A PET-LIKE COMPANION FOR THE BLIND PEOPLE WITH INFORMATIVE CAPABILITIES

Project Reference No.: *48S_BE_3980*

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Keywords:

Blind People, Autonomous Indoor Navigation, Object Detection & Avoidance, Voice Assistant, GSM Communication, Staircase Maneuverability

Introduction:

With advancements in robotics, assistive technologies are increasingly being developed to empower differently-abled individuals, especially those who are visually impaired. One of the critical challenges faced by blind individuals is navigating unfamiliar environments and accessing contextual information. To address this issue, our project proposes the development of **"A Pet-like Companion for the Blind People with Informative Capabilities"** — an intelligent, autonomous rover designed to serve as a **companion, guide, and assistant** for visually challenged users.

This robot is thoughtfully designed with a **user-friendly and empathetic approach**, closely mimicking the behaviour of a service pet while delivering the capabilities of a smart machine. It takes the form of a compact, six-wheeled rover built on a **rocker-bogie suspension system**, allowing it to **smoothly glide over uneven surfaces and climb stairs** without losing balance—ensuring the safety of its visually impaired user. The body is constructed from PVC pipes, to maintain stability.

At the front, there are two **ultrasonic sensors** that constantly scan the path ahead, intelligently detecting and avoiding obstacles like walls, furniture, or sudden drops. Mounted on the center-top is a **camera module** supported by two **servo motors** to rotate the camera, accompanied by a **VC02 AI Thinker offline voice module** equipped with a compact speaker and microphone enables the robot to **process voice commands locally** and respond with clear, audible feedback, enhancing its interactive and intelligent behaviour.

Throughout its movement, the robot maintains an awareness of its surroundings and communicates progress back to the user, saying phrases like, “Obstacle ahead, taking alternate route,” or “Approaching stairs, switching to climb mode.” Its **friendly appearance**, **interactive nature**, and **precise movement** allow users to feel a sense of trust and companionship, transforming it from a machine into a reliable, intelligent guide.

Objectives:

- Obstacle Detection and Avoidance System
- GSM controlled Rover Access
- Voice Assistance User Interactive
- Autonomous Navigation System
- Renewable Energy-Powered Battery System
- User controlled Imaging for Monitoring
- Staircase Maneuverability
- Autonomous Document Delivery System

Methodology:

The development of the pet-like companion robot for visually impaired individuals involves a systematic approach integrating **hardware design**, **sensor interfacing**, to enable autonomous navigation. The methodology is divided into two main components: **hardware implementation** and **software development**.

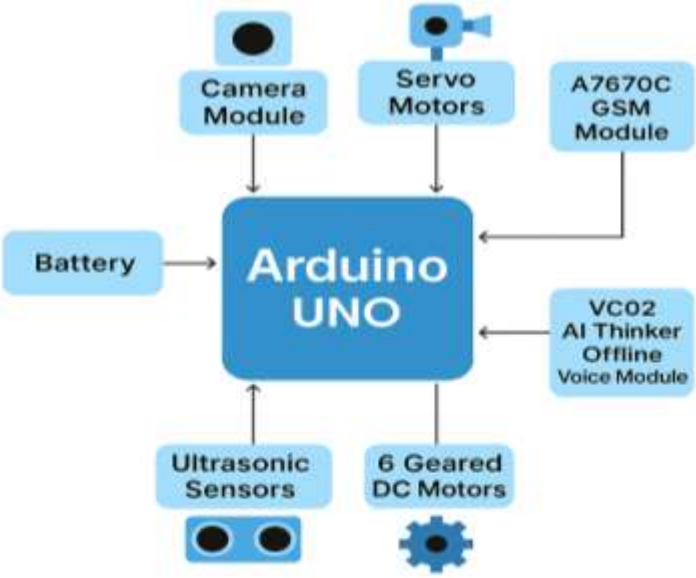

Figure 1: Block diagram of Rover

I. Hardware Implementation

1. Mechanical Design – Rocker-Bogie Mechanism

- The chassis is constructed using PVC pipes, 10 cm wheels, 45, 90-degree elbow joints to form a rocker-bogie suspension system that ensures stability and the ability to climb stairs or maneuver over uneven surfaces.

2. Microcontroller Unit

- An Arduino Uno microcontroller acts as the core processing unit to handle sensor data, motor control, and peripheral communication.

