Smart TransBot for Industries

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***Abstract*—these days, technology is evolving in tandem with the swiftly growing demands of humankind. Life is made easier every day by the efforts made to address these needs, and the focus of these studies is on robotic arms. Robotic arms can be controlled by an external operator or by following present instructions. The industrial and medical sectors now have the most advanced robot arm technology. The project's robot arm, which was designed and built, uses five servo motors to move in four different directions. You can transport the desired material from one location to another and mix it with the material it receives thanks to the holder. In the process, an Arduino Uno microcontroller-connected Bluetooth module connects to an Android application to offer robot control.**

***Index Terms*—Smart TransBot, Industrial Automation, Material Handling Robot, IoT-Based Robotics, Autonomous Mobile Robot (AMR)**

I. INTRODUCTION

People nowadays constantly require additional support systems. People are now guided to look for alternative markets and have entered the competition to make high- quality items at a low cost due to the rapid increase in the flow of information. To do this, automation systems are also required. Because having skilled and knowledgeable workers and standardized automation systems are necessary to reduce errors and produce high-quality products. People have to employ auxiliary equipment in situations where their physical strength was insufficient due to their physical traits. With the advancement of technology, some machines that formerly required human aid to operate can now function on their own without human intervention. Robots are among the most popular parts of automation systems. Mechanical engineering, computer engineering, electrical engineering, and mechatronics engineering have all joined forces to work on robotic systems. Researchers have worked on the project to gain an understanding of the mechanics and software used in the operations performed by the robot arm, which is intended to carry out the tasks assigned in compliance with preset commands.

Initially, the purpose and range of motion of the robot arm were established. A robotic arm controlled by an Android phone or tablet may carry the material of choice, mix it up, and carry out user-specified commands. The robotic arm grabs a piece of material, moves it to the desired place, records its motions, and continues to do so until we stop it, if this project has a set task as well. Since the motor to be chosen must function exactly, the servomotor is preferred in order to be able to accomplish these activities correctly and needs to have a lot of torque. With the help of its five servo motors, the robot arm can move in four different directions.

II. LITERATURE SURVEY

Ruth Anita Shirley.D, KaviyaSree B, Kavya M, Kishore S, and Mohamed AfsalM (2021), et al. They successfully completed their proposed goal of creating a voice-based arm that can pick and arrange objects using user commands, which is extremely useful for disabled individuals due to its compact size. And the program should feature operations such as pick, place, move, and so on to allow the user to utilize it on a regular basis. A robot arm with voice recognition is created using Arduino to pick out and arrange items more appropriately while causing less damage. The robot arm utilized here has a gripper that thoroughly deals with the item while moving.

Ankur Bhargava, Anjani Kumar, and others (2017). A degree of freedom (DOF) robotic arm has been constructed. It is controlled by an Arduino Uno microcontroller, which receives input signals from the user via a set of potentiometers. The arm is made up of four rotating joints and an end effector, with a servomotor providing the rotary motion. Each link was initially developed using Solid Works Sheet Metal Working Tool Box and then produced with a 2mm thick aluminum sheet. The arm's final shape was created by assembling the servo motors and links with fasteners. The Arduino has been configured to give each servo motor the same amount of rotation as the potentiometer shaft. A 5 DOF pick-and-place robotic arm has been built. The driving mechanism, which consists of an Arduino microcontroller and a series of potentiometers, has successfully controlled the arm based on the user's inputs.

Navin Kumar Agrawal, Vinay Kumar Singh, Vinay Singh Parmar, Vijay Kumar Sharma, Dipti Singh, and Muskan Agrawal (2020). This paper describes the process of building a robotic arm using Arduino and a potentiometer to control and coordinate industrial activities. They realize that the robotic arm can move in four directions using servo motors. The movement of the servomotor, UNO, is responsible for transforming the analog signal into a digital signal, which is then received by the servo motor. This project examines technological assumptions, the consequences of robotic arms, and their use in the sphere of industrial automation. It can be used as an artificial arm for a person who has lost their hand in an accident.

