GEAR INTEGRATED UNMANNED GROUND VEHICLE FOR REAL TIME SURVILLENCE

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Keywords:

Unmanned Ground Vehicle (UGV), Bevel gear, Rocker-Bogie mechanism, real time surveillance

Introduction:

1. An Unmanned Ground Vehicle (UGV) is a type of mobile robot that operates on the ground without a human onboard. It is widely used in defense, surveillance, and hazardous environments to perform tasks such as exploration, monitoring, and rescue operations. UGVs are more Stable, Stealth and Low Detectable compared to UAVs.
2. However, conventional UGVs often face challenges like complex suspension systems, high manufacturing costs, and limited terrain adaptability. These issues reduce their efficiency and make them less suitable for rough or uneven surfaces.
3. To overcome these problems, our project focuses on developing an innovative, low-cost six-wheeled UGV based on the rocker-bogie mechanism integrated with bevel gears. This design enhances stability, improves obstacle negotiation, and eliminates the need for a traditional spring suspension system.
4. Additionally, the system includes a real-time camera module and two-way communication, enabling live surveillance and remote control for defense and security applications. The rocker-bogie mechanism enables the UGV to climb obstacles up to twice the diameter of its wheels while maintaining body balance, making it ideal for surveillance and exploration on rough or rocky surfaces

Objectives:

1. To design and develop a Bluetooth-controlled UGV equipped with an mini ESP-32 CAM module for real-time video surveillance and an audio system for two-way communication.
2. To implement a rocker-bogie-inspired suspension system using bevel gears, enabling the vehicle to traverse uneven terrain with stability and minimal mechanical complexity.

Methodology:

1. The methodology of this project begins with problem identification, where the limitations of conventional suspension systems and the need for real-time monitoring are clearly defined. Based on this, a suitable concept design and mechanism selection is carried out, leading to the choice of a springless suspension system using bevel gears. This stage focuses on deciding how the system will function mechanically while also incorporating a camera module for surveillance, ensuring both mobility and monitoring requirements are addressed together.

a.

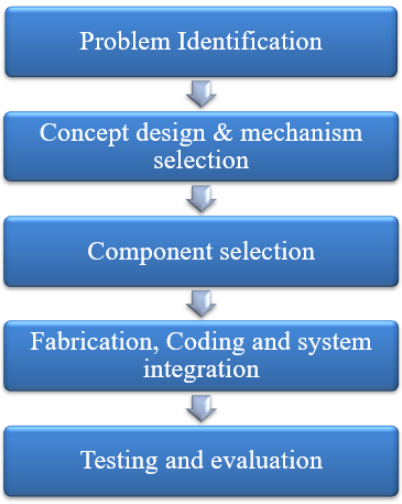

Figure 1: Methodology Flowchart of the Proposed UGV System

2. The next stage involves component selection, where all required hardware is chosen carefully to match the design goals. This includes selecting the ESP32 camera module for live streaming, Arduino Uno for control, DC motors for movement, and a motor driver for efficient power management. Each component is chosen based on compatibility, performance, and ease of integration, ensuring that both the mechanical and electronic systems can work seamlessly when combined.
3. Finally, the project moves into fabrication, coding, and system integration, where the physical model is built and all components are assembled. The coding part involves programming the microcontrollers for motor control and real-time video transmission. Once assembled, the system undergoes testing and evaluation to check performance, stability, and responsiveness. Any issues identified are corrected, and the system is optimized to ensure reliable operation under different conditions.

Result and Conclusion:

1. The developed system successfully demonstrates a functional springless suspension mechanism using bevel gears integrated with a remote-controlled mobility platform. The hardware setup, including the ESP32 camera and Arduino-based motor control, operated as intended, enabling smooth movement and real-time video streaming. The system showed stable performance under normal operating conditions, with effective coordination between mechanical and electronic components.

2. During testing, the suspension mechanism was able to handle minor surface irregularities without the use of conventional springs, validating the feasibility of the design. The DC motors provided adequate torque for movement, and the motor driver ensured controlled operation. The live video feed was transmitted with acceptable latency, making the system suitable for surveillance or remote monitoring applications.
3. The project proves that a springless suspension system using bevel gears can be a viable alternative to traditional suspension methods in small-scale applications. The integration of electronics and mechanical design enhances the overall functionality, making the system more versatile. It also highlights how combining embedded systems with mechanical innovation can lead to efficient and compact solutions.
4. Overall, the project achieved its intended objectives by developing a functional, stable, and integrated system. The results indicate that the design is effective, reliable, and suitable for applications involving remote operation and monitoring, while also showcasing the potential of combining mechanical and electronic engineering concepts in a single system.