3. Sensor Modules

- **Ultrasonic Sensors:** Used for obstacle detection and avoidance and distance measurement.

4. Power Supply System

- A **rechargeable battery unit** integrated with a **solar panel** enables sustainable and long-duration operation.

5. Actuation

- **DC gear motors** with torque 3 kg-cm are used to drive the wheels and enable precise movement through rough and indoor environments.

II. Software Development

1. Navigation Algorithm

- **Direct Path Method:** Predefined routes for known locations (e.g., rooms) using simple forward, turn-left, or turn-right commands.

2. Voice and Command Interaction

- A voice module like **AI Thinker VC-02 Offline Module** processes spoken commands.
- The robot responds with predefined audio feedback using a speaker.

3. GSM Communication

- A **A7670C GSM Module** enables sending SMS alerts or location updates to caretakers, enhancing safety.

4. User Controlled Imaging and Monitoring

- The system supports **GSM-based imaging control**, where the user or a remote individual can send an **SMS command** to capture an image, which is then automatically processed and sent back via **MMS or cloud link** for remote viewing and assistance.

5. Integration Platform

- Development and simulation are done using the **Arduino IDE** and visualized using the **Serial Monitor** and real-time testing on prototype hardware.

Result and Conclusion:

The project successfully demonstrates the development of an autonomous, interactive rover designed to assist visually impaired individuals by combining intelligent navigation, communication, and sensory capabilities. Through systematic hardware and software integration, the rover was able to navigate indoor environment using **direct path navigation**

algorithm, efficiently avoiding obstacles and climbing stairs using the **rocker-bogie mechanism**.

Key functionalities such as **voice-command recognition**, **GSM-based access control**, and **object detection and avoidance** were implemented and tested. The rover responded effectively to user instructions via **Voice and SMS**, confirming its **interactive adaptability**. The **user-controlled imaging and monitoring system** enabled to capture images by GSM message, which were successfully stored and shared with users or caretakers—providing valuable assistance in navigation and safety.

Testing through **Arduino IDE** simulation validated the logic of the algorithm, while hardware implementation confirmed mechanical stability and functional accuracy across various indoor scenarios.

In conclusion, the project illustrates the feasibility and relevance of building a **pet-like robotic companion** for blind users. It bridges the gap between human empathy and machine intelligence, offering an affordable, scalable, and efficient assistive technology.

Project Outcome & Industry Relevance:

This project presents a practical, low-cost assistive solution tailored for visually impaired individuals, combining autonomous mobility, interactive voice and GSM control, and environmental awareness. It contributes significantly to the fields of **embedded systems, robotics, and assistive technology**, showcasing how intelligent design can directly improve quality of life. The integration of **voice commands, remote imaging,** and **object detection** into a single mobile platform demonstrates its versatility and potential for adaptation in **healthcare, rehabilitation centres, smart homes**, and **elderly care** applications. In industrial settings, similar technology can be applied for **automated material delivery**, **security patrolling**, or **interactive customer service robots**. The project also provides a valuable foundation for further research in **human-robot interaction**, **context-aware AI**, and **social robotics**, with broad real-world applicability in both public and private sectors.

Working Model vs. Simulation/Study:

The project involved the development of a **physical working model** of a companion robot integrated with autonomous navigation, obstacle avoidance, and user interaction features. Initial algorithm was tested through **software simulation**, but the final implementation was successfully realized on **hardware**.

Future Scope:

The proposed rover system holds immense promise for future development, particularly with the integration of **advanced AI and machine learning algorithms**. These enhancements would allow the rover to learn from the user's environment and behaviour, enabling it to make adaptive, personalized decisions. Incorporating **real-time speech-to-text and text-to-speech** features would improve the system's interaction capabilities, making communication more natural and context-aware. To support outdoor navigation, **GPS and IMU modules** could be added, while **LiDAR** and **thermal sensors** could enhance obstacle detection for applications like **search and rescue or industrial safety**.

Additionally, expanding connectivity via **Wi-Fi or 5G** would allow for **cloud-based control, remote monitoring, and data logging**. Beyond aiding the visually impaired, the system could be tailored for **elderly care, hospital logistics, campus deliveries, or even surveillance**. Future research may focus on compact component design, optimizing power consumption, and developing **emotion-based HRI (Human-Robot Interaction)**. Together, these advancements would not only improve functional capability but also position the rover as an intelligent, empathetic assistant in diverse real-world scenarios.