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Designing and Development of Vehicle Towing system Using IoT

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Abstract

Vehicle breakdowns caused by mechanical failures frequently occur on roads and often create traffic congestion, operational delays, and safety risks. In such situations, an efficient mechanism is required to move the damaged vehicle safely to the roadside without depending entirely on conventional towing services. This project focuses on the design and development of an Emergency Car Towing System capable of lifting and towing a vehicle from one location to another in a controlled and safe manner. The proposed system incorporates mechanical lifting and towing mechanisms to improve operational convenience and reduce manual effort. A three-dimensional model of the system was developed using CATIA V5 R20 software, and necessary design calculations were performed to validate structural and functional requirements. Based on the finalized design, components were selected and assembled to develop the towing mechanism. The proposed design was evaluated to examine its feasibility, operational performance, and suitability for emergency vehicle handling applications. The study demonstrates a practical, compact, and efficient approach for roadside vehicle recovery operations.

Keywords: Emergency Car Towing System; Vehicle Recovery; Mechanical Design; CATIA V5 R20; Hydraulic Lifting Mechanism; Roadside Assistance; CAD Modelling; Towing Mechanism.

How to Cite This Article

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Introduction

Towing is the process of pulling one object using another object through a mechanical connection such as a rope, chain, towing bar, or towing hitch. The pulling force may be generated by vehicles, boats, animals, or human effort depending on the application requirements. One of the most common examples of towing is the transportation of broken-down vehicles using tow trucks. Other towing applications include trucks pulling trailers, passenger vehicles carrying luggage trailers, and heavy-duty systems used to transport industrial equipment and machinery.

Vehicle breakdowns caused by mechanical failures frequently occur on roads and highways, leading to traffic congestion, operational delays, and safety concerns. In such situations, damaged vehicles must be moved safely and efficiently to the roadside to restore normal traffic conditions. Conventional towing methods generally depend on dedicated towing vehicles and additional operational effort, creating the need for compact and efficient towing mechanisms.

Historically, towing methods evolved from rope-assisted movement of boats and barges by humans or animals to modern tugboats and advanced vehicle recovery systems. In aviation, towing is also used to launch gliders using powered aircraft.

Safe towing depends on several important factors including vehicle towing capacity, proper load distribution, correct use of safety chains, and adherence to operational standards. Improper weight distribution may lead to instability, trailer sway, reduced control, and damage to the towing system.

Towing capacity refers to the maximum load that a vehicle can safely pull and is generally classified into two categories:

Braked Towing Capacity: In this arrangement, the trailer is equipped with its own braking system connected to the towing vehicle. Since braking assistance is available, heavier loads can be transported safely with improved stability and control.

Unbraked Towing Capacity: In this case, the trailer does not contain an independent braking system and depends entirely on the towing vehicle for stopping force. Therefore, the allowable towing load is significantly lower to maintain safe operating conditions.

Considering these requirements and limitations, the present work focuses on the design and development of an **Emergency Car Towing System** intended to move damaged vehicles efficiently while reducing manual effort and improving roadside recovery operations.

Literature Review

Gaurav R. Jawale et al. proposed a Fabrication of Emergency Car Towing Machine, emphasizing the growing requirement for compact towing systems to handle roadside vehicle failures. Their study introduced a mechanical towing solution utilizing a screw jack and wiper motor, supported through CAD modeling in CATIA V5 and validated through manufacturing and testing procedures.

Ninad Patil et al. developed an Emergency Car Towing Machine based on existing transport industry towing methods. Their proposed design incorporated a screw jack or hydraulic jack integrated with an electric motor and scissor mechanism. The complete system was modeled, assembled, and experimentally tested to evaluate operational performance.

Ahmed Abdelmoamen Ahmed et al. introduced a Real-Time Car Towing Management System Using Machine Learning-Based Automatic Number Plate Recognition (ANPR). Their approach combined image processing and machine learning techniques to improve number plate detection and vehicle identification accuracy. The system achieved high recognition performance and included mobile-based user interaction for towing status tracking and fine management.

Ko Stroo and Robert Hekkenberg investigated Emergency Towing Vessel Design for marine environments. Their work focused on creating optimized towing vessel configurations capable of preventing accidents and improving towing efficiency through simulation-driven design methodologies.

Akash L. Nirmal et al. proposed an Emergency Car Towing Mechanism using hydraulic lifting and motor-driven operation. Their study demonstrated the integration of CAD design, manufacturing, and testing to evaluate towing performance under practical operating conditions.

Ayimba and Cislaghi presented Copy-CAV: V2X-Enabled Wireless Towing for Emergency Transport, introducing intelligent vehicle communication mechanisms to support autonomous emergency transport decisions and reduce delays in critical situations.