Muhammad Hunain Memon, Muhammad Hammad Memon, Aakashkumar, Syeda MunazzaMarium, Jalaluddin Khan, et al. (2019). The robotic arm is a type of manipulator that is used to do the most complex jobs, which are in high demand in today's society, and its applications are diverse. It can be used for a variety of reasons, including pick and drop, as well as in environments where humans are unable to work, such as hazardous chemicals, extreme temperatures, and storms. One requires competent workers to make that robotic arm functional as required, and to make changes to its functioning, one must reprogram its parameters, which requires an expert. A robotic arm that can learn from the mimicking of a human and can be quickly taught to do certain operations as needed by an inexperienced person. They have created a prototype of a robotic arm that can work in the same way that one teaches. Furthermore, the robotic arm does not require a skilled person; the mimicry feedback will be recorded in a processing unit, such as a microcontroller (Arduino), and on a single command of play, the robotic arm will work continuously to complete that specific task.
They successfully created a prototype of a smart trainable robotic arm. The prototype system costs roughly $250. The robotic arm prototype was created using a microcontroller (Arduino UNO), and we successfully implemented the kinematics algorithm in it. This robotic arm can pick and position objects weighing up to 500 grams. The learning mode will capture data in the processing unit from the controlling unit provided by the user while also displaying the robotic arm's movements and data in the serial monitor. In play mode, the robotic arm will begin to perform continually according to the specified application

III. PROPOSED SYSTEM

The proposed system, titled *Smart TransBot*, is a microcontroller-based autonomous mobile robot designed to streamline material handling operations within industrial environments. This intelligent system aims to replace conventional manual labour with automated transport, thereby increasing operational efficiency, reducing human errors, and minimizing workplace accidents. At the core of the system is a microcontroller (such as an Arduino or Raspberry Pi), which governs the logic and controls the movement of the robot. The robot is equipped with various components including DC or servo motors for locomotion, ultrasonic sensors for obstacle detection and avoidance, and line-following or path-mapping sensors to ensure accurate navigation along predefined routes. Additionally, the system integrates wireless communication modules such as Wi-Fi, Bluetooth, or LoRa, enabling remote monitoring and control through a centralized interface. The Smart TransBot is powered by a rechargeable battery and features a stable platform capable of carrying industrial materials of varying weights. Its architecture allows both manual and autonomous operation modes, with real-time feedback and alerts enhancing its reliability. The proposed system supports intelligent task assignment, load sensing, and dynamic rerouting, making it a cost-effective and scalable solution suitable for small to medium-scale industries. By automating internal logistics, the Smart

TransBot contributes to the goals of Industry 4.0, enabling smarter, safer, and more efficient industrial processes.

IV. METHODOLOGY

This section will describe the chosen design and check that it meets all of the specified requirements. This section also discusses how to waterproof the arm, interface, and receptacle. To address manufacture, please see the following: simulations, prototype testing plans, finite element analysis, cost analysis, engineering drawings, and a manufacturing and installation plan. The Articulated Arm has a maximum stretch length of 0.7m (see Appendix J) and will be mounted on a rotating base that allows for 360 degrees of rotation. A Yaskawa SGMGV-1EA Sigma-5, a medium inertia electric DC servo, powers the spinning base. This servo is fully enclosed and rated for continuous operation (YASKAWA AMERICA, Drives and Motion Division). A suitable servo was discovered after calculating a minimum torque of 82.48 Nm to spin the entire assembly.

Servo motors are utilized in a variety of control systems, including quick operation, excessive axis movement, and condition control. Servo motors are the final control element in a machine. They are extremely sensitive, and servo motors are utilized in conjunction with electrical or programmable circuitry. These engines are classified into AC and DC. When the AC servo motors are brushless, they brush. Most servo motors have three cables. There are three cables: red for power, black for grounding, and yellow for control (data, data). Figure 3.1 shows one of the servomotors utilized in the project's production phase.

Fig 4.1 Servo motors

Arduino has recently gained a lot of popularity worldwide, despite the fact that microcontroller type PICs are often utilized in programming and software domains. It is built on earlier wiring and processing projects for Arduino. Processing is designed for users who are not programmers. The programming language is used to create Arduino wire. Both share the characteristic of offering a setting that makes it simple to develop even with only little programming and electronics understanding. These days, Arduino is becoming more and more popular. There are also unmanned aerial vehicles built with Arduino, a platform that is utilized in practically every industry.

