Faculty of Industrial and Energy Technology

Information Technology Program

Galaxy Robust Versatile Rover (Galaxy RVR)

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ABSTRACT

The **Galaxy RVR** is an Arduino Uno-compatible robotic platform designed to emulate the operational capabilities of real-world Mars rovers, offering an immersive educational and exploratory experience. Equipped with a **rocker-bogie suspension system** — modeled after NASA's Martian rovers it ensures stable traversal across diverse terrains, including sand, rock, and grass. The rover integrates solar charging technology with a rechargeable battery for sustained operation, alongside an ultrasonic sensor for intelligent obstacle avoidance. Advanced onboard sensors enable real-time environmental monitoring, including fire and gas detection, temperature, and humidity measurement, while a dedicated mobile application facilitates remote control and data visualization.

Designed for versatility, the Galaxy RVR supports practical applications across multiple domains:

1. **Archaeological and Tourism Site Exploration:**
   - Enables non-invasive monitoring of sensitive or restricted areas, such as Egypt's Siwa Oasis and Western Desert archaeological zones.

2. **Smart Agriculture in Arid Regions:**
   - Assists in crop management by autonomously surveying fields, measuring soil moisture and temperature, and transmitting alerts to farmers via the app.

3. **Disaster Response Operations:**
   - Safely assesses hazardous environments, such as gas leaks or fire-prone zones, prior to human intervention, enhancing safety protocols.

By combining robust hardware, sensor-driven intelligence, and user-friendly software, the Galaxy RVR bridges educational engagement with real-world problem-solving, empowering users to explore, innovate, and address challenges in remote or high-risk environments. This project underscores the potential of accessible robotics in advancing STEM education, research, and industrial applications.

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LIST OF ABBREVIATIONS

RVR	**Robust Versatile Rover**
Rocker bogie	**Smart Obstacle Avoidance System**
Uno R3	**Arduino Uno R3**
TT DC GM	**Twin Torque Direct Current Gear Motor**
HC-05	**Bluetooth Module HC-05**
Li-ion	**Lithium-ion Batteries**
Dth11	**Digital Humidity and Temperature**
MQ-4	**Gas Sensor**
HC-SR04	**Ultrasonic sensor**
KY-026	**Flame Sensor**
L298	**Motor driver**
BB	**Bread bord**

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Chapter 1
LITERATURE OF REVIEW

Galaxy Robust Versatile Rover (Galaxy RVR)
In a world witnessing rapid advancements in technology and engineering innovations, the Galaxy RVRis more than just a technical prototype; it combines the realms of space exploration and intelligent robotics in a single design.

It is a customizable vehicle, compatible with Arduino Uno, featuring a smart suspension system and precise simulation of Mars terrain.
It can navigate smoothly over various surfaces such as sand, rocks, and grass, and it operates on solar power, enhancing its ability to continue exploring highly diverse environments.

What distinguishes Galaxy RVR?

What makes the Galaxy RVR unique is its ability to move flexibly across rugged terrains, as well as its integration of a range of advanced sensors, such as the ultrasonic sensor, gas and fire detection sensors, and temperature and humidity measurement sensors. These sensors, working in harmony with the compatible app, make remote vehicle control an innovative and seamless experience. The vehicle's smart system also provides the ability to effectively avoid obstacles, enhancing its efficiency during exploration.

The vehicle features 6 DC motors, each controlling two wheels, providing a total of 12 wheels. These wheels give the vehicle high maneuverability and flexibility, allowing it to easily adapt to various terrains such as sand, rocks, and grass. Thanks to the distribution of wheels across 6 motors, the vehicle achieves a balanced energy distribution, improving efficiency and stability during movement. Additionally, the wheels offer excellent obstacle handling capability due to their unique design, making them ideal for exploration tasks in challenging environments.

How Galaxy RVR Achieves All of This: A Practical Approach

The Galaxy RVR combines advanced engineering, robotics, and space exploration simulation to create a unique, versatile vehicle that thrives in complex environments. Here's how it manages to achieve all of this:

1-**Arduino-Based Customization**:
The **Galaxy RVR** runs on an **Arduino Uno** platform, making it highly customizable. This allows users to tweak and program the vehicle's behavior to fit specific tasks and environments.

