International Journal of Engineering Science and Advanced Technology (IJESAT)
Vol 26 Issue 4(1) (April) 2026
Received: 10-2-2026 Accepted: 17-3-2026 Published: 5-4-2026

SMART ACCIDENT-PREVENTION WHEELCHAIR USING AI & IOT

G.Kamal Bee
Dept. of Electronics and Communication Engineering
Annamacharya Institue of Technology and Sciences
Kadapa, India
gangguturkamalbee@gmail.com

Muthuru venkata Lakshmi
Dept. of Electronics and Communication Engineering
Annamacharya Institue of Technology and Sciences
Kadapa, India
muthurulakshmi@gmail.com

Mangali Dinesh
Dept. of Electronics and Communication Engineering
Annamacharya Institue of Technology and Sciences
Kadapa, India
ddinesh8718@gmail.com

Nookanaboyina Uday Kiran Dept. of Electronics and Communication Engineering
Annamacharya Institue of Technology and Sciences
Kadapa, India
kiranudaya787@gmail.com

Naraboina Prasad
Dept. of Electronics and Communication Engineering
Annamacharya Institue of Technology and Sciences
Kadapa, India
nprasadprasad106@gmail.com

Abstract— Smart Accident-Prevention Wheelchair Using AI & IoT is an intelligent, mobile device that will increase the safety of users, avoid accidents, and provide the possibility of remote monitoring. The system will be based on a Raspberry Pi as the central processing unit with an aid of a memory card to store the data and an Arduino to interface real-time sensors and control the motor. The wheelchair has MEMS sensors to detect sudden movement and tilt, and an ultrasonic sensor to detect obstacles, and predict unsafe conditions with the assistance of an AI-based Random Forest algorithm. The sensor information is shown on a LCD, and a buzzer is used to give instant warnings in potentially hazardous conditions. The DC motors are mounted on a motor chassis mounted on wheels and driven by a motor driver which provides motion. A power supply controls the system, which is powered by a 12V battery and has a slide switch, female power jack, and adapter that ensures good working performance. An IoT platform (Adafruit IO) is used to implement remote monitoring and control to ensure that caregivers or operators can monitor the status of the wheelchair and react to it when needed. The project shows an integrated, AI-based, and automated wheelchair prototype that puts more emphasis on preventing accidents, safety of the user and autonomy.

Keywords AI-based Accident Prevention , IoT-enabled Wheelchair , MEMS Sensor Tilt Detection, Ultrasonic Obstacle Avoidance , Remote Monitoring and Control.

[1] INTRODUCTION

This paper introduces a head gesture-controlled wheelchair that is wireless and aimed at physically challenged people. Head motions are identified and converted into commands to control the wheelchair, which offers a natural and selfsufficient motion. The system has such safety measures as obstacle detection and emergency stops, which make the system operate safely. Wireless control makes users more comfortable and responsive and the general quality of life is better [1].

The article describes a low-budget DIY retinally powered wheelchair, with an ATmega128P microcontroller. The movement of the eyes is converted to instructions to navigate a wheelchair, thus being able to move hands-free. The safety functions such as obstacle detection and emergency stops make sure that the device operates safely and offer disabled people greater independence and easy movement [2].

Human-Machine Interface wheelchair, which is operated via Wi-Fi, thus allowing disabled people to navigate in a remote and intuitive manner. A smartphone or a computer processes commands and drives the motors of the wheelchair, and the safety features such as obstacle detection and emergency stops make the wheelchair safe to use. The system improves the real time control, mobility and autonomy of physically challenged users [3].

This paper introduces a two-wheel-chair that has a multidegrees-of-freedom steering control to navigate safely on hilly slopes. Sensors and control algorithms keep on changing the inputs to the motor to keep it well-balanced and move accurately. The safety requirements such as obstacle detection and automatic stabilization make sure that it is safe to operate it and improve the mobility and independence of physically challenged users [4].

This project introduces an electric wheelchair that is automated and can be operated by physically challenged people so that they can move freely and safely. The system has built-in navigation and obstacle avoidance sensors and microcontrollers, easy to use control interfaces, and safety measures that guarantee safe operation. The design improves the real-time control, convenience, and quality of life among the users with limited physical abilities [5].

RELATED WORKS

The presented work describes a smart wheelchair that combines AI and IoT to monitor health conditions of patients and provide assistance to them in moving. Vital signs are monitored by sensors and processed by AI to identify threats to health and notify caregivers. It also has automated navigation and obstacle avoidance that makes the system

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safer, more independent, and improve the quality of life of the users [6].

