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An Autonomous Cooperative Rescuing & Delivery Purpose Robot.

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Robots are gradually becoming available to delivery services and search and rescue organizations. One of the robots that are helping with this effort is a portable robot that uses sensor technologies to make it simple to screen any dark places for the goal of rescue. Supporting autonomous or teleoperated robots and multi-robot systems can be very beneficial for search and rescue (SAR) operations. These can help with situational analysis and mapping, monitoring, and surveillance, setting up communication networks, and victim recovery. This skilled robot is one of the few robots designed exclusively for the delivery of goods and search and rescue industries. The transformation of the analyzed model from an industrial practice into a competent and adaptable service provider, search and rescue robot, is described in this study. These modifications were made in response to evolving demands put forth by rescue organizations, scholarly investigation, and considerable field testing. A narrative account of a fruitful inspection of the developed and examined model is provided to substantiate these claims.

Keywords:

Rescuing and Delievery purpose robot, design analysis, performance evaluation, safety features, performance evaluation.

Introduction:

The significance of rovers in the exploration of the solar system nowadays is evident. Although the majority of rover designs were created for the surface of Mars and the Moon to understand the geological history of the soil and rocks, rovers are phenomena that extend beyond space exploration. To provide search and rescue services, we have taken the initiative to employ a rover on Earth. An autonomous device that can move across terrain with both natural and man-made barriers is called a mobile robot. Its chassis has wheels, tacks, or legs, and it may also have a manipulator setup attached to it for handling workpieces, tools, or specialty equipment. A pre-programmed navigation strategy is used to carry out several previously planned actions while taking into account the state of the surroundings.
The technology industry is developing quickly, and there are many different types of robots available with different features. Every day, automatic delivery robots are used to transport things like water bottles, drinks, and medications. The robot will assist in searching for or rescuing individuals through any low-light or dark environments, such as caverns, jungles, etc. The prototype was created through experimentation based on the facts and theories already available.
Understanding the robot's movement characteristics on various surfaces is one of the research's challenges. An ultrasonic sensor was used to keep the robot from crashing as it moved from one location to another, while an infrared sensor was utilized to locate impediments. A video camera, remote control, and horn are also part of the emergency system, which serves to alert those standing in front. Using a mobile device, a microcontroller manages the entire system.

Objective:

The major goal of this study is to present a thorough overview of two complementary perspectives on multi-operational service cum search and rescuing systems:

- (i) algorithm coordination and control, and
- (ii) modelling and deep learning for prototype perception.

• As a result, this review aims to serve as a starting point for researchers from either of the two domains who are seeking an overall perspective on autonomous design for the entire machine operations.

• To that purpose, a system-level perspective and an overview of the most important projects and competitions in the sector are presented before diving into the project work.

Literature review:

The term "rocker" refers to how the bigger links on either side of the suspension system rock when they are in motion. Through a differential, these rockers are linked to the chassis of the car as well as one another. When one rocker moves up about the chassis, the other moves down. The average pitch angle of both rockers is maintained by the chassis. A drive wheel is attached to one end of a rocker, and a bogie is attached to the other end. [1] The links with a drive wheel at either end are referred to as "bogies." Bogies were frequently employed on the tracks of army tanks as load wheels to distribute the load over the ground. Bogies were also frequently utilized on semitrailer truck trailers. Trailing arm suspensions are now preferred for both applications. [2] Rocker Bogie Suspension has the unique capacity to traverse obstructions twice the diameter of the wheel without sacrificing the overall stability of the rover. It has some elements that make it a true design. The Mars Science Laboratory mission's Curiosity rover can endure a tilt of at least 45 degrees in either direction without tipping over, but automated sensors prevent tilts of more than 30 degrees. In order to reduce dynamic shocks and subsequent damage to the vehicle when navigating large obstacles, the system is intended to be employed at slow speeds of about 10 centimeters per second (3.9 in/s). [3]

1. The mechanism enables climbing over tall barriers while maintaining ground contact for all six wheels. This is only accurate while operating at rovers' typical speeds, which are approximately 10 cm/s, like Curiosity.