Shinde Sumit Vishwanath et al. proposed a Remote Operated Car Towing Machine designed to reduce dependency on conventional towing vehicles while improving convenience and minimizing traffic congestion caused by breakdown incidents. Their approach demonstrated the practical benefits of remote-assisted vehicle movement systems.

Problem Statement

Vehicles often break down on the road due to mechanical failures. This causes traffic problems and can even lead to accidents. In such situations, the vehicle needs to be moved aside so the road becomes clear again. Currently, towing vehicles are used, but they require extra space and time to reach the spot. Therefore, there is a need to design a compact and efficient system that can help in moving the damaged vehicle to the roadside without depending fully on large towing vehicles

Objectives

- To design and develop a system that can tow and shift a broken-down vehicle to the roadside.
- To study the working principles of existing hydraulic jacks.
- To create a CAD model of the system using CATIA V5 R20 software.
- To design the required components and select suitable materials for the system.

Methodology

1. We began by studying various research papers from sources such as ScienceDirect to understand the existing technologies used in towing systems.
2. Relevant information was collected from these papers, along with reference books and academic textbooks, for a detailed understanding of the topic.
3. Based on the literature study, we finalized the working concept of our prototype and designed the model using CATIA software.
4. After finalizing the design, we performed calculations and detailed force analysis to determine the appropriate materials for each component.
5. Once the design and material selection were complete, we visited the market to procure the required components with the correct specifications.
6. During this procurement stage, we also estimated the approximate cost of components and machining processes.
7. The manufacturing of the prototype will be carried out in the second semester, followed by testing and drawing final conclusions based on the results.

Design of the Basic Components

Computer-Aided Design (CAD) refers to the use of computer software to create, modify, analyze, or optimize a design. CAD helps improve the productivity of designers, enhances the quality and accuracy of designs, and provides clear documentation for manufacturing. The final output is usually in the form of electronic files that can be used for printing, machining, or further production.

Uses of CAD

CAD is commonly used for:

1. Creating detailed 2D and 3D engineering drawings of mechanical components.

2. Developing conceptual designs, layouts, and performing strength or dynamic analysis of assemblies and manufacturing processes.

3. Preparing environmental or visual impact reports using realistic 3D renderings.

CAD Systems And Tools

CAD software is available on major operating systems like Windows, Linux, Unix, and macOS.

Users typically work with a mouse, but other tools like a graphic tablet, space mouse, or 3D glasses can also be used for better model visualization.

In earlier times, engineers and draftsmen faced difficulties in manually creating accurate engineering drawings. Tasks such as drawing lines,

setting dimensions, scaling, and making corrections were time-consuming and required high precision. CAD has eliminated these problems by providing fast, accurate, and editable digital drafting tools.

Advantages of CAD

- CAD allows the creation of highly accurate designs.
- Drawings can be made in 2D or 3D and easily rotated or viewed from different angles.
- CAD models can be linked to other engineering software for analysis or manufacturing.
- Unlike manual drafting, CAD models are created at a 1:1 scale, and scaling is applied only during printing.
- CAD ensures consistency by allowing the creation of preset styles for text, dimensions, and line types.
- Repetitive tasks such as copying, mirroring, rotating, or modifying objects can be done quickly.
- Incorrect actions can be undone easily, reducing mistakes and saving time.
- Once a component is drawn, it can be reused without redrawing.

Model Space and Paper Space

In CAD:

- Model Space is where the actual design is created at full scale.
- Paper Space is used to arrange the drawing sheets, including the title block, border, dimensions, and scaled views of the model through layout viewports

Comparison: Manual Drafting vs CAD

- Manual drafting requires physical tools like pencils, scales, compasses, and erasers. CAD uses digital tools to draw precise lines, circles, curves, and shapes.
- Manual scaling and alignment require careful measurement, whereas CAD offers grid snapping, coordinates, object snaps, and angle tracking for accuracy.
- Revisions in manual drawings require erasing and redrawing. In CAD, modifications can be made instantly using editing tools.
- CAD allows copying components between drawings, creating libraries, and maintaining standards easily.

Important Considerations for Efficient CAD Use

To use CAD effectively, organizations must focus on:

1. High-end software like AutoCAD, ProgeCAD, and MicroStation, which can be expensive for individuals. Free alternatives such as QCAD, LibreCAD, and OpenSCAD can be used when needed.

2. CAD operators must frequently update their skills as new software versions are released.

3. Proper use of layers, blocks, and standards is essential. Poor organization makes it difficult for others to update or modify the drawing later.