2-**Smart Suspension System**:
The vehicle's **smart suspension system** allows it to navigate rugged terrains effortlessly. This system is designed to adapt to various surfaces like sand, rocks, and grass, ensuring smooth movement even in challenging environments. The suspension is engineered to mimic real Mars rover designs, making it capable of traversing the toughest terrains.

3-**Solar Power for Continuous Exploration**:
Equipped with a **solar panel**, the **Galaxy RVR** operates independently without the need for constant recharging. This makes it perfect for extended exploration missions in diverse environments. Solar power enhances the vehicle's autonomy, ensuring that it can continue its tasks even in remote or sun-drenched areas.

4-**Advanced Sensors for Enhanced Awareness**:
The vehicle integrates a variety of **advanced sensors** including **ultrasonic sensors** for obstacle detection, **gas and fire sensors**, and sensors for **temperature and humidity measurement**. These sensors work in perfect coordination with the **Galaxy RVR's** smart system, providing real-time feedback that allows it to adapt to its surroundings, avoid obstacles, and respond to environmental changes.

5-**Six DC Motors and 12 Wheels for Enhanced Mobility**:
The vehicle features **six DC motors**, each controlling **two wheels**, for a total of **12 wheels**. This wheel configuration allows for precise control over movement, enhancing maneuverability and stability across diverse terrains. The even distribution of energy across the motors helps optimize performance, ensuring better traction, stability, and speed control.

- By combining these cutting-edge technologies, the **Galaxy RVR** achieves its impressive performance in exploration, with each component working together in a seamless and efficient manner. The integration of **Arduino-based programming**, **solar power**, **advanced sensors**, and a **smart suspension system** makes it an exceptional tool for exploration, both on Earth and in future Mars missions.

Chapter 2

DESCRIPTION OF THE SYSTEM

The project relies on a set of carefully selected electronic and mechanical components to ensure optimal performance and integration between various functions. These components include control units, sensors, power systems, mobility systems, and actuators. Each component plays a crucial role in enabling the rover to navigate, explore the environment, and collect data efficiently. In this chapter, we will review these components and their role in the overall rover system.

1- Mechanical Design

The mechanical design is fundamental to the Galaxy Rover project, where the structure is designed to be lightweight yet strong enough to endure movement across rugged terrains. The design includes:

Figure 1

The **structural frame** made of **acrylic** to reduce weight while increasing durability.

- The **smart suspension system** to ensure stability and flexibility during movement.
- **Axles and motors** that provide the necessary propulsion to move the rover
- **Optimal component distribution** to achieve balance and stability.

The design aims to achieve integration between the mechanical and electronic components to ensure optimal performance in various environments.

Using acrylic in the rover's structural frame has several advantages:

1- Lightweight
2- Durability
3- Weather Resistance
4- Ease of Shaping and Manufacturing
5- Aesthetic Appeal

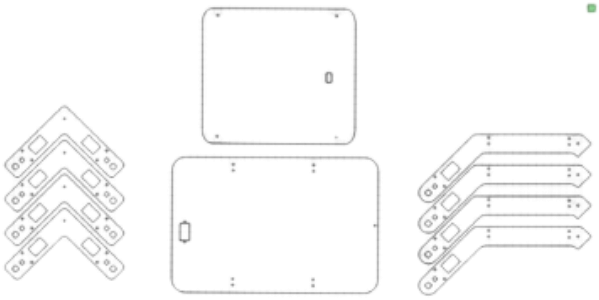


Figure 2

2-components

2-1-Arduino UNO R3

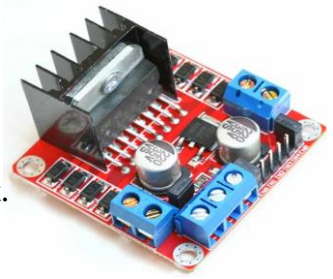
The choice of Arduino UNO R3 in the Galaxy RVR project is due to its ease of programming, seamless integration with components, and low cost. All these factors make it the ideal choice for controlling the rover and performing various tasks reliably and efficiently.

