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Innovative Safety Monitoring Solutions for Children, Elderly, and Pets: A Smartphone-Free Solution for Affordable Protection

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A B S T R A C T :

Human safety is a critical area of research study due to its connotation and the increasing demand in the market for safety devices. Researchers have developed numerous human safety devices (HSDs) by leveraging advancements in the Internet of Things (IoT), such as sensing technologies, embedded systems, and wireless communication, etc. A key functions of these devices are human activity recognition (HAR).This article introduces a low cost safety solution that can be easily installed in homes without the need for smart devices. This gadget is especially useful in areas with limited internet connectivity and frequent power outages. Building sensors into an easy-to-use interface makes this innovative solution better for both home and business security. The system informs users about visitors, prevents elderly individuals from unknowingly approaching hazards, safeguards pet animals from potential dangers, and detects unauthorized access in industrial regions.

Keywords: human safety device, cost-effective, human activity recognition

Introduction

The home is the primary setting of injury-related deaths and health complications, particularly for children under 10 as well as adults older than 70 years. The causes of childhood injuries differ by age and different developmental stages. Burns due to fire, suffocation due to inhalation of toxic agents, and drowning are the major causes of accidental home injury deaths. Meanwhile, falls are the foremost contributors of non-fatal injuries, which necessitates immediate medical attention.

Child safety is one of the major concerns for all the parents, as inadvertent injuries are a leading source of morbidity and mortality among young children. Similarly, home safety is vital for elderly people, as a lack of safety measures can lead to increased vulnerability. Given that many individuals consider pets as their own family members, safeguarding their protection is equally important. Domesticated animals play a momentous role in the lives of family members, particularly the elderly and children. Additionally, these animals rely on their owners for protection. Household perils such as electrical cords, wires, etc., pose substantial danger to pets, further leading to potential injuries. To a cat or a dog, a power cord resembles a toy to play with, a toy or a prey animal. Pets are obstinate in their play, and if they bite or chew the insulation off a cord, it could result in an electrical shock.

According to IRES 2020, nearly 97% of Indian households have electricity, while 2.4% remain unelectrified. Most of these unelectrified households are in rural areas. Furthermore, over 43,000 inhabited villages in our country lack mobile phone services, with Odisha accounting for the highest number. Safeguarding the safety of children, the elderly, and pets is essential, especially in rural communities. Unfortunately, access to advanced technologies is often limited in those areas. In order to solve this issue, we have developed an innovative, novel safety device that functions on a simple electric circuit (Figure 1). This cost-effective, simple-to-assemble gadget has been designed particularly for rural areas, eliminating the need for smartphones and offering a practical, accessible safety solution. This device not only reduces the risk of electrical hazards for children and pets, but also helps prevent fire-related accidents caused by faulty wiring or unattended appliances. By integrating basic safety mechanisms, it guarantees a safer living environment for vulnerable populations without the dependence on any other complex technology.

Objectives

The main objectives are to

- Design an economic safety device to alert individuals to potential hazards or unauthorized access.
- Develop a simple, easy-to-assemble electrical circuit for safety purposes.
- Provide a versatile solution applicable in various safety-sensitive scenarios.

1. Components and Working Mechanism of the Safety System

1.1. Components

• Passive Infrared (PIR) Motion Sensor

This motion sensor recognizes motion by sensing infrared radiation from an object within its range. Human bodies and other warm objects naturally emit infrared radiation, and the sensor identifies variations in this radiation to determine movement. When a change in infrared levels is spotted, the sensor generates a signal, which is then processed to trigger the alert system. (Figure 2)

• BC 547 Transistor

The BC 547 transistor behaves like an electronic switch, allowing the activation of the buzzer when motion is perceived. The PIR sensor produces a low-power signal, which may not be strong enough to drive the buzzer directly. The transistor amplifies this signal, allowing sufficient current to pass through and operate the buzzer efficiently.

• Buzzer

The buzzer is accountable for providing an audible alert whenever a movement is noticed. This feature is vital in ensuring immediate awareness of any motion, whether for security purposes, elderly assistance, or pet safety. The buzzer's activation helps as an immediate response mechanism to unauthorized access, potential hazards, or the presence of visitors.

• 220-Ohm Resistor

The resistor acts as a defensive role in the circuit by restraining the flow of electric current. Without this, dangerous current could damage the transistor or other components in the circuit. Therefore, the 220-ohm resistor guarantees stable operation and enhances the lifespan of the components by preventing overheating and short circuits.

• 9-Volt Battery Terminals

The system's battery-powered design makes it apt for off-grid use, as it delivers the necessary power (voltage and current) for the PIR sensor, transistor, and buzzer to function properly.

Fig. 1 - (a) Innovative safety device –front

Fig.1-(b) Innovative safety device –back

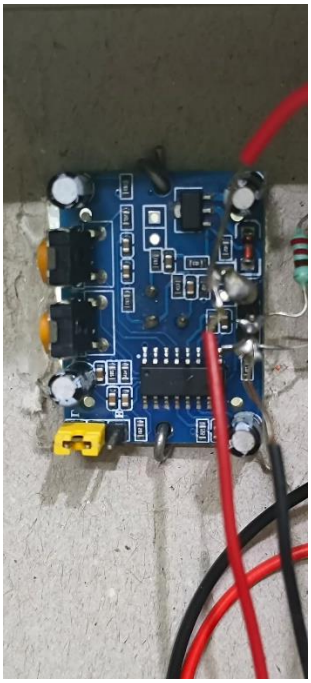


Fig 2- PIR motion sensor

1.2. Working Mechanism

• Motion Detection

The infrared motion sensor continuously screens the area for any disparities in radiated heat. Any movement happening within its range will prompt the sensor to output a high signal for its use, as it will surge infrared level.

