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TECHNOLOGY - ENHANCED SAFETY SHOES FOR WOMEN

Prasanna Mery K[*1], Ranjith Kumar S[*2], Siva S[*3], Pavankalyan G[*4]

[*1]Assistant Professor, Dept. of ECE, Paavai Engineering College, Namakkal, Tamil Nadu, India.

[*2,3,4]UG Student, Dept. of ECE, Paavai Engineering College, Namakkal, Tamil Nadu, India.

Email:[1]prasannasct6225498@gmail.com, [2]ranjithkumars124@gmail,com, [3]sivaseenuvasan56@gmail.com, [4]gpavankalyan375@gmail.com

ABSTRACT

This project enhances an existing smart shoe system by integrating improved automation and energy efficiency to bolster women's safety. The accelerometer is programmed to recognize unusual motion patterns, such as sudden falls or struggles, triggering an emergency response without requiring manual activation. To ensure continuous functionality, a piezoelectric sensor embedded in the sole generates backup power from walking or running, reducing reliance on external charging and maintaining the operation of essential components like the GPS and GSM modules. Additionally, a built-in self-defense mechanism delivers a non-lethal electric shock when activated in critical situations, providing an immediate deterrent against potential threats. These advancements make the system more autonomous, reliable, and user-friendly, reinforcing its effectiveness as a safety device in various real-world scenarios.

Keywords: Smart Shoe, Women Safety Device, Automatic Emergency Alert System, Accelerometer Sensor, GPS Module, GSM Module, Piezoelectric Sensor, Self-Defense Shocking Unit, Location Tracking, Motion Detection, Power Harvesting, Backup Power Supply, ATmega328 Microcontroller, Wearable Technology, Personal Security System.

I. INTRODUCTION

Personal safety is a growing concern, especially in vulnerable situations, where traditional devices often fail to provide adequate support. This project presents an innovative smart shoe that integrates advanced technologies for enhanced security. The shoe features an accelerometer that automatically detects falls or struggles, triggering emergency alerts with the user's location via GPS and GSM. Additionally, a shocking unit offers immediate self-defence when needed. To extend battery life, a piezoelectric sensor harvests energy from walking, reducing reliance on external charging. Powered by an ATmega328 microcontroller, this smart shoe combines automation, energy efficiency, and user-friendly design, providing a discrete yet effective safety solution for users in potentially dangerous situations.

II. EXISTING SYSTEM

The existing smart shoe system for women's safety integrates several key components, including the ATmega328 microcontroller, GPS receiver, GSM module, accelerometer sensor, shocking unit, lithium-ion battery, charging unit, emergency press button, and power button. The microcontroller manages the operation of these components, sending emergency alerts when necessary. The GPS receiver tracks the user's location, which is sent to the microcontroller, while the GSM module sends alerts to predefined contacts. The accelerometer detects sudden movements, triggering the emergency response, and the shocking unit offers additional protection by delivering an electric shock to an attacker. The lithium-ion battery powers the system, and the charging unit ensures it remains charged. The emergency press button manually activates the system, and the power button controls its operation. This system offers the advantages of being portable, always accessible, and capable of real-time GPS tracking for quick response. With the added feature of a shocking unit, the system enhances personal safety, aiming to provide women with greater security and peace of mind when traveling alone.

III. PROPOSED SYSTEM

The proposed system is a smart shoe designed to enhance personal safety, specifically for women, by incorporating advanced technologies for automatic emergency detection, alerting, and self-defence. At the core of the system is an ATmega328 microcontroller, which manages the various integrated components and ensures seamless operation, as illustrated in Figure 1.

