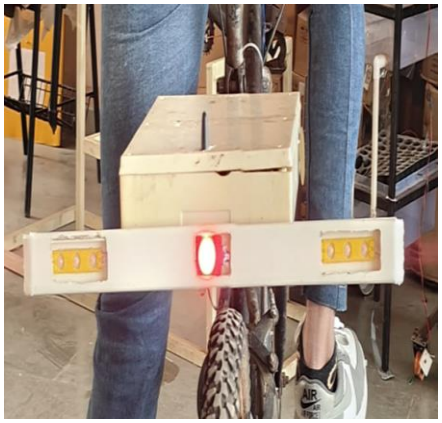


Fig.5 Hardware implementation

When an accident happens the message will be sent to the concerned member along with its location and the example is shown below in fig. 6

Fig.6 Message indicating accident location.

5.0 RESULT

Table 1.0 shows status of Hand Gesture for cyclist safety.

Table 1.0 Status of Hand Gesture

Hand Gesture	Right Indicator	Left Indicator	Brake light
No Gesture	OFF	OFF	OFF
Right Gesture	ON	OFF	OFF
Left Gesture	OFF	ON	OFF
Brake	OFF	OFF	ON

CONCLUSION

The Gesture Control Bicycle Indicator Gloves aim to enhance road safety for cyclists by making their signals more visible to drivers. This technology bridges the gap between traditional hand signals and modern lighting systems, offering a user-friendly and intuitive solution. The gloves are lightweight, easy to use, and provide an additional layer of safety, particularly for nighttime or low-visibility cycling.

FUTURE SCOPE

Gesture-controlled bicycle indicator gloves have great potential in the future as they align with the growing demand for safety, convenience, and innovation in cycling. Here's an analysis of their future scope

1. Enhanced Road Safety:

Gesture-controlled gloves can significantly improve safety for cyclists by providing clear, hands-free signaling, making them more visible to motorists, especially at night or in low-visibility conditions.

The integration of LED indicators or haptic feedback can further ensure that signals are noticed.

2. Growing Cycling Trends

With increasing focus on environmental sustainability, cycling is becoming a preferred mode of transport in urban areas. Gesture-controlled gloves cater to this trend, providing a modern and functional accessory for urban commuters.

3.Integration with Wearable Technology

The gloves could include additional features such as fitness tracking, navigation support, or even sensors for monitoring hand movements, temperature, or grip pressure.Pairing with smartphones or smartwatches could allow cyclists to control music, receive call notifications, or access navigation.

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