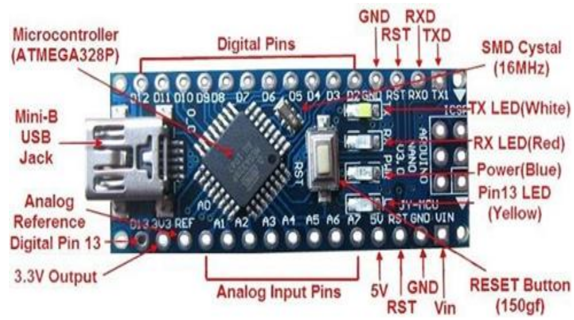

Fig 4.2 Arduino microcontroller

Operating as a slave, the HC-06 BT module employs a serial communication protocol. The connection start state determines the master and slave in Bluetooth communication. The connection can be started by a master module, but not by a slave module. As part of our project, we will supply an external device that may be connected to an Android handset or a slave PC. It is possible to send and receive bi-directional data in a healthy manner.

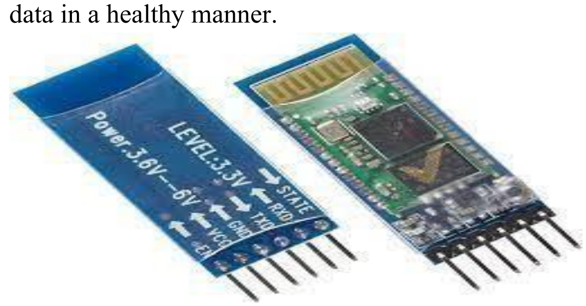

Fig 4.3 HC Bluetooth module

The HCSR04 timing diagram is displayed. Trig of SR04 must receive a high (5V) pulse for at least 10us in order to begin measuring; this will start the sensor will send off eight ultrasonic burst cycles at 40 kHz, then watch for the reflected burst. The sensor will set the Echo pin to high (5V) and delay for a duration (width) proportionate to distance when it detects ultrasonic from the receiver. Measure the echo pin's width (Ton) to determine the distance

Fig 4.4 HCSR04 ultrasonic sensor

Wide spread adoption of ESP32-CAM. For Internet of Things applications, it is the perfect answer. By adopting the DIP package, the ESP32-CAM can be utilized directly by plugging in the bottom plate. This allows for speedy product manufacturing and gives clients high-reliability connecting methods, making it convenient for usage in a variety of IoT hardware terminal circumstances Essence's most recent compact camera module is the ESP32-CAM. With a deep sleep current as low as 6mA and a dimension of just 27*40.5*4.5mm, the module can function independently as the smallest system. Home smart devices, industrial wireless control, wireless monitoring, QR wireless identification, wireless positioning system signals, and other IoT applications can all benefit from the.

Fig 4.5 ESP32-CAM

A motor driver is a crucial component that gives a stepper motor the necessary voltage and current to ensure smooth operation. This motor is of the DC type and rotates in stages. Choosing the right power source, microcontroller, and motor driver is crucial when designing a stepper motor driver. Although we are aware that microcontrollers can be used to turn a motor, we must consider voltage and current when constructing the driver. A single motor driver board can manage a motor's voltages and currents. With the aid of a driver, a controller synchronizes the pulse signals to operate a stepper motor precisely. This motor driver converts the pulse impulses from a microcontroller into stepper motor action.

Fig 4.6 Servo motors

V. EXPERIMENT

The robot must be able to "start, move 100mm, and stop in 1 second," according to the design brief. To get the most acceleration, all motors can be moved diagonally. On the floor, place two spots 300 mm apart. Set the arm to make ten trips from point A to point B and back. Time how long it takes to cycle through ten moves using a timer. When the response is less than one second, the robot arm has met the design brief's speed requirements. Divide this time by ten. The screenshots below show that the robot is able to take 10 steps of 100 mm in 10 seconds. This was accomplished by adding a software delay each time each side motion was controlled by a button press.
The robot arm must be able to lift 150 grams of weight when it is stretched, which is a power requirement. The prototype arm's motors are rated to 4Nm after the gearbox, per the manufacturer's standards. About 2Nm is required to lift 500g with an arm 40 cm fully extended. In order to raise the necessary load, the motors should be well within their power range. Attach a water bottle to the robot arm's end effector. Pour 100mL of water into the bottle, pull it up five times, and then bring it down again. If required, raise the current output by adjusting the potmeter on the stepper motors' driver board.