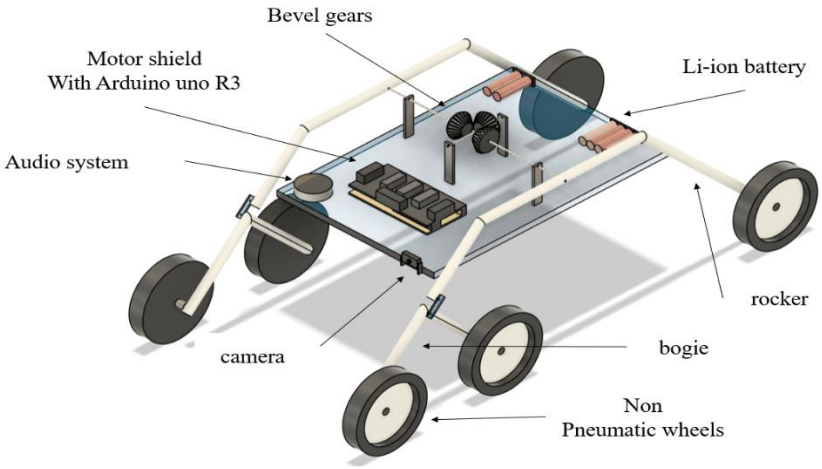

Figure 2: CAD model

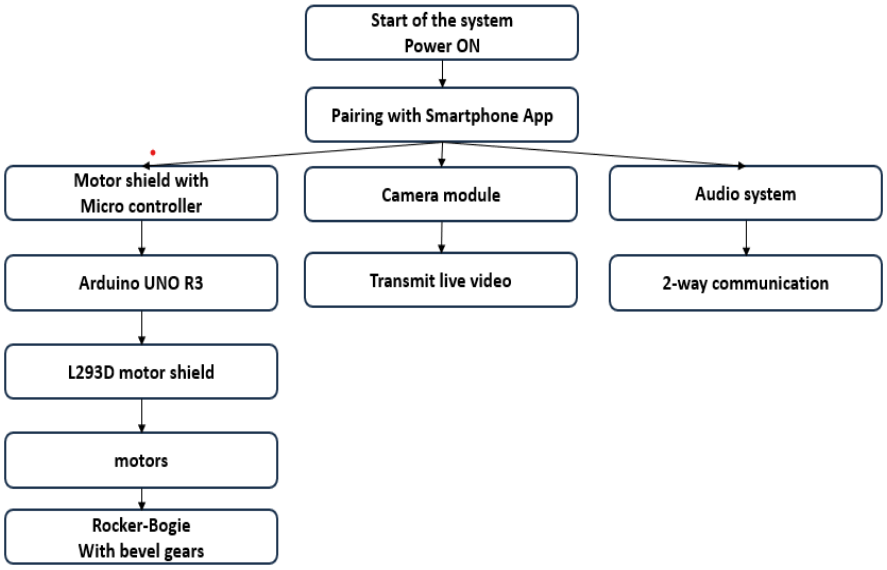

Figure 3: Working block diagram

Comparison with existing ugv's:

1. The final prototype was successfully developed by integrating the springless suspension mechanism with the electronic control and monitoring system. All components, including the bevel gear setup, DC motors, motor driver, Arduino Uno, and ESP32 camera module, worked cohesively. The system achieved stable movement along with continuous real-time video transmission, meeting the intended design objectives.
2. Testing results indicated that the system performed reliably under basic operating conditions. The bevel gear mechanism effectively minimized shocks and maintained balance without conventional springs. The motor response was precise and consistent, while the video streaming feature operated smoothly with acceptable latency, ensuring effective remote monitoring.
3. The project demonstrates that a springless suspension system can be practically implemented using mechanical design principles combined with embedded electronics. The successful operation of the prototype confirms the feasibility of replacing traditional suspension elements with gear-based mechanisms in small-scale applications.
4. Overall, the system proved to be stable, efficient, and functionally reliable. The integration of motion control and real-time surveillance enhances its applicability, showing that the project effectively meets its goals and serves as a strong example of interdisciplinary engineering design.

Project Outcomes and Learnings:

- Gained practical knowledge of designing and implementing a springless suspension system using bevel gears.
- Developed hands-on experience with microcontrollers like Arduino and ESP32 for control and communication.
- Learned integration of mechanical, electronic, and software components into a single system.
- Improved programming skills for motor control and real-time video streaming.
- Enhanced problem-solving, testing, and system debugging abilities through practical implementation.

Applications:

- Border monitoring.
- Search and rescue.
- Industrial inspection.
- Agricultural field monitoring.
- Security surveillance.
- Environment monitoring.
- Defence surveillance.
- Cost-Effective and Sustainable Technology.

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Future Scope:

The future scope of this project includes:

1. Integration of AI/ML for intelligent decision-making and autonomous navigation.
2. Addition of a robotic arm for object handling and manipulation tasks.
3. Implementation of a GPS and mapping system for real-time location tracking and path planning.
4. Use of a solar charging system to improve energy efficiency and extend operational time.
5. Incorporation of night-vision or thermal cameras for enhanced surveillance in low-light conditions.
6. Upgrading to a stronger communication module for long-range and stable connectivity.
7. Integration of environmental sensors to monitor parameters like temperature, humidity, and gas levels.