WIRELESS, VOICE CONTROLLED, AUTOMATED 2 WHEELDRIVE FORKLIFT FOR INDUSTRIAL WAREHOUSES

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Abstract*—One of the most exciting advances in the fast-expanding field of forklift automation is the incorporation of automation technologies into 2-wheel drive forklifts. Forklift automation technology has greatly enhanced material handling and warehouse operations, boosting output, security, and effectiveness. By lowering labor expenses, lowering the chance of accidents, and making the best use of available space, this technology has the potential to completely transform the industrial sector. By utilizing cutting-edge technologies like artificial intelligence, IOT, automation and robotics, 2-wheel drive forklifts can be automated so that they can run automatically. With the help of these technologies, forklifts can move and stack pallets, load, and unload freight, and move objects from one location to another. Forklifts that have automation technology integrated into them perform better overall, pay less for labor, and are safer. To create a user-friendly interface for operating the forklift, this work focuses on merging cutting-edge wireless communication technologies, mobile computing, and voice recognition algorithms. As the principal control interface, a specially developed mobile application enables users to operate the forklift by sending commands through their smart phones. To facilitate hands-free operation, voice recognition capabilities are also included. The initiative paves the path for upcoming advancements in the realm of voice- and mobile-controlled industrial automation systems.

***Keywords*— Forklift, Automation, Wireless Control, Voice Recognition, Innovation.**

I. INTRODUCTION

In order to increase productivity and enable more adaptable products, advanced manufacturing adds intelligent behaviors into smart factories [1]. Modern warehouses can be broadly divided into two types: fully automated lights-out warehouses and traditional warehouses that depend on human labor [2]. Despite the potential for extremely efficient fully automated warehouses, retrofitting an existing warehouse is expensive and disruptive. Furthermore, performing some tasks by humans might be more economical or effective. Partial autonomy might be a desirable alternative for typical warehouse operations in terms of boosting productivity and reducing costs. They are called "Forklifts" because of the two metal plates that protrude from the front of them. A powered industrial truck called a forklift, sometimes known as a lift truck or forklift truck, is used to lift and transport goods over short range [3]. Early in the 20th century, several businesses, including Clark, a manufacturer of transmissions, created forklifts; since then, forklift use and development have significantly increased globally. Forklifts are now a necessary piece of machinery for both manufacturing and warehousing [4][5][6]. In addition to being known as a raise truck, fork truck hoist, or vehicle truck, a wheeled vehicle is also a high-powered industrial truck that wants to speed up and carry cargo over small distances [7]. Various companies, like Clark, which invented the gearbox, and Yale & Towne Manufacturing, which invented the hoist, developed wheeled vehicles throughout the first two decades of the twentieth century. Automation of processes offers competitive benefits in modern industry in terms of speed, efficiency, and output value [8][9]. Whereas the environmental effects connected to it are typically undetectable. Many times, especially in small and medium-sized businesses, there is a lack of knowledge about the need to pay the environmental fees incurred using internal transportation, which suggests that this also applies to off-road vehicles like wheeled vehicles, excavators, or loaders [10]. Typically, the wheeled vehicle is advertised as a device capable of lifting several kilograms of weight. A vehicle with wheels can be a truck-like vehicle with two metal forks used to carry cargo on the front. The wheeled vehicle operator moves the wheeled vehicle forward until the forks push the cargo to a lower position.

The term "automation process" has a wide range of definitions today. Only terminology that is generally acknowledged in the field of automation are used in the work because this study is specifically focused on the logistics sector [11]. Only terminology that is generally acknowledged in the field of automation are used in the work because this study is specifically focused on the logistics sector [12]. The definition of automation that is presented in the chapter on key terminology is one that is frequently used in today's logistics industry [13][14]. As can be seen, automation includes both independently operating processes and systems as well as machines that can move themselves. To put it another way, human labor is replaceable. A few design goals were considered when creating the forklift. First off, it's crucial that the vehicle platform allows for research that will eventually be commercially feasible in a real warehouse setting because the work is targeted at an industrial market segment and supported by a corporation that is extensively involved in warehouse logistics.