2-2-dc motor

The DC Motor Yellow was chosen for the Galaxy RVR project because of its ability to provide the required movement, ease of control over speed and torque, seamless integration with electronic circuits, low cost, reliability in performance, and small size.

2-3-Motor driver

The Motor Driver was chosen to control the DC Motor in the Galaxy RVR project because it provides direction and speed control, motor protection, power supply for high-current motors, easy integration with the control unit, and efficiency improvement.



2-4-wheels

Using 12 wheels provides greater stability, higher maneuverability, terrains. It also improves load capacity and climbing ability, making the rover more capable of performing tasks efficiently in various environments.

2-5-Solar panel

Its ability to provide sustainable energy, improve energy efficiency, and work effectively in open environments. It also helps reduce the need for battery recharging, maintain environmental sustainability, and enhance autonomy in long-term missions.

2-6-Ultrasonic sensor

It was chosen for its ability to measure distances accurately, avoid obstacles, and work effectively in various environments. It is also low-cost and easy to integrate with other systems.

2-7-Micro servo Motor

It allowed the ultrasonic sensor to move accurately left and right, helping to explore the environment and avoid obstacles efficiently.

2-8-Flame Sensor

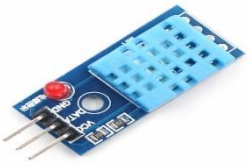
For its ability to detect fires or flames, ensure the safety and security of the rover and the environment, and provide easy integration with systems. It is also low-cost and effective in field environments that may contain fire hazards.

2-9-Gas Sensor

For its ability to detect harmful or combustible gases, ensure improved safety in hazardous environments, and interact with the surrounding environment intelligently.

2-10-Dth11

For its ability to measure temperature and humidity with moderate accuracy, helping to improve performance in various environments.



2-11-Bluetooth HC-05

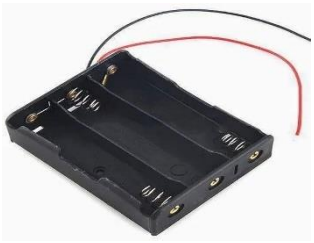
It was chosen for its ease of use, low cost, and easy integration with electronic systems like Arduino. Additionally, it provides an effective wireless connection for controlling the rover without the need for complex Wi-Fi networks, making it ideal for projects that do not require long-range connectivity or internet access.

2-12- Li_ion (1200mAh / 3.7v)

They were chosen for their high energy density, long lifespan, lightweight, ease of charging, and seamless integration with the system. They are also effective in supporting the continuous operation of the rover's various components, especially when used alongside solar panels as a renewable energy source.

2-13-Battery holder

A 3-slot battery holder was used to simplify the connection of the batteries to provide the required voltage, protect the batteries, and offer a safe and easy way to install and replace them.

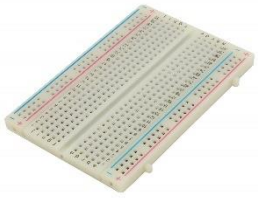


2-14-Wires

They are used to transfer power and signals between components, connecting the electronic system into a single integrated unit.

2-15-Bread bord

It was used to easily and flexibly connect electronic components without soldering, allowing for quick modifications and testing during the project development.



2-16-screws

To securely mount the body and engines, ensuring stability and durability during rover movement and operation.

Chapter 3
INTEGRATED SYSTEM

The electronic circuit of the Galaxy RVR project consists of a set of integrated components such as the control unit, motors, sensors, and communication systems, working together to achieve smart navigation, data collection, and effective control of the rover.