The project is an intelligent health-monitoring wheelchair that monitors the heart rate and blood pressure in real-time. The system notifies the caregivers about any critical conditions and provides automatic navigation as well as safety, which increases safe mobility, independence, and the overall quality of life of users [7].

The current paper introduces AI-powered health wheelchairs with the vision-based navigation system that will help physically challenged people move safely and independently. The system uses cameras and sensors to scan the surrounding space and AI algorithms analyze the visual information to identify the obstacles, route and take real-time navigation decisions. The wheelchair is able to adjust to changing environments and it does not collide and runs smoothly. Other safety measures, including speed control and emergency stop are also incorporated in order to improve reliability. The experimental outcomes show that the system offers precise, effective and intelligent navigation which enhances mobility, independence and general quality of life of the users [8].

This paper will introduce an IoT-based wheelchair which will combine real-time health and safety control to physically challenged people. The vital signs and the environmental data are monitored and emergency alerts are given to the caregivers. The system is also equipped with automated navigation and obstacle detection systems, which promote safe movement, independence, and the general quality of life [9].

This paper describes a multimodal smart wheelchair, where AI is applied to support elderly people in terms of mobility and health control. It facilitates voice, gesture, and sensor-based controls, and AI is used to guarantee the obstacle detection and safe navigation. The system improves autonomy, safety, and quality of life of the aged users [10].

The presented piece of work is a patient care wheelchair that combines AI and real-time monitoring health sensors and safe navigation. Critical parameters are monitored and evaluated to notify caregivers about any abnormalities, whereas the obstacle identification and automated regulation guarantee safe work. The system promotes the mobility, safety and general quality of life among physically challenged individuals [11].

This paper introduces a smart wheelchair that combines machine vision and sensors to monitor the health status in realtime and to navigate safely. The system identifies barriers, monitors vital signs and notifies caregivers during emergencies. It improves movement, security, and general quality of life among the physically challenged users [12].

This paper introduces an intelligent wheelchair that has human-machine interaction to monitor the patient in real time. The vital signs and wheelchair activity are monitored by sensors and intelligent algorithms and alert caregivers when necessary. It is a system that offers safe navigation, increased autonomy and better overall life quality of users [13].

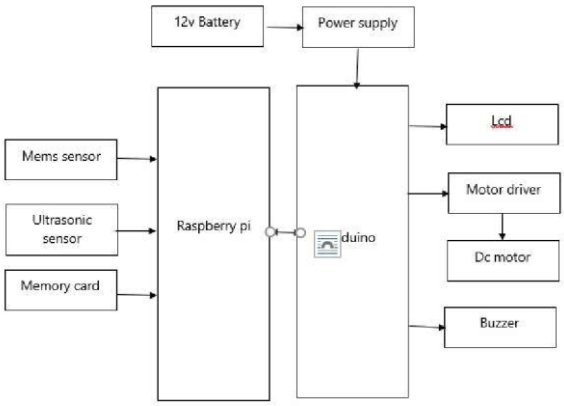
In this project, the author introduces an inbuilt AI system that operates smart wheelchairs to track the health of the user and guarantee safety. Sensors monitor vital signs, posture, and environmental barriers, and AI processes information to give warnings and minimize navigation. The system increases safe mobility, independence, and general quality of life to the physically challenged users [14].

This paper introduces a sensor formalism architecture of medical AI wheelchairs that combines several sensors to control vital signs, user posture, and the environment. AI algorithms handle the data to safely navigate, identify hazards, and issue caregiver warnings. The system improves the mobility, safety, and overall patient care to users who have limited physical abilities [15].

[2] PROPOSED METHOD

[3] The model to be proposed is an AI and IoT-based wheelchair that will improve safety and avoid accidents. It has a Raspberry Pi as the central processing unit, and an Arduino to deal with sensor connection and motor control. Tilt and obstacle sensors are the MEMS and ultrasonic ones, whereas a Random Forest AI algorithm forecasts unsafe circumstances. There is an alert provided by a buzzer and sensor data is displayed on an LCD. The DC motors are controlled by a motor driver and driven by a 12V battery. The system is compatible with remote monitoring through the Adafruit IoT platform which allows caregivers to monitor and control the status of wheelchairs. The model illustrates an automated, connected and safety-oriented prototype of wheelchair.