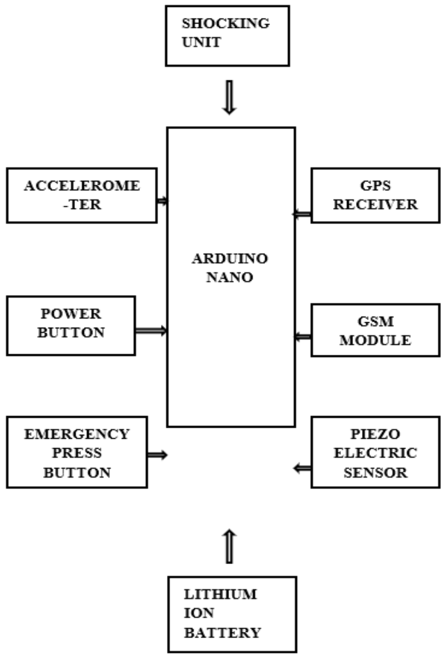

Figure 1: Block diagram of proposed system

A programmable accelerometer sensor is used to identify specific motion patterns, such as sudden falls, unusual movements, or physical struggles. When such patterns are detected, the system automatically triggers an emergency response. The user's real-time location is acquired using a GPS module and transmitted to predefined emergency contacts via a GSM module**,** enabling quick assistance during critical situations.

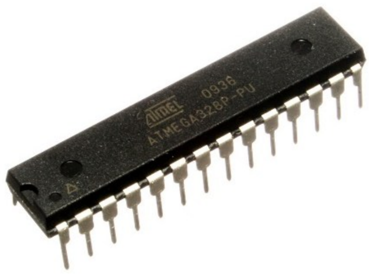

Figure 2: ATmega328p Microcontroller

To enhance the system's energy efficiency, a piezoelectric sensor is embedded into the shoe sole to convert mechanical energy from walking or running into electrical energy. This harvested energy serves as a backup power source, extending the battery life and ensuring continuous operation of the system without frequent recharging.This smart shoe combines automation, power efficiency, and practicality, providing users with a reliable and discreet safety solution for emergency situations.

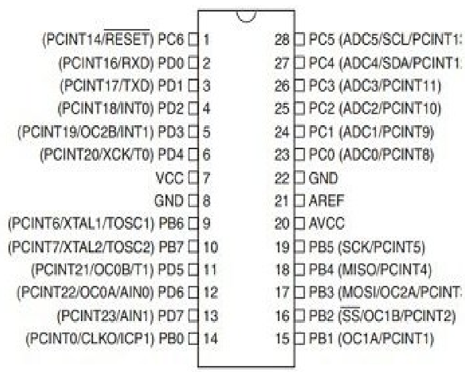

Figure 3: Pin diagram of ATmega328p microcontroller

IV. SYSTEM ARCHITECTURE

A. ATmega328 microcontroller

The ATmega328 is a highly efficient and widely used 8-bit microcontroller developed by Microchip Technology, as shown in Figure 2. Built on the AVR enhanced RISC architecture, it executes most instructions in a single clock cycle, ensuring fast and reliable performance. It features 32 KB of Flash memory for program storage, 2 KB of SRAM for runtime data, and 1 KB of EEPROM for retaining non-volatile data. Operating at up to 20 MHz, it supports various peripherals like timers, digital and analog I/O, and communication protocols (I2C, SPI, UART), making it highly versatile.

Known for its low-power operation and multiple power-saving modes, the ATmega328 is ideal for battery-powered and energy-efficient applications. It is prominently used in Arduino boards, particularly the Arduino Uno, due to its simplicity, reliability, and compatibility with a wide range of sensors and modules. This microcontroller is a robust choice for projects ranging from prototyping to industrial automation and IoT devices.

B. Pin Diagram

The ATmega328P microcontroller, commonly used in embedded systems, comes in a 28-pin package with versatile pin functionalities. It includes power supply pins such as VCC (Pin 7) for the main supply voltage and GND (Pins 8 and 22) for grounding. AVCC (Pin 20) provides power to the ADC module and must be connected to VCC when the ADC is in use, while AREF (Pin 21) is used as a reference voltage for ADC operations. The microcontroller features several digital I/O pins (Pins 1-6, 9-19, and 23-28) that can be configured as input or output and support various functionalities like PWM, SPI, I2C, and UART communication.

Special function pins include TXD (Pin 3) and RXD (Pin 2) for UART serial communication, enabling data transmission and reception. The SPI interface is supported through MOSI, MISO, SCK, and SS pins, allowing high-speed communication with external devices. Additionally, some pins, as shown in Figure 3, are shared with analog inputs (Pins 23-28) for ADC functions, enabling the conversion of analog signals to digital values. This flexible pin configuration makes the ATmega328P ideal for applications in automation, IoT, and embedded systems.