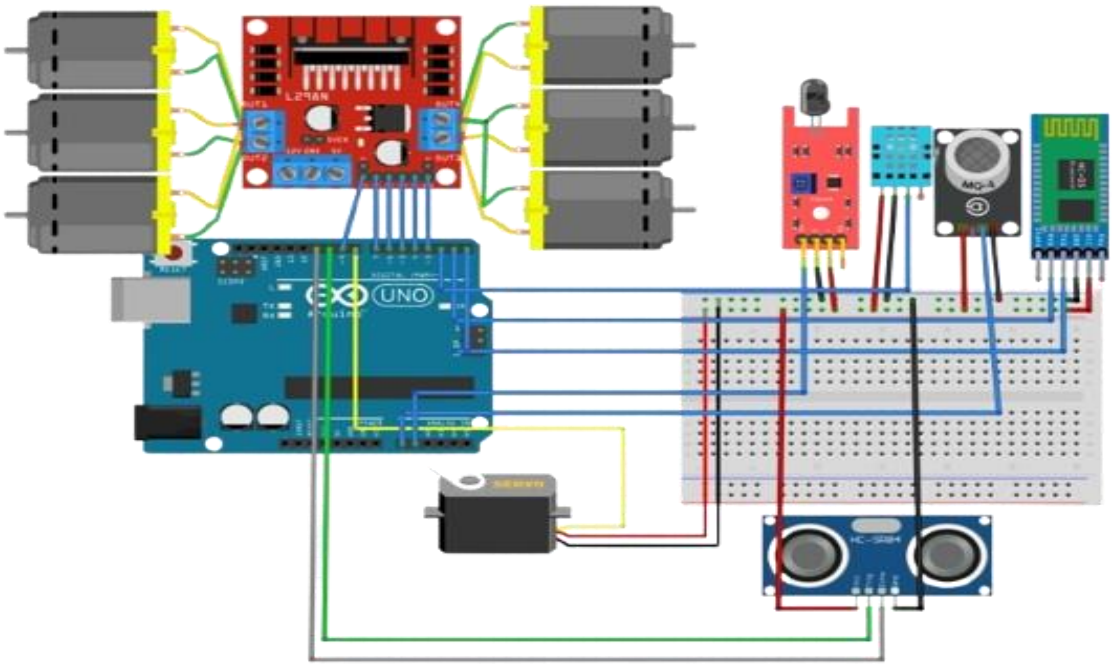


Figure3

Description of the electrical circuit:

The attached circuit shows the design of an integrated control system for the Galaxy RVR robot, based on the Arduino Uno board as the central controller.

Motion and Control Units:

- The L298N Motor Driver Module controls six DC motors, providing sufficient power and precise control over the robot's direction and speed, based on commands from the Arduino.
- An **Ultrasonic Distance Sensor (HC-SR04)**, supported by a **servo motor** for directional scanning, enables the robot to detect obstacles and calculate distances for collision avoidance.

Additional Communication and Sensing Units:

- The Bluetooth Module HC-05 and IR Receiver Module offer options for wireless remote control of the robot.
- A **DHT11 sensor** collects ambient temperature and humidity data.

Integration and Functionality:

The Arduino processes sensor data and received control commands, then issues the necessary instructions to the motor driver and other components via the breadboard and jumper wires. This enables the robot to achieve autonomous movement with obstacle avoidance, respond to external control, and collect environmental data. This circuit represents a flexible and scalable system for mobile robotics applications.

Arduino programming code:

[Arduino Galaxy RVR code file]

Control application:

Remote.XY is a platform that provides tools for developing remote control applications using online graphical interfaces.

Figure4

Galaxy RVR Control App Description:

1- Temperature and Humidity Display
2- Distance Display
3- Ultrasonic Motor Control
4- Rover Control Joystick
5- Gas Alarm
6- Fire Alarm

Conclusion:

The Galaxy RVR control application provides an interactive and comprehensive environment, combining the ability to monitor the rover's surroundings with precise control over its movement. Additionally, safety alerts like gas or fire detection enhance the application's effectiveness in ensuring the rover operates safely and efficiently in various environments.

Chapter 4
EXPERIMENTAL RESULTS

After assembling and testing the various components of the Galaxy RVR project, a series of experiments and tests were conducted to evaluate the performance and integration of the different systems. Below are the key experimental results achieved:

1- Movement and Steering Control
2- Distance Measurement and Obstacle Avoidance
3- Temperature and Humidity Measurement
4- Safety Alerts (Gas and Fire)
5- Interaction with the Application
6- Energy and Efficiency

Conclusions:

- The Galaxy RVR demonstrated efficient movement and navigation across rough terrains.

- The sensors were effective in gathering environmental data, such as temperature, humidity, distance, and detecting gases or flames.