There must be a market incentive for any autonomy solution to be embraced in the commercial sector. Additionally, a variety of researchers with various levels of hardware expertise used the vehicle platform [15]. As a result, the hardware and platform need to be trustworthy, durable, and safe. Additionally, it is necessary to work alongside and near people in partially automated warehouses. The vehicle must therefore enable safe operation around people. The forklifts are frequently used to move bulky goods and supplies quickly and with minimal effort from one location to the next. Forklifts are small, simplified equipment designed to operate in confined spaces. Interestingly, depending on your needs, you can choose a forklift with the right design and capacity. The forklifts' ability to reach objects located in high places is one of their advantages. Without these machines, the stockrooms would not be able to function effectively and without difficulty [16]. The forklift tips forward, pivoting on the front axle or fulcrum, and the truck and load system's combined Centre of gravity changes forward outside the stability triangle because of the load's moment being greater than the vehicle's moment. This research will show how the forklift is driven by voice commands and operated by the mobile application.

This work presents a wireless, voice controlled two-wheel forklift for industrial operations with the purpose of reducing dangers to human lives, working in industry. The proposed smart model can not only perform pick and place operations for industrial warehouses but can also track its way on its own in a smart fashion. In addition to that it has the additional feature of a remote control with the mobile application which provides it more flexibility in terms of control.

II. EXPERIMENTAL SETUP

Figure 1 presents the proposed hardware model of the two-wheel forklift. The forklift automation system is composed of two batteries connected with 24 volts DC motors and actuator motor. The whole system is being controlled via an Arduino Nano, which is a compact, inexpensive microcontroller board that is frequently used in do-it-yourself electronics work. A variety of input/output (I/O) pins on the board can be used to connect and control various electrical components, like motors and sensors. The Arduino Nano used in this work offers a flexible and adaptable framework for managing the forklift's electronic systems. IBT2 BTS module has been used to direct and regulate the speed of the motors on this forklift. Using inputs from the Arduino Nano, the module offers a quick and effective method of controlling the motors. For wireless control of the forklift, HC06 Bluetooth module has been used, which enables communication between the forklift and a remote control or other control system. It is a low-cost wireless communication module which enables wireless forklift operation, enhancing ease and security.

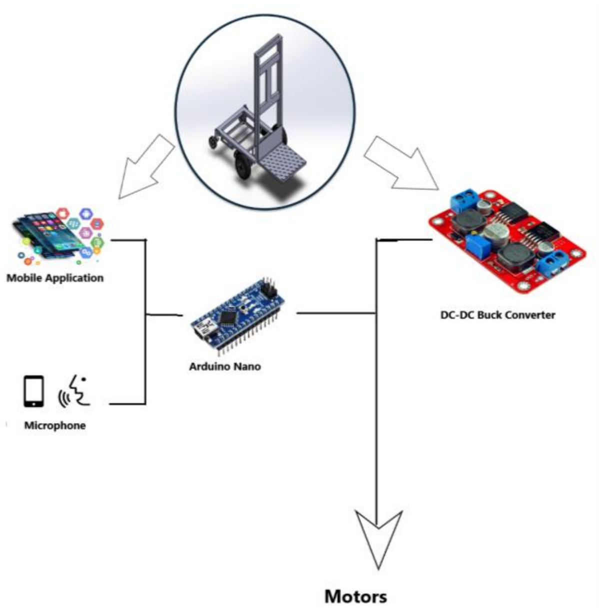

Figure 1: The proposed automation system for the proposed two-wheel forklift.