2. Because the left and right sides (left and right rockers) move separately, the rover may navigate terrain where the right and left rockers cross various types of obstacles.

3. The system is made to keep the rover body at an average of two rockers even when the chassis pitches.

4. Spring suspension systems are more likely to flip over sideways than rocker-bogie systems.
By design, Curiosity can withstand tilts of up to 50 degrees in any direction.

5. Each wheel has its own independent motor in the design. The design is easier and more dependable because there are no axles or springs.

6. When compared to alternative suspension systems, the design cuts the primary body motion in half. Through the differential connecting the two rockers, the jerk experienced by any wheel is transmitted to the body as a rotation rather than a translation as with traditional suspensions.[4] The centre and rear wheels push the front wheels up against an impediment to go over a vertical obstacle face. The front of the car is then raised and driven over the obstruction as a result of the front wheel rotating. The front wheel then pulls against the obstacle as the rear tyre presses against it, lifting the centre wheel up and over. Finally, the front two wheels lift the rear wheel over the obstruction. Each wheel moves ahead as it goes around the obstruction. The back wheel is finally dragged over. The obstruction between the two front wheels. The car moves ahead at a delayed or stopped rate when each wheel passes over the impediment. The operational speeds at which this occurs do not provide a problem.

Up till now, these vehicles have been used. Astronaut support during surface activities will be one of the rovers' future uses. The rover must be capable of moving significantly quicker than or at least equivalent to a human walking pace to be a valuable assistant. Even faster speeds (4–10 km/h) are needed for some proposed missions, such as the Sun-Synchronous Lunar Rover.[5] According to JPL, compared to previous suspension systems, this rocker bogie technology significantly decreases the motion of the main MER vehicle body. The six wheels on the rover each have a separate motor. The vehicle can turn in place thanks to separate steering motors on each of the two front and two rear wheels. Additionally, each tyre includes studs that offer traction for clambering over rocks and in soft sand. For the motors to be geared down and each wheel to be able to independently lift a significant amount of the mass of the entire vehicle, the maximum speed of the robots operated in this fashion is limited to avoid as many dynamic effects as feasible.[6] The rocker-bogie suspension design has established itself as a reliable mobility application over the past ten years because to its enhanced vehicle stability and ability to scale obstacles. The system was successfully flown as a component of Mars Pathfinder's Sojourner rover after numerous technology and research rover installations. Due to its long history, the use of a rocker-bogie suspension was a logical choice when the Mars Exploration Rover (MER) Project was first proposed.

Design Methodology:

1)Define the Requirements:

Define the robot's specifications and goals in detail. Determine the precise activities it must carry out, the delivery payload capacity, the necessary range and speed, and any environmental restrictions.

2)Modular Design:

Use a modular design strategy to improve reuse and adaptability. Disassemble the robot into modular parts that can be quickly modified or replaced as needed. This gives the robot flexibility to respond to various delivery conditions or potential upgrades.

3)Navigation and Localization:

Implement trustworthy localization and navigational tools. Consider employing methods like GPS, odometry, or simultaneous localization and mapping (SLAM), depending on the environment, to help the robot travel on its own and deliver goods precisely.

4)Payload Handling:

Give the robot the right sensors for obstacle detection and perception. The robot can more easily assess its surroundings, avoid impediments, and interact with the delivery environment with the use of sensors like cameras, LIDAR, or ultrasonic sensors.

5)Sensing and Perception:

Give the robot the right sensors to sense obstacles and detect them. Cameras, LIDAR, and ultrasonic sensors can aid the robot in effectively navigating its environment, detecting impediments, and interacting with the delivery environment.

6)User Interface and Interaction:

Make a simple user interface for controlling the robot's actions. Create an intuitive control interface that enables users to enter delivery locations, monitor the robot's movement, and manage extraordinary scenarios.

7)Safety Considerations:

Design the robot with safety in mind. Include safety elements including fail-safe systems, emergency stop devices, and collision avoidance. Make sure that the robot moves safely and complies with all applicable laws when it interacts with people or other things.

