IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 12, Issue 3, March 2024

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.379

International Journal of Innovative Research in Computer and Communication Engineering

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 3, March 2024 ||

| DOI: 10.15680/IJIRCCE.2024.1203117 |

Semi Automatic Forklift

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ABSTRACT: The study proposes the design and fabrication of a remote controlled mini forklifter, which utilizes a pulley-based mechanism for weight lifting and placement. According to the control system disclosed by the invention, switching is carried out manually by manual work after cargos are loaded and unloaded by the manual work under the manual control state of the forklift, the forklift enters an automatic operation mode, the forklift automatically runs to a destination or each site according to the ground guide medium, and automatically stops after arriving at the destination or the site, the forklift turns to the manual control state, and at the moment, the cargos are loaded or unloaded by manual work.

I. INTRODUCTION

1.1 GENERAL

In general the forklift can be defined as a tool capable of lifting hundreds of kilograms. A forklift is a vehicle similar to a small truck that has two metal forks on the front used to lift the load. The forklift operator drives the forklift forward until the forks push under the cargo, and can then lift the cargo several feet in the air by operating the forks. The forks also known as blades or tines, are usually made out of steel and can lift up to a few tons. Forklifts are either powered by gasoline, or electricity. Electric forklifts relay on batteries to operate. Gasoline or propane forklifts are sometimes stronger or faster than electric forklifts, but they are more difficult to maintain, and fuel can be costly. Electric forklifts are great for warehouse use because they do not give off noxious fumes like gas powered machines do. Forklifts are most often used in warehouses, but some are meant to be used outdoors. The vast majority of rough terrain forklifts operate on gasoline, but some use diesel or natural gas. Well- maintained and safely operated forklifts make lifting and transporting cargo infinitely easier. This is the general description of a normal forklift.

1.2 OBJECTIVE

A semi-automatic forklift's goal is to improve productivity, safety, and efficiency in material handling activities by fusing the advantages of manual operation with a small amount of automation. Enhanced Efficiency by automating time-consuming or repetitive processes, such lifting and moving items inside a warehouse or industrial plant, semi-automatic forklifts seek to improve efficiency

1.3 EXISTING SYSTEM

The existing systems of a semi-automatic forklift typically include a combination of hardware and software components that work together to enable automated or semi-automated operation.
Semi-automatic forklifts often utilize navigation systems to move within the facility autonomously or semi-autonomously. These navigation systems can include technologies such as laser guidance, inertial navigation, vision-based navigation, or magnetic tape guidance. They allow the forklift to navigate predefined routes, avoid obstacles, and reach specified destination safety.

1.4 LITERATURE SURVEY

existing research on automation integration in semi- automatic forklifts, covering topics such as technology utilization, safety protocols, efficiency enhancement, and human-machine interaction. It examines case studies to understand real-world applications and challenges faced in deploying semi-automatic systems. Additionally, it explores future trends like AI integration and predictive maintenance, identifying avenues for further research and development. The survey aims to provide a comprehensive understanding of current practices and potential advancements in the field of automated forklift technology. The article discusses the importance and relevance of semi-automatic forklifts in material handling operations, their historical development, and automation principles in the logistics industry. It covers

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features such as AGVs, collision avoidance systems, load sensing, fork positioning, and height adjustment.

1.5 PROPOSED SYSTEM

Semi-automatic forklifts integrate automation features to assist operators in tasks, requiring human intervention for critical functions. These include collision avoidance systems using Human-machine collaboration is enhanced through intuitive HMIs and control systems, allowing for better communication between the operator and the semi- automatic forklift. These advancements help for safer and more efficient operations.

1.5.1 ADVANTAGES OF THE PROPOSED SYSTEM

The advantages of semi-automatic forklifts lie in their pivotal role within material handling operations, offering increased efficiency and safety. By leveraging automation principles like AGVs and collision avoidance systems, these forklifts optimize workflow and minimize the risk of accidents. Features such as load sensing, fork positioning, and height adjustment further enhance their versatility and effectiveness in various operational scenarios. Overall, semi-automatic forklifts contribute to streamlined logistics processes, improved productivity, and a safer working environment, making them indispensable assets in modern warehouses and distribution centers.