[4] Block Diagram



The suggested smart accident-prevention wheelchair will combine a Raspberry Pi and Arduino, with the power supply being a regulated 12V battery. The Raspberry Pi receives sensor data of a MEMS tilt sensor and an ultrasonic obstacle detector and logs them to a memory card. The Arduino manages movement of wheelchairs through motor driver, realtime reporting on an LCD screen, and a buzzer to give safety warnings. This system integrates sensor surveillance, microcontroller control, and instant feedback to increase the safety of the user and avoid accidents.

[4] Methodology

Principle of Functioning

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The proposed AI-based IoT Smart Accident-Prevention Wheelchair works on the principle of constant monitoring of the orientation, movements, and the environment around the wheelchair to avoid accidents and provide safety to the user. MEMS sensors are used to detect the tilt, abrupt movements, or possible tipping, and the ultrasonic sensor is used to detect any obstacle on the way of the wheelchair. The information of such sensors is fed on a Raspberry Pi into an AI algorithm based on a Random Forest that forecasts unsafe conditions. Once a possible risk is identified, the system notifies the user of this fact through a buzzer and sensor status is shown on LCD. A robot chassis has DC motors that are controlled by a motor driver that is connected to an Arduino to enable the robot to move safely and responsively. A network of IoT (Adafruit IO) also allows remote monitoring and control, as the caregiver can monitor wheelchair position and take required actions.

Hardware & Alerts:

The hardware description is as follows: a Raspberry Pi serves as the central processing unit, an Arduino will be used to interface with sensors and control the motors, MEMS tilt sensors, an ultrasonic distance sensor, DC motors, a motor driver, a 16x2 LCD display, and a buzzer to provide immediate feedback. The Raspberry Pi runs AI-based prediction models, whereas the Arduino guarantees real-time processing of sensor data and motor control. The LCD always displays the results of detection, system status and alerts. The buzzer will give immediate feedback during hazardous scenarios and the motor driver will stop the movement when hazardous conditions will be identified to avoid accidents and keep the user safe.

Power Requirements

Parameter	Specification / Metric	Description
Central Controller	Raspberry Pi	Serves as the main processing unit, analyzing sensor data, predicting unsafe conditions using AI, managing alerts, and controlling motor operations.
Sensor Interface	Arduino	Handles realtime interfacing with MEMS tilt sensors and ultrasonic sensors, enabling accurate monitoring
		obstacle detection.
Tilt & Movement Detection	MEMS Sensors	Detects wheelchair tilt, sudden movements, or potential tipping to ensure user stability and safety.
Obstacle Detection	Ultrasonic Sensor	Measures distance to obstacles in realtime, allowing the system to prevent collisions and navigate safely.
Safety Alerts	Buzzer & LCD Display	Provides immediate audible alerts and displays sensor status, warnings, and system conditions to the user.
Motion Control	DC Motors with Motor Driver	Drives the wheelchair on a robot chassis, halting motion when unsafe conditions are detected and allowing movement when safe.
Data Storage	Memory Card	Stores sensor readings, AI predictions, and system logs for monitoring and analysis.
Remote Monitoring	IoT Platform (Adafruit IO)	Enables caregivers or operators to monitor wheelchair status, receive alerts, and intervene

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A regulated 12V power supply is used to power the system which will provide a stable operation of the Raspberry Pi, Arduino, sensors, motor driver, motors and display. A battery and a slide switch, female power jack, and an adapter are reliable energy sources that ensure continuous monitoring, sensor processing, and alert communication.

to monitor remotely using Adafruit IO. The system operates off a 12V controlled supply, which guarantees the reliable and automated operation and improves the user safety and autonomy.

Table 1: Comparative Analysis of Conventional Techniques and the Developed Approac

Parameter	Existing Methods	Proposed Approach (Our System)
Safety Monitoring	Manual supervision or periodic checks, which may miss sudden unsafe events or tilts.	Continuous real-time monitoring using MEMS tilt sensors and ultrasonic sensor, analyzed by a Random Forest AI algorithm on Raspberry Pi.
Tilt & Movement Detection	Relies on user caution or delayed manual intervention to prevent tipping or accidents.	MEMS sensors detect sudden movements or potential tipping instantly, enabling predictive safety actions.
Obstacle Detection	Users rely on visual observation; collisions may occur.	Ultrasonic sensor identifies obstacles in realtime, allowing the wheelchair to avoid collisions automatically.
Safety Alerts	Warnings occur only after incidents, often manually communicated.	Buzzer and 16×2 LCD display provide immediate audible and visual alerts during unsafe situations.

This controlled power system ensures a stable operation, and the wheelchair can be used in practice in terms of accident prevention and autonomous mobility.