In this work, the greater voltage of the lead-acid battery (often 12V) is converted to the lower voltage required to power the electronics (generally 5V or 3.3V) using a DC-DC buck converter. The buck converter's output voltage is intended to be reliable and effective even when the battery's input voltage varies because of changes in the load or other variables. The module is designed to handle high currents and voltages, making it suitable for driving high-power motors. By using the BTS7960 dual MOSFET in a motor control circuit, you can achieve precise and efficient control over the motor's speed and direction.

III. HARDWARE AND SOFTWARE REQUIREMENTS

The hardware model in this study consists of 18-gauge steel structure in which DC motors and actuator motors are attached with circuit box (Arduino Nano, Bluetooth module, IBT2 BTS, DC-DC buck converter, Heat sinks, Relays). On the other hand, the software part mainly covers the simulation of proposed model along with the app development and Arduino coding for the automation system. Complete hardware model with block diagram has been provided in figure 2. The hardware model has been designed in such a way that it is able to move, pick and place the industrial loads precisely. The top figure in figure 2 presents the solid edge model of the proposed forklift. The model is designed in solid edge in such way that it could move steadily and could perform "pick and place" operation in a smoothed way.

A. *Hardware Requirement:*

The following hardware components have been used in this research.

- 18 Gauge Steel
- DC motors
- Actuator motor
- DC-DC Buck converter
- Arduino Nano
- HC-06 Bluetooth module
- BTS7960 dual MOSFET
- IBT2 BTS module
- Auto Relays

The bottom figure in figure 2 presents the control model of the forklift.