1.6 FORKLIFT SAFETY

Load characteristics and surface conditions can affect forklift performance- Overloading or unevenly distributing a load can strain the forklift and potentially lead to stability issues- Slippery or uneven surfaces may require adjustments in operation.

1.7 CONTROLS AND CAPABALITIES

Forklifts have hydraulics controlled by levers or electrically controlled actuators. They come in various variations and load capacities, ranging from one to 50 tons. Operators can tilt the mast to compensate for load angles and operate on non-level ground. Skilled operators compete in regional forklift rodeos.

II. PROJECT DESCRIPTION

2.1 GENERAL: PROJECT OVERVIEW

Some semi-automatic forklifts are designed with energy- efficient features, such as regenerative braking systems or battery optimization algorithms, to minimize their environmental footprint. Reducing energy consumption and emissions contributes to sustainability goals and may also result in cost savings over time.

2.2 WORKING PRINCIPLES

A semi-automatic forklift operates on a combination of manual control by an operator and automated assistance for certain tasks. The working principle of a semi-automatic forklift involves various components and systems working together to enhance the efficiency and safety of material handling operations.

- Operator Control
- Steering
- Lifting Mechanism
- Load Sensing

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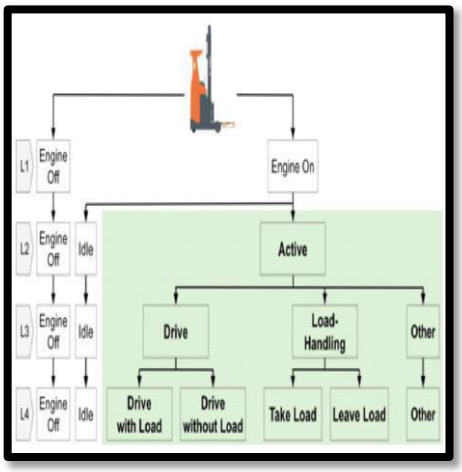

2.3 OBJECT DETECTION

Object detection is a key technology behind advanced driver assistance systems (ADAS) that enable cars to detect driving lanes or perform pedestrian detection to improve road safety. Object detection is also useful in applications such as video surveillance or image retrieval systems. Object detection is a computer vision technique for locating instances of objects in images or videos. Object detection algorithms typically leverage machine learning or deep learning to produce meaningful results. When humans look at images or video, we can recognize and locate objects of interest within a matter of moments. The goal of object detection is to replicate this intelligence using a computer.

2.3.1 EDGE DETECTION

Canny edge detection is a technique to extract useful structural information from different vision objects and dramatically reduce the amount of data to be processed. It has been widely applied in various computer vision systems.

2.3.2 LANE LINE DETECTION

The common objective of any model designed for lane line detection and/or lane line exit point notification is to determine the trajectory of the road lane with accuracy, efficiency and in real time. The sensor used in line detection is LiDar. In addition to cameras, light detection and ranging (LiDAR) systems and radars have also been proposed as sensors for lane recognition [9,10,11,12,13]. The method using LiDAR uses the difference in intensity of the received signal reflected from the asphalt and the lane of the road.

2.3.3 JOY STICK SETUP DESIGN

measure their reflection to detect nearby objects. Laser rangefinders use laser beams to measure distances accurately, enabling precise object detection. Infrared sensors detect objects based on their heat signature, making them suitable for detecting living beings or hot objects. Vision systems utilize cameras and image processing algorithms to identify objects visually. Proximity sensors detect the presence of objects by measuring changes in electromagnetic fields or capacitance. These sensors work together to provide comprehensive object detection capabilities, ensuring safe and efficient operation of semi-automatic forklifts in diverse environments.