- The control application interface was user-friendly, allowing for easy management of the rover's functions.

- **Sustainable energy** from **solar panels** and **lithium-ion batteries** proved effective in supporting continuous operation of the rover.

Chapter 5
COST ESTIMATION

Name	Quantity	Price	Total
DC Geared Motor	6	50	300
solar panel and module	1	500	500
Arduino UNO R3	1	500	500
wheels	12	40	480
Ultrasonic sensor	1	50	50
DHT11	1	60	60
Flame Sensor	1	40	40
MQ-2	1	80	80
Motor driver	1	110	110
Jumper Wire	30	1.5	45
Ultrasonic Holder	1	25	25
Micro servo Motor	1	120	120
li-ion 1200mA battery	6	60	360
HC-05	1	240	240
Breadboard	1	35	35
Battery holder	1	40	40
screws	30	2	60
Body material	-	1320	1320
Battery charger	1	100	100
Power switch	1	30	30
Arduino electric jack	1	15	15

Total Cost: 4610 L.E

Chapter 6
CONCLUSION & FUTURE WORK

Conclusion:

The Galaxy Robust Versatile Rover (Galaxy RVR) project marks a significant step forward in the development of intelligent, integrated models for simulating planetary exploration. It effectively combines engineering, robotics, and renewable energy technologies. With its advanced design, which includes a smart suspension system, solar power, and a range of environmental sensors, the rover demonstrates the ability to efficiently navigate rugged terrains and simulate real-life exploration scenarios on Mars or other challenging environments on Earth.

Future Work:

1- Adding GPS Navigation or Internal Tracking (SLAM):
To improve the rover's ability to precisely determine its location and create maps of the area being explored.

2-**Expanding Sensor Capabilities**:
By adding high-resolution cameras, radiation or magnetic sensors, to broaden the scope of data that can be collected during missions.

3-**Improving Mechanical Design**:
To reduce weight, increase movement and energy efficiency, and possibly add robotic arms for additional tasks such as sample collection.

REFERENCES

- SunFunder Galaxy RVR
- remote.xy
- fritzing
- Arduino Project Hub
- YouTube

الملخص العربي

في عصرٍ تتسارع فيه وتيرة الابتكار، تبرز مركبة **Galaxy RVR** كأيقونة متقدمة تجمع بين هندسة الروبوتات واستكشاف الفضاء في تصميم فريد وعملي. تم تطوير هذه المركبة الذكية لتكون أكثر من مجرد نموذج تقني؛ فهي منصة تعليمية وتطبيقية تحاكي بيئة المريخ بواقعية.

تعتمد Galaxy RVR على **نظام Arduino Uno** ، ما يمنحها مرونة عالية في البرمجة والتخصيص. وتزود بمجموعة من **المستشعرات الدقيقة** التي تمكّنها من قراءة وتحليل البيئة المحيطة بذكاء، مثل مستشعرات الكشف عن العقبات، والغاز، والنار، وقياس درجة الحرارة والرطوبة. هذه المستشعرات لا تعمل بشكل منفصل، بل بتكامل تام مع النظام الذكي للمركبة، ما يجعلها قادرة على التفاعل مع البيئة وتجنّب المخاطر بكفاءة.

مزودة بـ **نظام تعليق ذكي** و**ستة محركات** تتحكم في **12عجلة**، تتميز Galaxy RVR بقدرة هائلة على المناورة فوق أصعب التضاريس مثل الرمال والصخور ، مستفيدة من **توزيع متوازن للطاقة** يضمن الثبات والفعالية. كما أن اعتمادها على الشحن عن طريق **الطاقة الشمسية** يجعلها خيارًا مثاليًا للمهام الطويلة والمستقلة في البيئات القاسية.

Galaxy RVR ليست مجرد مركبة، بل تجربة تكنولوجية متكاملة تمهد الطريق لجيل جديد من المركبات الذكية المخصصة للاستكشاف والتعليم والابتكار.

"وفي نهاية هذا المشوار، تظل Galaxy RVR أكثر من مجرد مشروع... إنها بداية لطريق جديد من الابتكار، يحمل المستقبل على عجلات الذكاء"