1. Arduino Nano Board:

The Arduino Nano is a compact, lightweight, and versatile microcontroller board designed for embedded system applications, as shown in Figure 4. It is based on the ATmega328P microcontroller and offers a small form factor suitable for breadboard-friendly projects. The board includes 14 digital I/O pins (6 of which support PWM), 8 analog input pins, and supports communication protocols like UART, SPI, and I2C. It operates at 5V and can be powered through USB or an external power source. The Arduino Nano is widely used in robotics, IoT, and DIY projects due to its ease of programming, reliability, and compatibility with various sensors and modules.

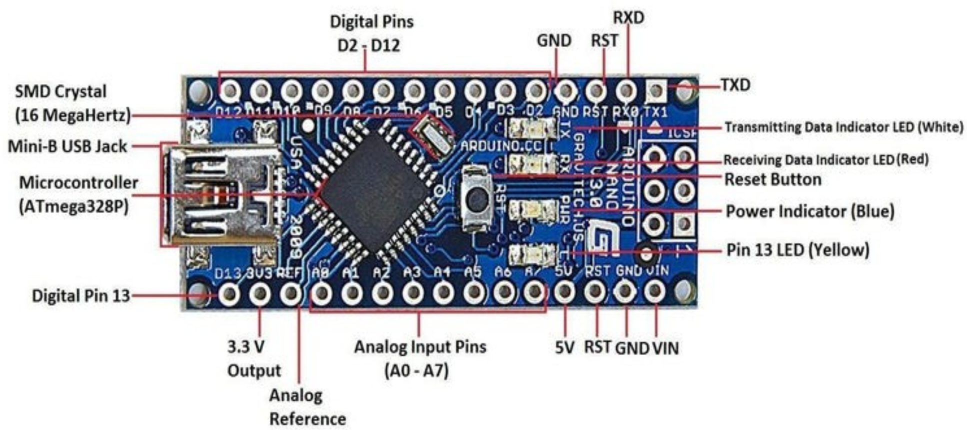

Figure 4: Arduino Nano

2. GPS Module and GSM Module:

A GPS module is an electronic device that determines its location by receiving and processing signals from GPS satellites, as illustrated in Figure 5. It provides precise data on the device's location, altitude, and longitude. In the case of the smart shoe, the GPS module will be embedded within the shoe, enabling it to track the wearer's position during an emergency. This real-time location information can be used to notify emergency responders or family members, ensuring the wearer's safety and potentially preventing harm.

Figure 5: GPS Module

A GSM module, as shown in Figure 6, is a device that enables communication through cellular networks. It utilizes a SIM card to connect to the network and is capable of transmitting data, voice, and text messages. In the smart shoe design for women's safety, the GSM module will be used to send emergency alert messages to a predefined contact number in case of distress. The module will be integrated into the shoe's circuitry and activated either by pressing an emergency button or detecting a shock via a sensor, signaling that the wearer is in danger. The alert will include the GPS coordinates of the wearer's location, enabling emergency responders to quickly reach and assist them.

Figure 6: GSM Module

3. Accelerometer Sensor:

An accelerometer is a sensor that measures acceleration forces acting on an object, such as movement, vibration, or orientation changes, as shown in Figure 7. It detects acceleration along one or more axes (X, Y, and Z), providing data about the rate of change of velocity. This information can be used to determine motion patterns, detect falls, or monitor vibrations. Accelerometers are commonly found in wearable devices, smartphones, and automotive systems due to their ability to sense movement and tilt. They operate using various principles, such as piezoelectric, capacitive, or microelectromechanical systems (MEMS), and are valued for their small size, low power consumption, and high precision.