III. REQUIREMENT ENGINEERING

3.1 GENERAL

These are the requirements for doing the project. Without using thesetools and software we can't do the project. So we have two requirements todo the project. They are:

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1. Hardware Requirements.
2. Software Requirements.

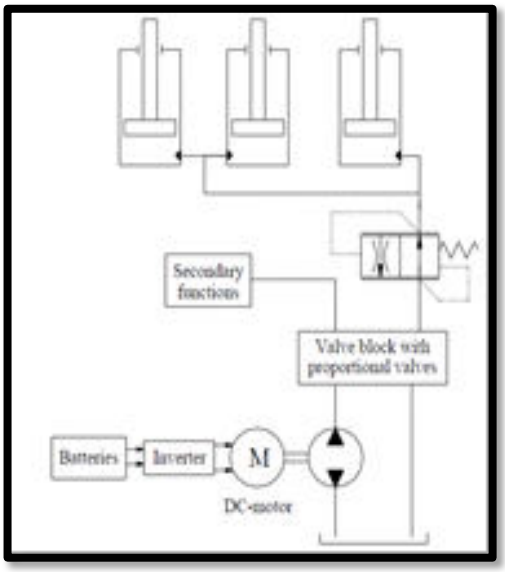
3.2 HARDWARE REQUIREMENTS

The hardware requirements for integrating automation features into semi-automatic forklifts will vary depending on the specific functionalities and technologies being implemented.

3.2.1 SENSORS

Sensors used for object detection in semi-automatic forklifts include ultrasonic sensors, laser rangefinders, infrared sensors, vision systems, and proximity sensors. Ultrasonic sensors emit high-frequency sound waves and

3.2.2 CONTROL UNITS



Control units in semi-automatic forklifts manage and coordinate various functions, ensuring smooth and efficient operation. These units typically include a central processing unit (CPU) responsible for executing control algorithms and coordinating sensor inputs. Additionally, they may incorporate motor controllers to regulate the speed and direction of propulsion motors, as well as servo controllers for precise control of lifting and positioning mechanisms. Control units integrate sensor data and user inputs to make real-time decisions, facilitating autonomous navigation, obstacle avoidance, and load handling. By providing intelligent control and coordination, these units optimize performance and safety in material handling operations.

3.3 SOFTWARE REQUIREMENTS

The software requirements for integrating automation features into semi-automatic forklifts are diverse and cover various aspects of development, testing, and deployment.

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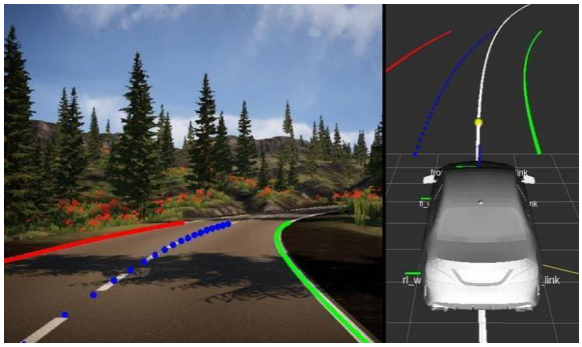
3.3.1 ROAD LANE DETECTION

Road lane line detection is a computer vision technique used in autonomous vehicles and driver assistance systems to identify and track lane markings on road surfaces. It typically involves processing images captured by onboard cameras to detect lane boundaries, including solid and dashed lines. Advanced algorithms analyze pixel intensity, color, and edge gradients to identify lane markings accurately. Lane line detection enables vehicles to maintain lane position, navigate curves, and assist drivers in staying within designated lanes, enhancing safety and driving efficiency.



3.3.2 CANNY EDGE DETECTION

Canny edge detection is a technique to extract useful structural information from different vision objects and dramatically reduce the amount of data to be processed. It has been widely applied in various computer vision systems.