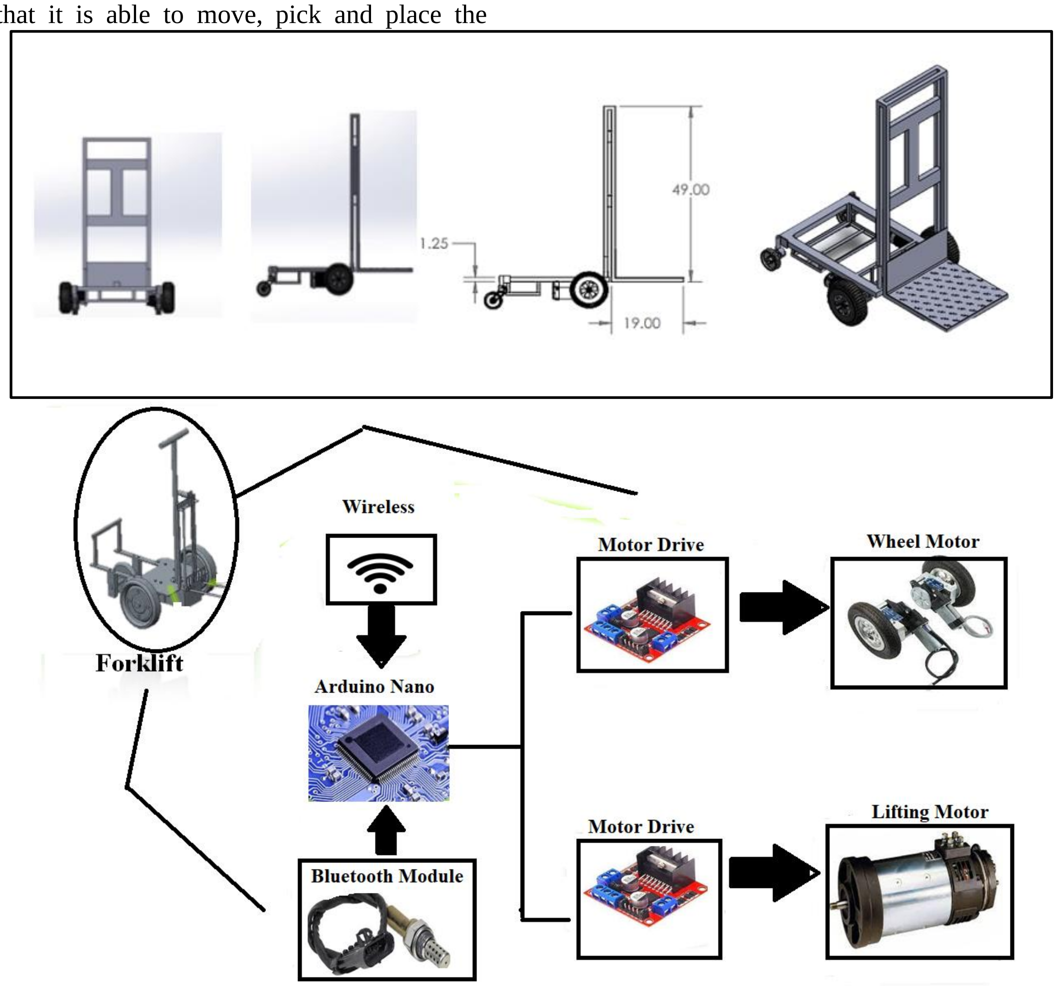

Figure 2: The figure presents (top) the hardware model of the proposed system as developed in Solid Edge. (bottom) the block diagram of hardware and control flow of the proposed system.

It is apparent from the figure that the hardware structure is composed of “lifting and wheel motors” controlled via a central controller. Secondly, the circuit box and the whole system is being controlled remotely by using Bluetooth module. The wireless control is being made user-friendly by developing mobile applications for the control of devices. The mobile application has been developed with a voice recognition feature which senses the voice commands and issues instructions to the hardware model accordingly. In this work, we have used five various voice commands “forward, reverse, left, right and stop” for the control of forklift. The main feature of the mobile app is voice recognition with the help of Arduino programming. Figure 3 presents both the final hardware model of the proposed system and mobile application developed in Arduino. The mobile application for the control of forklift is explained through various interface screens of the mobile application in figure 3. The control features such as “steering” “moto speed” and “voice control” can be controlled through this developed application effectively.

Figure 3: (Top)The real-time images of the developed Industrial forklift. (bottom) The interface of the mobile application developed in Arduino for control purposes.

Th proposed system has been designed for 25 kg and all the related calculations for design have been chosen according to this limit. The velocity has been set at 2.2 m/s and the radius of tyre is 7.5’’. Thus, circumference of tyres will be 47 inches and thus the motor desired speed is 120 rpm. To attain this speed level, the motors of 3600 rpm have been implemented with gear ratio of 1:30.

B. Software Requirement

In this work, we employed Proteus and MATLAB software for the simulation of the proposed system. Simulation plays a crucial role in validating the proposed model in a virtual environment before real-world implementation. Figure 4 presents the proteus simulation of the overall system. Proteus, a comprehensive simulation, and design software, was utilized for simulating the electronic circuitry and microcontroller-based systems of the proposed system. We designed the electronic circuitry of this model using Proteus' schematic capture feature, leveraging the available component libraries. Parameters such as component values, initial conditions, and external inputs were defined for the simulation. Proteus' simulation engine was used to analyze the behavior of the circuit, enabling us to validate the functionality and performance. Real-time simulation capabilities in Proteus enabled us to evaluate the behavior of the system under various conditions.

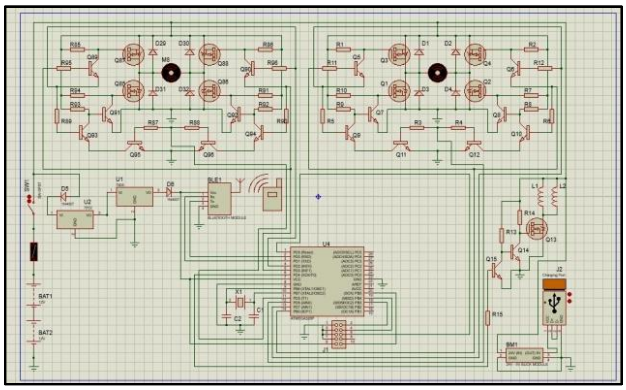

Figure 4: The simulation model of proposed system as developed in Proteus.