• Transistor Activation

The PIR sensor constantly checks its surroundings for variations in infrared radiation. Any movement within its detection range, which prompts the sensor to provide a strong output signal, causes a change in infrared levels.

• Buzzer Activation

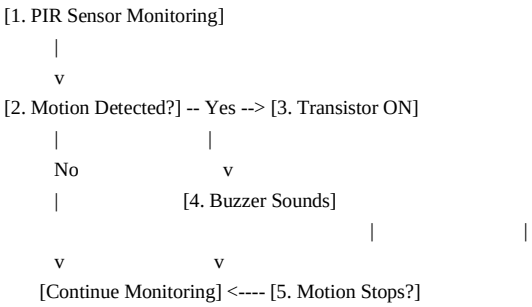
The PIR sensor has an output that shuts off the transistor by reverting to a low state whenever motion is no longer detected. This pauses the alert sound until new motion is detected by interrupting the buzzer's current flow.

• Motion Cessation

When there is inactivity, and the PIR sensor puts out a low output, the sensor turns off the active transistor. The buzzer turns off, making no sound, until it receives another signal to wake up from alert state.

This system provides an efficient, cost-effective, and reliable safety solution, particularly for rural areas with limited internet connectivity and frequent power outages.

1.3. ***Flowchart:*** This flowchart frameworks the sequence of events involved in the motion detection mechanism. In the flowchart, "v" represents the direction of the flow or progression from one-step to the next. It indicates the path that should be followed based on the outcome of previous steps.



2. Applications

• Child Safety:

The device performances as a proactive measure to protect children by identifying their movement near potentially dangerous areas such as balconies, staircases, or open wells. It promptly alarms the parents or caregivers, averting falls, injuries, or accidents.

• Kitchen Safety:

Kitchens are often engaged with perils like hot surfaces, sharp objects, and electrical appliances. This device alerts caregivers when a child enters the kitchen or interacts with potentially dangerous objects, reducing the risk of burns, cuts, and electrocution.

***• Elderly Monitoring*:**

Elderly people, particularly those with cognitive impairments like dementia, may wander into unsafe areas. The current device delivers real-time alerts if an elderly individual moves beyond selected safe zones, allowing caregivers to intervene quickly and prevent accidents.

• Playground Safety:

Since unsupervised playground areas can be risky, the device helps monitor children's movements, ensuring they remain within safe play zones. If a child ventures too far or tries to exit a secure area, an alert is generated to notify parents or supervisors.

• Pet Safety:

Pets are naturally curious and may attempt to access restricted or dangerous areas, such as electrical wiring, toxic substances, or open doors leading outside. The device averts pets from escaping or coming into contact with hazards by detecting movement and triggering an alert.

• Security:

Unlawful entry into homes, commercial areas, and other restricted zones can be recognized using this system. The motion sensor triggers an alert whenever an intruder is spotted, augmenting security for properties.

• Industrial Safety:

Unauthorized access to hazardous areas can lead to mishaps in industrial settings. By acting as an early warning system and notifying staff when someone enters restricted areas, the gadget reduces workplace accidents and improves safety in general.

3. Benefits

• Cost-Effectiveness

This safety expedient is an economical solution for residential areas and business premises because it is made with readily available and reasonably priced electronic components. Due its low cost of production, it can be widely adopted, particularly in areas where access to sophisticated safety equipment is frequently restricted by financial constraints.

• Ease of Assembly:

The candid design of this device ensures that even those with elementary knowledge of electronics can easily assemble and maintain it. The use of few components reduces the complexity, making installation hassle-free without requiring specialized technical expertise.

• Versatility:

In light of its great adaptability, this safety design is suitable for use in a variety of settings, such as commercial buildings, playgrounds, homes, and industrial areas. It is a prudent choice for boosting security and preventing accidents in a variety of settings because of its versatility across safety applications.

4. Discussion

In both residential and commercial contexts, the safety surveillance system described offers a creative, economical, and easily accessible way to safeguard young children, the elderly and pet animals. While traditional human safety devices (HSDs) frequently necessitate smartphone integration and IoT connectivity, the safety surveillance system described operates independently without depending upon smart devices. This makes them suitable for areas with frequent power outages and poor internet connectivity. The main advantage of this system is the Passive Infrared (PIR) sensor, which proficiently detects any kind of motion without the requirement of physical contact. The system alerts homeowners of any dangerous movement found within residential premises, as a pre-emptive safety measure. The BC 547 transistor enables the buzzer to produce an instant, unambiguous warning by refining the sensor signal. In fact, the simple design of its electric circuit makes the assembly as a gadget with easy maintenance, presenting it as a good choice for low-income communities and rural households. This device offers an effective substitute with minute complexity, whereas commercially available safety devices stereotypically require costly installation and complex setup. The inexpensive parts and 9V battery of this device allow for effective operation in places where there is electrical unpredictability. The system demonstrates a high degree of adaptability by enabling applications that offer industrial protection through unauthorized access detection, which helps prevent workplace accidents. Despite its advantages, the system can still be constrained by its reliance on motion detection, which can result in false alarms set off by movements of the objects. One possible development that could increase system accuracy is the integration of artificial intelligence for object differentiation and activity recognition. However, this study epitomizes a significant breakthrough in the development of affordable safety technologies for vulnerable populations.

Conclusion:

The compact and reasonably priced gadget augments daily security protocols while providing more convenience. With its simple electronic components, the product offers steadfast safety protection in a variety of environments, such as public places, workplaces, and residential areas. The current device provides a useful and convenient safety solution, helping to shield workers, children, elderly people, and pets from potential dangers. It was specifically designed for rural interior areas with frequent power outages and limited smartphone accessibility.

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