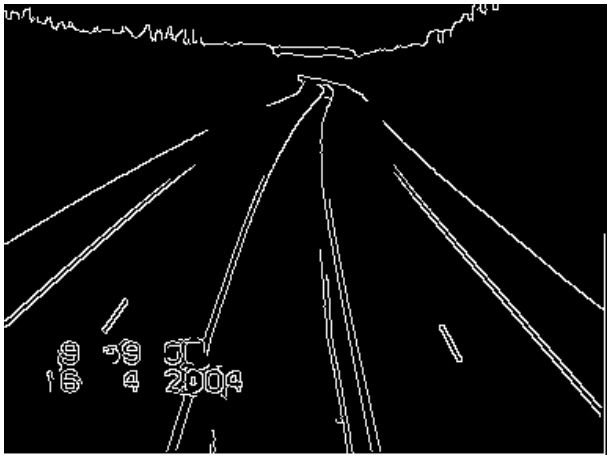
IV. SYSTEM DESIGN

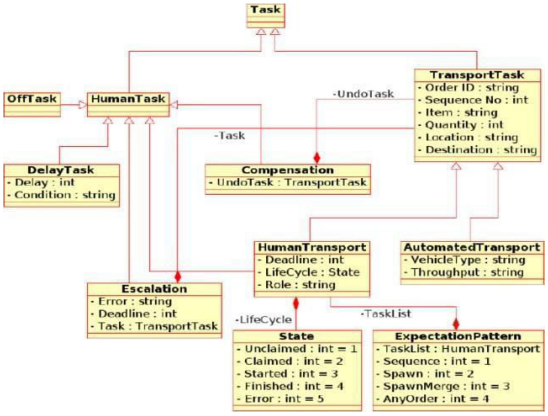
4.1 GENERAL

Design Engineering deals with the various UML (Unified Modeling language) diagrams for the implementation of projects. Design is a meaningful engineering representation of a thing that is to be built.

4.1.1 Class Diagram

A class diagram is a type of UML diagram that describes the structureof a system by showing the classes, their attributes, methods, andrelationships between them.





4.1.2 Use case Diagram

A use case diagram is a visual representation of how actors (users orexternal systems) interact with a system or software application to achieve certain goals or tasks.

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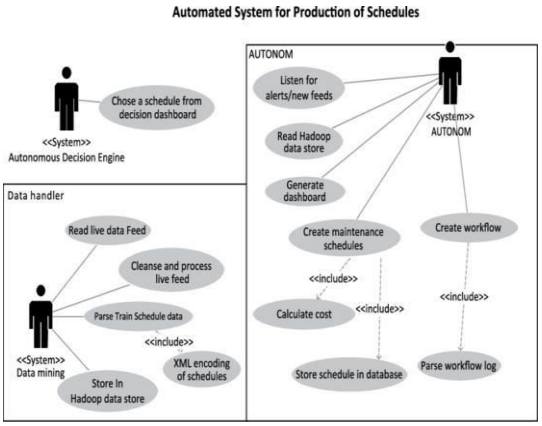
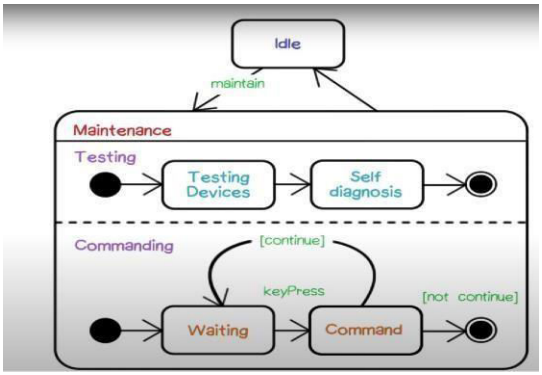