3D Model

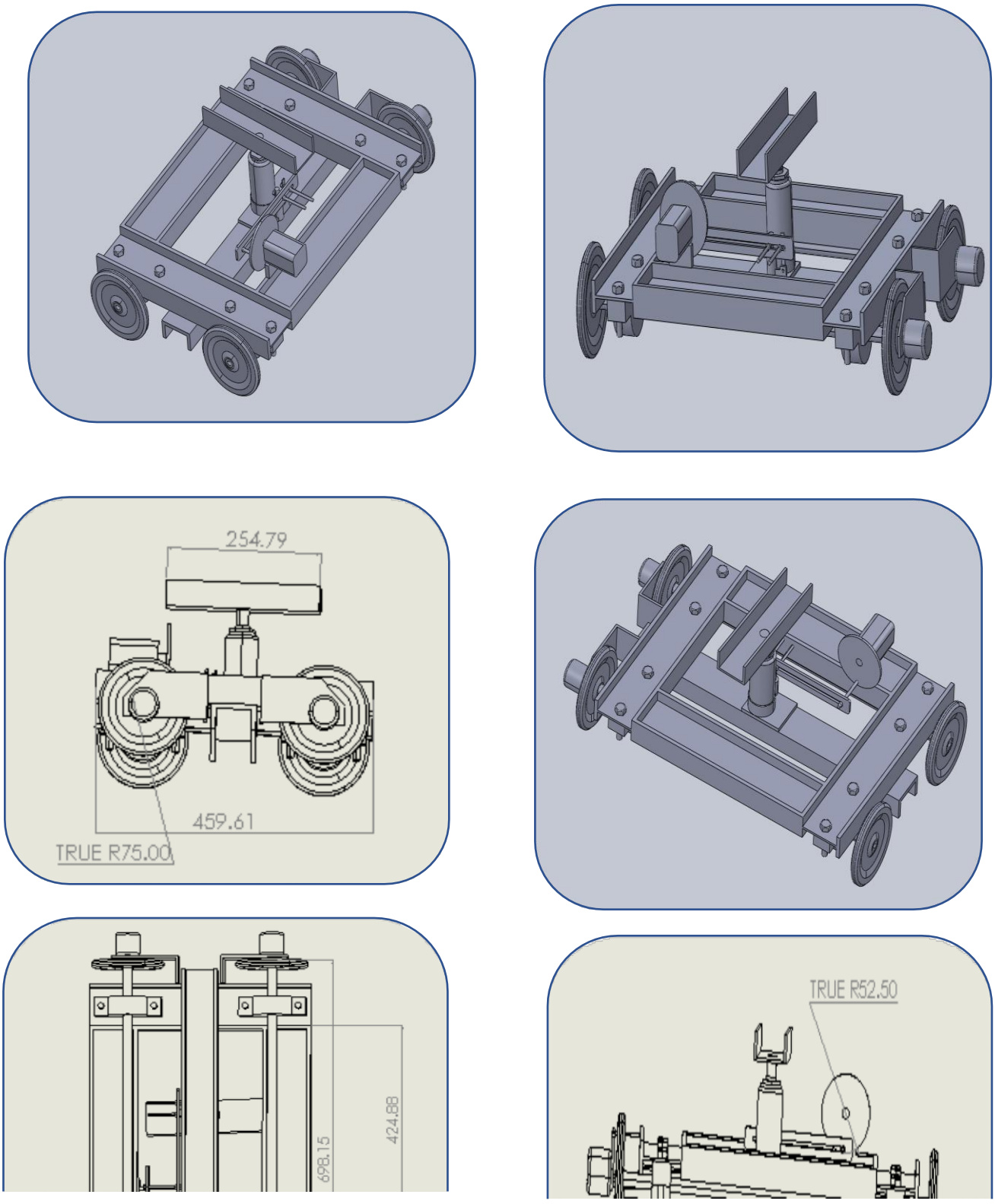

Fig. 1. *CAD Model of the Emergency Car Towing System Developed Using CATIA V5 R20*

Conclusion

In this first-semester project, we successfully designed and developed a conceptual model of an Emergency Car Towing System using CATIA V5 R20 software. The design process included detailed study of the mechanical layout, component selection, and integration of various subsystems required for safe and efficient towing operations. All design calculations—such as load analysis, torque requirements, hydraulic pressure estimation, and motor selection—were performed systematically to ensure that the proposed system satisfies the functional, operational, and safety requirements.

Through the analysis, appropriate materials were selected based on strength, durability, and cost considerations. The use of engineering tools enabled accurate modeling of each component, ensuring proper fit, alignment, and compatibility within the overall assembly. This project also helped in understanding the practical application of engineering concepts such as Pascal's law, frictional forces, power transmission, hydraulic lifting mechanisms, and kinematic motion.

Furthermore, the project enhanced our technical skills in CAD modeling, problem-solving, and engineering decision-making. It demonstrated the importance of combining theoretical knowledge with practical design methods to develop a functional mechanical system.

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