Requirements Analysis:

Understanding the design requirements and figuring out the fundamental requirements for the autonomous cooperative rescuing & delivering robot is part of the requirements analysis process. Choosing the desired payload, lift height, speed, and safety measures are included in this. In addition, consideration is given to elements including intended usage, ambient circumstances, and user preferences. The requirements are carefully examined, and a solid foundation is established for the subsequent design phase.

Conceptual design:

Various design concepts are developed during the conceptual design phase to satisfy the specified requirements. Based on performance, efficacy, and adherence to predetermined criteria, this perception is formed. The intelligent design phase takes into account several factors, including the choice of a control system, safety measures, and the drive mechanism (hydraulic, electric, or pneumatic). Load capacity, energy efficiency, ease of use, required maintenance, and cost savings are a few examples of evaluation criteria. Several workable design ideas were chosen for future development through this procedure.

Mechanical design:

The goal of the mechanical design phase is to turn the chosen conceptual design into a fully functional mechanical structure. This covers sensible material choice, component sizing, and structural evaluation. Considerations are made for variables such as motor carrying capacity, stability, and delivery robot strength. Motors, the Rocky Boggy Mechanism, tyres, and bearings are examples of mechanical components that have been meticulously designed and integrated into the system. Tools for computer-aided design (CAD) and finite element analysis (FEA) can be used to check structural integrity and maximise designs.

Electrical design:

The selection and integration of the electrical components needed to power the motor are the main objectives of the electrical design phase. This entails picking the appropriate sensor, motor, motor controller, and wiring system. To ensure safe operation, safety circuits including limit switches and emergency stop mechanisms are integrated. Usability is also improved by user-friendly elements like buttons, displays, and control interfaces. The goal of the electrical design phase is to maximise power usage, control precision, and system dependability.

Performance Evaluation and Analysis:

An autonomous cooperative rescuing and delivery robot that has been designed goes through a thorough performance evaluation and analysis to determine its functionality, effectiveness, and safety. This comprises the following features:

Load testing:

To establish the motor hoist's maximum weight capacity and confirm its capability to securely lift large loads, it is put through rigorous load testing. To guarantee that the lifter satisfies or exceeds the required load requirements, load testing is carried out in compliance with industry standards and regulations.

Efficiency analysis:

The main goal of efficiency analysis is to assess the Robot's overall effectiveness and power usage. To maximise the Robot's energy efficiency, factors including energy utilisation, mechanical losses, and control system effectiveness are taken into account. This research identifies potential areas for improvement and ways to save energy.

Security Analysis:

An evaluation of the safety systems and features included in the autonomous cooperative rescue and delivery robot is part of the safety analysis. It involves assessing the efficiency of limit switches and other emergency safety equipment. By ensuring that the autonomous cooperative rescuing and delivery robot comply with safety norms and laws, the analysis seeks to minimise the risk of failures.

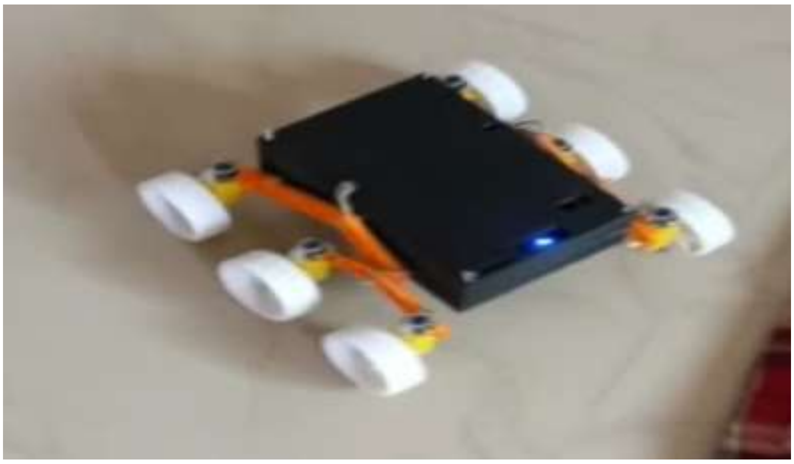
The effectiveness of the suggested design can be confirmed, and any alterations or enhancements to the design that are required can be found, by undertaking a thorough evaluation and performance study.