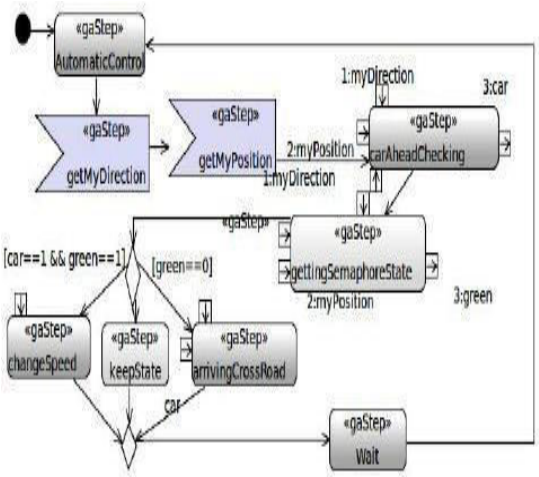
4.1.3 State Diagram

A state machine diagram is a type of UML diagram that represents the behavior of an object or a system over time. It consists of a set of states, transitions between the states, and actions or events that cause the transitions to occur.



4.1.4 Activity Diagram

An activity diagram is a type of diagram used in software engineeringto describe the flow of activities in a system or process. It is a graphical representation of a process that shows the steps involved as well as the sequence of these steps.



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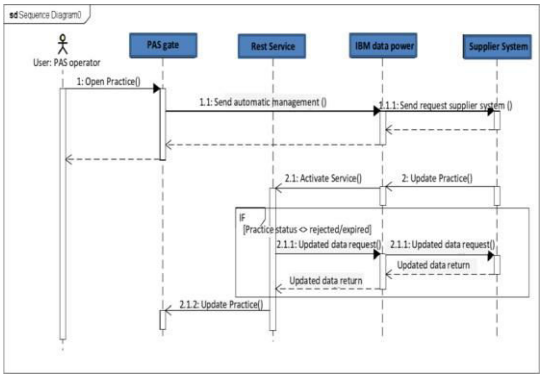
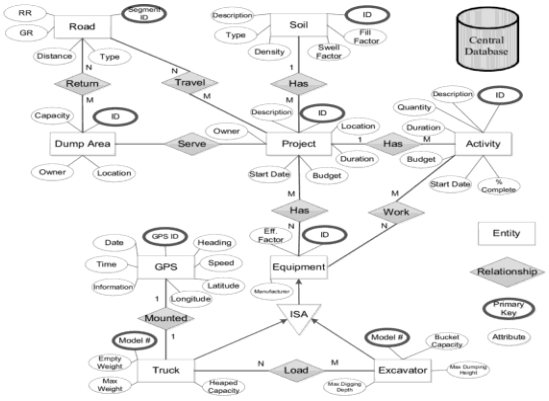
4.1.5 Sequence Diagram

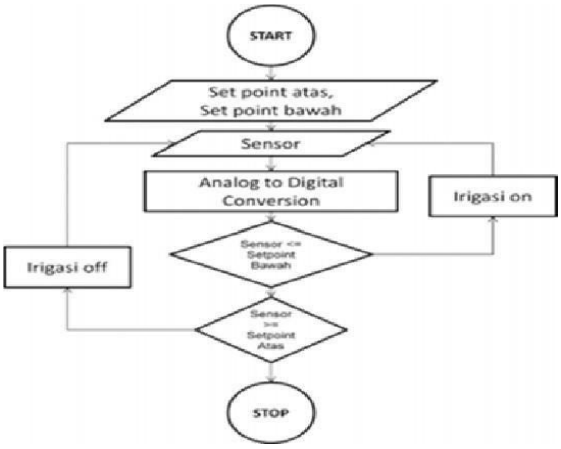
A sequence diagram is a type of diagram used in software engineeringto illustrate the interactions between objects or components in a system or process. It shows the sequence of messages exchanged between objects or components in a system and the order in which they occur.