Performance Comparison Table:

Table 1 Performance Comparison Table

Table 1 The Smart Accident-Prevention Wheelchair is an AI-based, IoT-based, and real-time sensors device that is designed to ensure safe movement of users. A Raspberry Pi computes the data of MEMS tilt sensors and ultrasonic sensor, and an Arduino controls the motors and detects obstacles. It gives alerts through a buzzer and LCD and it is also possible

Motion Control	Wheelchair operation may continue unsafely until human intervention.	DC motors with motor driver halt motion automatically when unsafe conditions are detected.
Remote Monitoring	Not available or limited to occasional checks.	IoT platform (Adafruit IO) enables caregivers to monitor wheelchair status and intervene remotely.

Table 2The Smart Accident-Prevention Wheelchair is a device that allows its users to be more secure due to its support of MEMS tilt sensors, an ultrasonic sensor, and AI-assisted predictions to track their movement and obstacles in real-time. Buzzer and LCD notifications promptly, automatic motor, and IoT-based remote monitoring are so that the work is safe and independent. This system is a stable, preemptive, and integrated approach to supervision as opposed to the manual supervision approaches.

[5] RESULTS

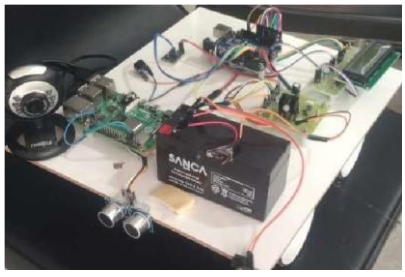

Fig1.Proposed System Hardware Setup

The prototype is made of an embedded system which is a microcontroller with embedded sensors, a camera, and a display unit. The sensor is an ultrasonic sensor which is used to measure the distance and the processing unit is used to analyze the data and make decisions. The system has real time feedback in LCD and audio output device. All the elements are interlinked on a small platform with the help of a rechargeable battery which makes it portable and efficient.

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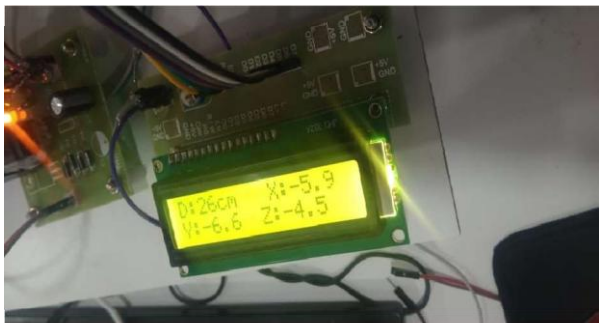

Fig2.Real-Time LCD Output Display

This LCD module displays real time readings, such as distance, in centimeters and the values of coordinates (X, Y, Z). It is connected to the control unit to give good and precise visual feedback and be able to monitor the sensor data and system performance easily.

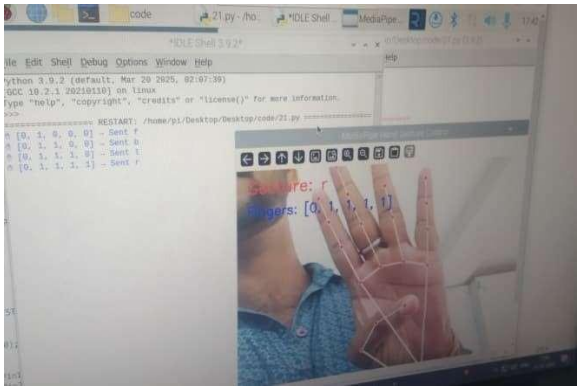

Fig3.Real-Time Hand Gesture Recognition Output

The system captures a live video feed and attempts to detect and track the real-time hand gestures. It determines the location of fingers in landmark points and shows the identified gesture and finger states, which allows the interactive control and real-time feedback.

[6] CONCLUSION

The Smart Accident-Prevention Wheelchair Using AI and IoT is a valid and smart solution to making the mobility process safer. The system has the capability of preventing accidents and hazardous situations through the combination of real-time sensor data, AI-based prediction, and remote monitoring with the help of the IoT. MEMS and ultrasonic sensors with AI algorithms will guarantee prompt notification, whereas motorized control will allow a smooth and responsive movement. The prototype demonstrates the possibility of the connected, automated wheelchairs to enhance the user autonomy, safety, and quality of life and provides an exciting way of how to address the assistive mobility needs and challenges in the future.

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