Note: High-level descriptions of the design methodology and performance evaluation are provided here. Each step would be covered in greater detail in a true research report, along with the precise procedures, calculations, and analytical methods employed.

Design of An autonomous cooperative rescuing & delivery purpose robot

Figure-3.1 Co-operative rescuing & delivery purpose robot.

Actual model :



Calculation:

If horizontal length of stairs is 400 mm

Then wheel base = horizontal length of stairs – (Rf + Rr)

Rf = radius of front wheel

Rr = radius of rear wheel

So wheel base = 400 – (35+35)

Wheel base = 330 mm

Let θ = 450

In Triangle BNC,

Angle BNC = 900

Angle NBC = Angle NCB = 450

Therefore, NC = NB

NC2 + NB2 = BC2

(from Pythagoras theorem)

BC2 = 2(NC2) ……. (1)

= 2(1652)

BC = 233.33 mm

Rounding off to 230 mm

BC = 230 mm

Substituting in eqn (1) we get,

2302 = 2(NC2)

NC = 162.63 mm

Also,

NC = AN = 162.6 mm

In Triangle AMN,

angle AMN = 900

AM2 + MN2 = AN2

2(AM2) =AN2

AM = 114.99

AM = 115 mm

Now due to symmetry,

AM = MN =115 mm

BM = AB – AM

= 230-115

BM = 115 mm

Height of RBM

Height2 = BC2

– NC2

Height2 = 2302

– 162.632

Height = 162.4 mm

Net Height = Height + radius of wheel

= 162.4 + 35

= 197.64 mm

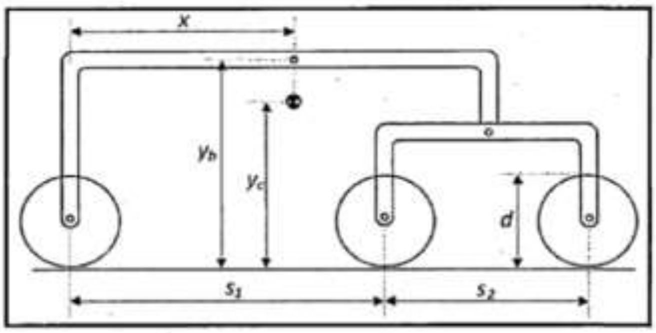


Fig.4.3 Rover parameters

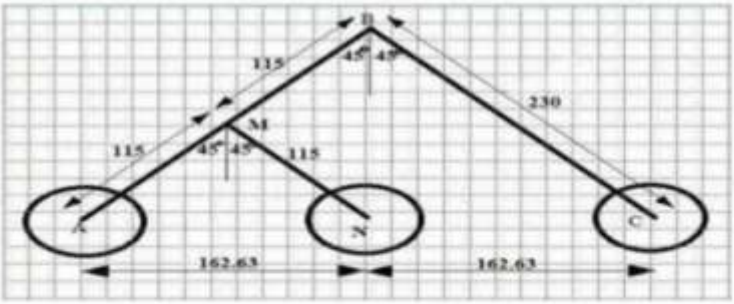


Fig.4.4 Link Diagram

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Conclusion :

In conclusion, numerous investigations and studies have amply demonstrated how effective robots could be in search and rescue operations. They work particularly well for finding and gathering information that can improve or optimise search and rescue activities. Rescue robots must, however, function in hazardous conditions, therefore they must be able to work autonomously or with little to no human supervision. Increasing the use of sensors is what is now being done to accomplish this. Unfortunately, sensors are brittle and still have the potential to drive up the price of finished goods. However, the enormous potential of sensorless sensing techniques in the robotics industry has been illustrated by this scholarly review.

There were also some gaps in the literature that were found. First, more research must be done on how to make sensorless robots operate as efficiently as possible. Future research should concentrate on expanding the operational range of rescue robots using dependable, wide-area wireless networks as well as advancing robots from their current semi-autonomous state to full autonomy. Last but not least, advanced motion control systems must be created so that robots can move and transfer patients out of catastrophe areas.

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