4.1.6 Data Flow Diagram

A data flow diagram (DFD) is a type of diagram used in software engineering to illustrate the flow of data in a system or process. It shows howdata is input, processed, and output within a system or process





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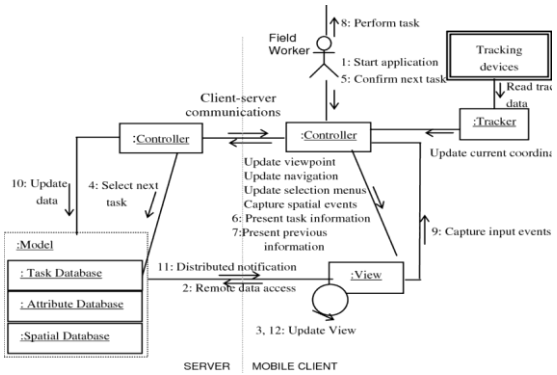
4.1.7 Collaboration Diagram

Collaboration diagrams can be used to show the flow of messages and the sequence of interactions between objects in a system. They are particularly useful for modeling systems that involve multiple objects that collaborate to achieve a common goal.



4.1.8 ER Diagram

An entity-relationship (ER) diagram is a type of data modeling diagram that depicts the relationships between entities in a database.
It represents the logical structure of a database and helps to visualize the relationships between entities.

V. DEVELOPMENT TOOLS

5.1 GENERAL

In a project involving the integration of automation features into semi-automatic forklifts, a variety of development tools can be utilized across different stages of the project lifecycle. These tools aid in software development, hardware integration, simulation, testing, and project management.

5.1.1 Integration of automation

Development tools for a project involving the integration of automation principles into semi-automatic forklifts encompass a range of software and hardware resources. Software development tools include integrated development environments (IDEs) such as Visual Studio Code, PyCharm, or Eclipse for coding and debugging control algorithms and software modules. Hardware development tools comprise microcontroller platforms such as Arduino or Raspberry Pi for prototyping and testing embedded systems. Version control systems like Git enable collaboration and tracking of software revisions.

5.1.2 Design tools

Design tools for a project involving the integration of automation principles into semi-automatic forklifts encompass various software and hardware resources. for designing mechanical components, including the forklift chassis, lifting mechanisms, and sensor mounts.

Electrical design software like Altium Designer or Eagle PCB assists in designing electronic circuits and printed circuit boards (PCBs) for sensor interfaces, motor controllers, and control units. Multiphysics enable engineers to simulate and analyze the structural integrity, thermal performance, and electromagnetic interference of mechanical and electrical components. Additionally, system modeling tools like Simulink or Modelica aid in developing mathematical models and simulating the dynamic behavior of the semi-automatic forklift system. Integration with PLM (Product Lifecycle Management) software facilitates collaboration, version control, and documentation management throughout the design process. Prototyping tools such as 3D printers and CNC machines enable rapid iteration and testing of mechanical components. Human-machine interface (HMI) design software like Qt or Adobe XD is used to design intuitive user interfaces for operator control panels and display systems. By leveraging these design tools, engineers can efficiently conceptualize, prototype, and refine the design of semi- automatic forklift systems, ensuring optimal performance, safety, and reliability.

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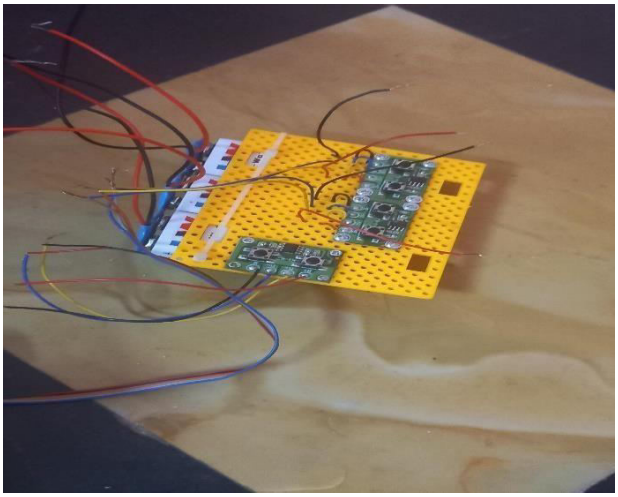
VI. RESULTS AND DISCUSSION