Figure 5 depicts the MATLAB-Simulink model of the proposed work, a powerful numerical computation and simulation tool, was employed to implement and simulate the mathematical models and algorithms used in this work. The extensive range of mathematical functions provided by MATLAB allowed for efficient computation and analysis. MATLAB scripts and functions were developed to implement the mathematical models and algorithms associated with this work. Input parameters and initial conditions were specified within the MATLAB environment. MATLAB's simulation capabilities were utilized to simulate the system's behavior and obtain numerical results. The utilization of Proteus and MATLAB software facilitated the successful simulation of the proposed model. The comprehensive features and capabilities of these tools allowed for accurate modeling, analysis, and validation of the system. The simulation results provided valuable insights and laid the foundation for the further development and implementation of this work.

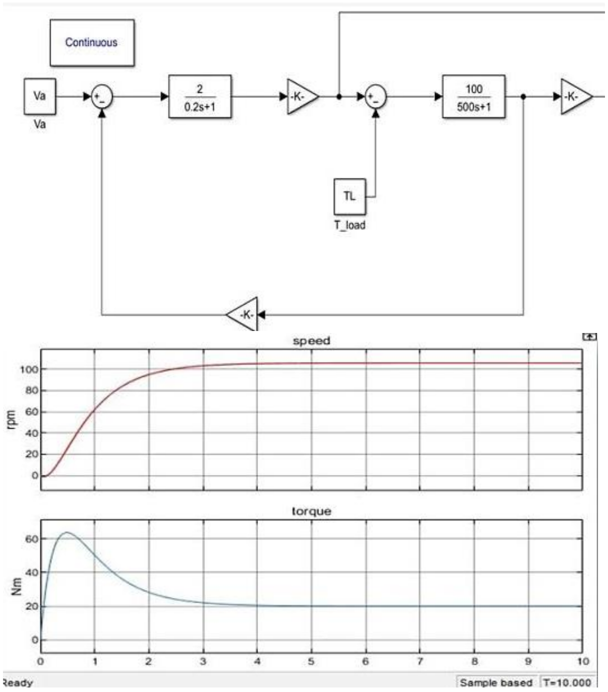

Figure 5: MATLAB-Simulink model of proposed circuit and simulation for DC motors control.

IV. CONCLUSIONS

This work presents a wireless and voice-controlled forklift, with a power of 250 watts, which can lift objects weighing 25 to 40 kilograms (extendable by modifications in design). This work is an important step towards industrial warehouse automation which will ultimately improve efficiency and human safety in industrial applications. The proposed model can be wirelessly controlled through voice commands at remote location; moreover, a mobile application has been developed as well to control the machine to make it more user friendly. In addition to that, it is a smart device and can also find the suitable path on its own in warehouses without assistance. Application areas for this work are in industrial warehousing, load transportation, inventory management, and material handling. For many industrial operations, unmanned wireless controlled systems provide an effective and trustworthy option by reducing the life risks in industrial operations. The success of this study paves the way for more [illegible] into the application of automation (Artificial Intelligence) in industry and commerce. In terms of convenience and adaptability, a wireless control system that enables remote operation of the machine is ideal. This work delivers a high level of efficiency and dependability, making it excellent for industrial applications, along with a mobile app and wireless control. The circuit design is low-cost and is made up of numerous parts, including microcontrollers, sensors, motor drivers, and communication modules. Each component is crucial to the system's proper operation, and the work's success depends on the careful selection and integration of each one. In this work, the Arduino Nano is utilized to control two H-bridge motor drivers, and several relays are used to prevent overvoltage and overcurrent. In a nutshell the development of the two-wheel wireless control forklift truck for use in industrial warehouse works is a significant accomplishment that offers an effective and dependable solution for such facilities.

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