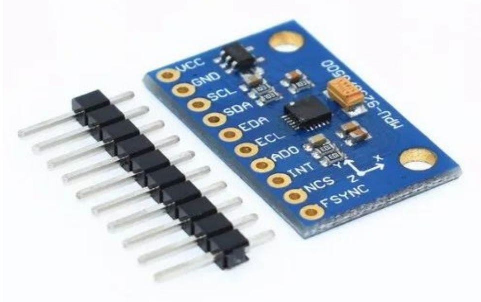

Figure 7: Accelerometer Sensor

4. Shocking Unit:

A shocking unit sensor is a component designed to deliver controlled electric shocks, typically used in personal safety devices or self-defense systems. It works by generating a high-voltage, low-current pulse that can temporarily incapacitate an attacker without causing long-term harm. Figure 8 illustrates the structure of a shocking unit sensor, highlighting key components such as the power source, voltage booster, and electrodes for delivering the shock. Its activation can be triggered manually or automatically based on specific conditions, such as stress detection or emergency alerts. Compact and efficient, shocking unit sensors are widely implemented in safety-focused wearable technology, ensuring swift defensive actions in critical situations.

Figure 8: Shocking Unit

5. Piezo Electric Sensor:

A piezoelectric sensor, as appeared in Figure 9, is a gadget that employments the piezoelectric impact to degree changes in weight, constrain, or vibration by changing over mechanical vitality into electrical vitality. When mechanical stretch, such as weight or misshaping, is connected to a piezoelectric fabric (like quartz or ceramics), it produces a little electrical charge relative to the connected constrain. These sensors are broadly utilized in applications such as vibration checking, affect location, and vitality collecting. In wearable frameworks, piezoelectric sensors can tackle vitality from developments like strolling or running to control little electronic gadgets, making them valuable for self-sustaining frameworks. They are esteemed for their tall affectability, compact measure, and unwavering quality.

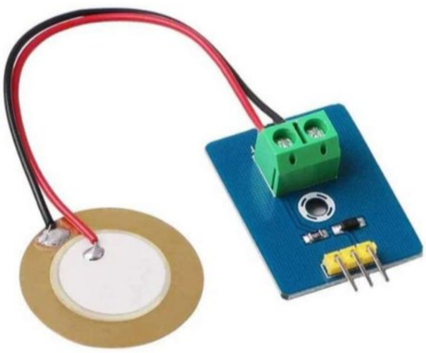

Figure 9: Piezo Electric Sensor

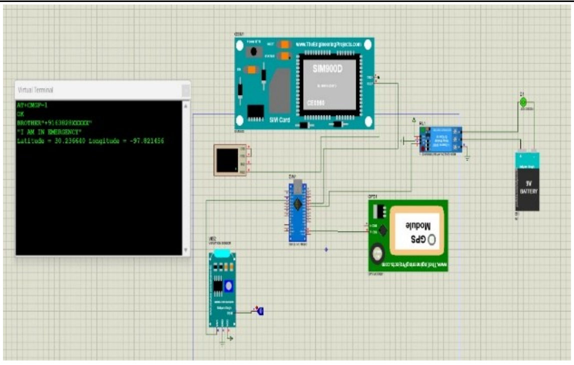

Figure 10: Simulation Output

SIMULATION OUTPUT

The simulation of our smart shoe for women's safety was carried out using Proteus software, where the primary system components were tested for functionality, as shown in Figure 10. A vibration sensor was utilized to detect specific triggers, which initiated the sending of emergency alerts through the GSM module and location tracking via the GPS module. To simulate the response mechanism, an LED was used in place of a self-defense unit. This simulation effectively showcased the coordination of the hardware components, demonstrating the system's design viability and readiness for the next phase of development.

V. CONCLUSION

The conclusion of this project highlights the successful development of a smart shoe designed to enhance women's safety through a combination of advanced technologies. The system integrates an accelerometer for automatic detection of falls or distress, a GPS module for real-time location tracking, and a GSM module for sending emergency alerts to predefined contacts. A self-defence shocking unit is also included, offering immediate protection during dangerous situations. The use of a piezoelectric sensor to harvest energy from walking ensures that the system remains operational without frequent recharging, enhancing its sustainability.

Through rigorous testing and simulations, the system has demonstrated its capability to function seamlessly in real-life emergency scenarios. The project has laid the foundation for further enhancements, such as waterproofing and improving the system's durability for long-term use. With its user-centric design and practical applications, this smart shoe has the potential to become an essential tool for personal safety, offering peace of mind to women in various potentially hazardous environments.

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