6.1 GENERAL

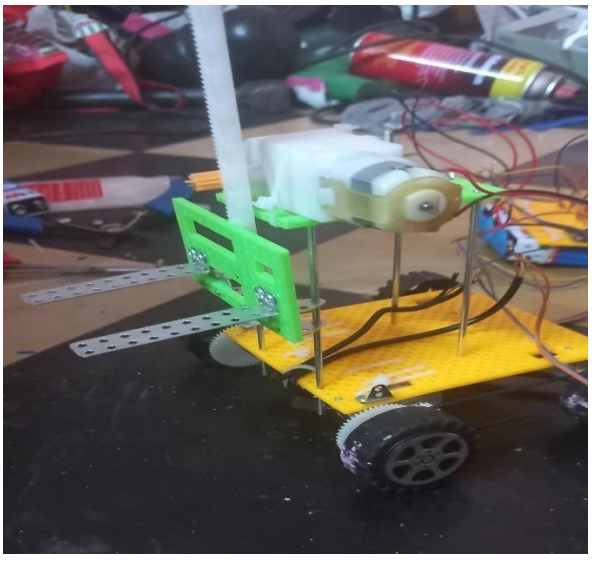
The project's achievement of objectives in integrating automation into semi-automatic forklifts is summarized. Detailed performance metrics, including efficiency improvements and safety enhancements, are presented. Functional testing outcomes validate the system's components, while safety evaluations highlight effectiveness. User feedback offers insights into operational experiences, and comparative analysis identifies strengths and areas for improvement. Limitations and challenges are acknowledged, along with suggestions for future research and development.

6.2 PROCEDURES AND SCREENSHOTS

Automated forklift trucks are programmed to track, monitor, and mimic the actions of human workers. They learn where to move and what to do next, just as if they were being operated by humans. They can move, lift, and
stack items and do similar tasks the same as if they were being driven by humans. Automated forklifts sense every detail of the area around them. This includes the presence of human coworkers. They can predict the movements that are needed for certain jobs. They'll also come up with the fastest and safest route to avoid obstacles while moving around the warehouse.



Although most self-driving forklifts can also be operated manually, each is continually updated with data gathered over time. This enables them to safely perform tasks without a human operator. The result is fewer accidents and damages to workplace property and equipment. There's also an increase in productivity and less chance of injuring an employee.



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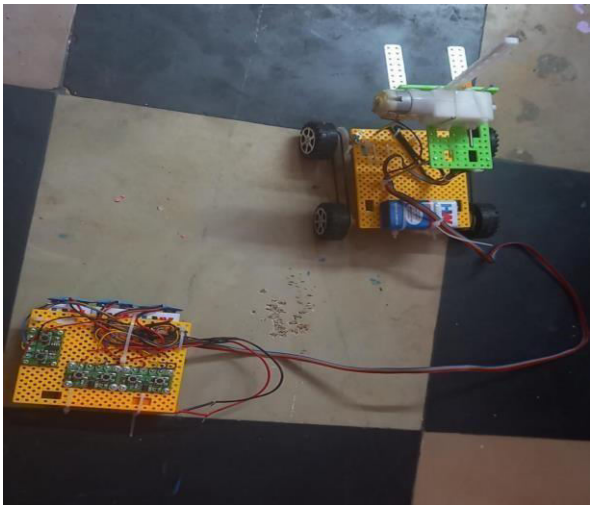

We can update the status of the product delivery, including the time and location of delivery. They can also view the products they are responsible for delivering and the products that have been delivered.
Self-driving forklifts will reduce the number of warehouse workers needed to operate regular forklifts. The result is a huge savings in payroll and payroll taxes, employee benefits, and workman's comp insurance. Human workers will, however, still be needed to carry out tasks such as wrapping and packaging certain products by hand before they're ready to be stored or shipped.

VII. TESTING

7.1 GENERAL

The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a work product. It provides a way to check the functionality of components, sub assemblies, assemblies and/or a finished product. It is the process of exercising software with the intent of ensuring that the Software system meets its requirements and user expectations and does not fail in an unacceptable manner.

7.2 SOFTWARE TESTING

Software testing is the process of evaluating software applications or systems to find defects, bugs, or errors that could affect its functionality, performance, or usability. There are several types of software testing that can be conducted, depending on the software's complexity, intended use, and the testing objectives.
Here are some of the most common types of software testing:

1. **Unit Testing**: This type of testing focuses on testing individual units or components of software code. It is usually conducted by developers and involves writing and executing test cases for each unit or component to ensure that it works as intended.
2. **Integration Testing**: Integration testing is the process of testing how different units or components of the software code work together when integrated. It is done to ensure that the software system functions as a whole and that all the components work together without any issues.
3. **System Testing**: System testing is the process of testing the entire software system, including its hardware and software components. It is done to ensure that the software system meets the requirements and specifications set by the stakeholders.
4. **Acceptance Testing**: Acceptance testing is the final stage of testing before the software is released to the end-users. It involves testing the software's usability, functionality, and performance to ensure that it meets the user's expectations and requirements.
5. **Regression Testing:** Regression testing is the process of testing the software after making any changes or updates to it. It is done to ensure that the changes or updates do not affect the existing functionality of the software and that the software continues to work as intended.
6. **Performance Testing:** Performance testing is the process of testing the software's performance under different load conditions to ensure that it can handle the expected number of users and data volume.

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7. **Security Testing:** Security testing is the process of testing the software security features to identify any vulnerabilities or weaknesses that could be exploited by hackers or unauthorized users.

These are just a few examples of the different types of software testing that can be conducted. Each type of testing has its own set of objectives, methods, and tools, and the appropriate type of testing should be selected based on the software's requirements and objectives.

VIII. CONCLUSION AND FUTURE ENHANCEMENTS

8.1 CONCLUSION

Automation principles in semi-automatic forklifts can enhance efficiency and safety, but do not replace the need for trained operators. These innovations contribute to a more efficient, safer, and sustainable material handling ecosystem. The literature review summarizes key findings, suggests areas for further research, and highlights the growing interest in automation technologies in the logistics industry. The introduction provides an overview and scope of the literature review.

The semi-automatic forklifts represent a significant advancement in the domain of material handling within industrial environments. These principles leverage technologies such as sensors, actuators, and control systems to streamline operations, improve efficiency, and enhance safety. However, it's crucial to recognize that while automation can greatly augment efficiency and safety, it does not obviate the need for trained human operators. This symbiotic relationship between automation technology and human expertise is pivotal in ensuring optimal performance and safety in material handling tasks.

8.2 FUTURE TRENDS AND INNOVATIONS

Exploring the future trends and technological innovations in semi- automatic forklift systems can provide valuable insights into potential advancements and opportunities for further enhancing efficiency and safety. There are several potential future enhancements that can further improve efficiency, safety, and functionality. Enhanced sensor technology will enable more precise object detection and collision avoidance capabilities, while IoT integration will facilitate real-time data monitoring and remote diagnostics. Development of more compact and energy-efficient components will further optimize system performance and sustainability. Additionally, the adoption of 5G and edge computing will enhance connectivity and enable faster data processing for improved responsiveness. Human-robot collaboration will continue to evolve, with the emphasis on intuitive interfaces and safe interaction to augment operator capabilities while ensuring safety. Integration with advanced warehouse management systems and cloud-based platforms will enable seamless integration into smart logistics networks. Overall, future innovations aim to enhance efficiency, safety, and adaptability, positioning semi-automatic forklifts as indispensable assets in modern material handling operations.

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| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | Monthly Peer Reviewed & Referred Journal |

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