Fill the bottle with 100 mL of water, and then pick it back up. Keep adding water. Testing the motors in increments of 100 mL until 150 mL, (150 g) is attained. The robot arm achieves power performance when it can lift a 150 mL bottle. Additionally, the power test was finished successfully. The arm could lift the fully filled 150 mL water bottle, which weighed somewhat more than 150 mL, when it was extended. Additionally, the arm had no trouble lifting the bottle.

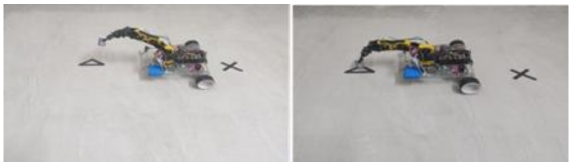

Fig 5.1. Precision & speed Testing

VI. IMPLEMENTATION

The implementation of the Smart TransBot includes wireless control through an Android application called *Arduino BlueControl*, which plays a crucial role in enabling real-time, remote operation of the robot. This application leverages
Bluetooth communication to establish a seamless connection between the user's smartphone and the onboard microcontroller (Arduino). The robot is embedded with a Bluetooth module (such as HC-05), which receives specific command signals from the app to control movement directions including forward, backward, left, right, and stop functionalities. The app features a user-friendly interface with customizable button controls, allowing the user to send predefined characters corresponding to various motion commands. These characters are interpreted by the microcontroller and translated into electrical signals that drive the motors accordingly. This setup not only simplifies robot operation but also eliminates the need for wired controllers, thus offering enhanced flexibility and mobility during industrial tasks. The integration of Arduino BlueControl enhances the usability of the system, making it accessible even to non-technical operators while maintaining precise control over the Smart TransBot's movements within the industrial workspace.

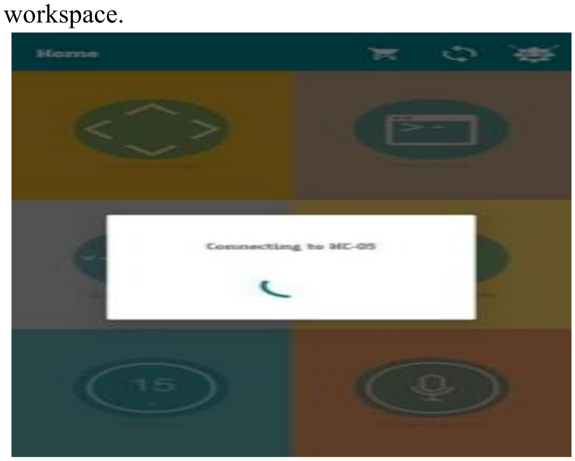

Fig 5.1 connecting to android app

COMMAND	FUNCTIONS
Forward	Move Forward
Backward	Move Backward
Left	Turn Left
Right	Turn Right
Stop	Stop

Table 5.1 Bluetooth Command Table

Fig 6.2 control Panel

V. RESULTS

The Smart TransBot was successfully designed and implemented to carry out autonomous and manual material transportation tasks within an industrial setup. Using the Arduino BlueControl
Android application, the robot responded accurately to all directional commands (forward, backward, left, right, and stop) through the Bluetooth HC-05 module, with minimal latency. The obstacle detection mechanism using ultrasonic sensors worked reliably, preventing collisions in real-time during navigation. In manual mode, the operator could easily control the robot from a distance of up to 10 meters, ensuring flexibility and safety. The robot followed pre-defined paths effectively using line sensors, and could carry payloads of up to [insert actual weight, e.g., 2 kg] without loss of balance or motor efficiency. The system's performance was evaluated under various conditions, such as different floor surfaces, lighting environments, and payload weights. In all cases, the robot exhibited stable movement, reliable communication, and responsive control.
The successful integration of hardware components and software resulted in a cost-effective and scalable

robotic system suitable for automating intra-logistics tasks in small to medium-sized industrial units. Below are some images and measurements that illustrate the results:

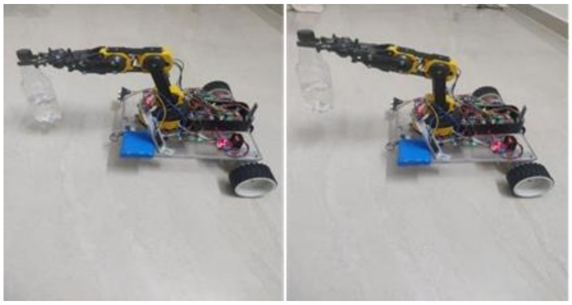

Fig 6.1 Weight Testing

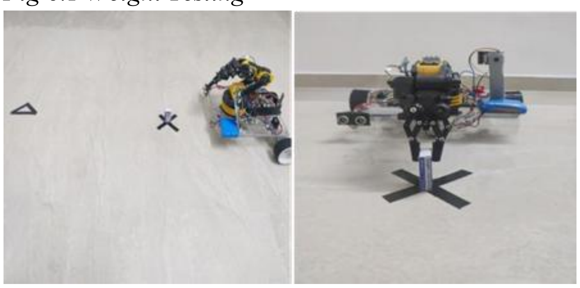

Fig 6.2 Forward & Backward Moves

VI. CONCLUSION & FUTURE SCOPE

As a result, the goal of examining the many parts, their functions, and how they affect the robot arm's performance was accomplished. After testing, the model used in this research to determine the necessary motor torque was found to be accurate. The worst-case scenarios for play in bearings, motor resolution, backlash, and frame deflection were also used in this work to develop a model that predicts a robot arm's precision. The actual precision was 1.5 mm, but the model estimated the worst-case imprecision to be 1.59 mm. These findings appear to support the model's validity for this test. Nevertheless, the model does not account for the
tolerances in the upper arm's fit on the shoulder axel and the lower arm's fit on the elbow axel. The prediction would be higher and the precision would still be within the bounds if these were included

There is a lot of room for advancement in robotic arms. The arms will soon be able to carry out all human-like tasks, albeit considerably more effectively. The possibilities for its future uses are endless.

- For persons with disabilities, such as those who are paralyzed or have lost their hands in an accident, it can be a blessing.
- The arm can be trained to obey human commands and carry out that task.
- It is also feasible to have a system that is precisely controlled by gestures. Wearable technology can be used to control arm motions and deliver commands.
- Brain-Computer Interface (BCI) is a new area of study. BCI can be used to control the arm by receiving signals from the human brain. The technology can function similarly to a human arm.
- With these prosthetic arms, a person who may have lost a hand in an accident can resume his life as usual. Because of their versatility, robotic arms can be used in a wide variety of ways.

REFERENCES

[1] AM Al-Busaidi, Development of an educational environment for online control of a biped robot using MATLAB and Arduino, (MECHATRONICS), 9th France-Japan.2012.

[2] Angelo, J. A. (2007). Robotics: A Reference Guide to New Technology. Westport: Greenwood Press.

[3] AtmelATmega328Datasheet, AVRCorporation, Feb2 014

[4] AUTOMATION: A ROBOTIC ARM By:(ARSALANALLAHYAR) Bachelor of

[5] Technology in Mechanical Preston Institute of Management Sciences & Technology (PIMSAT) Karachi, Sindh, Pakistan

[6] Carlson, M., Donley, E., Graf, K., & Jones, T. (2013). Helping Hand: Senior Design Final Documentation. Orlando: University of Central Florida.

[7] Craig, J. J. (2005). Introduction to Robotics-Mechanics and Control (3rded.).(M.J. Horton, Ed.) Upper Saddle River, USA: Pearson Prentice Hall.

[8] Electric Electronic Technology-Step and

Servo Motors, SVET, 2007.
[9] HS Juang, KY Lurrr. Design and control of a two-wheel self-balancing robot using the Arduino microcontroller board. Control and Automation (ICCA), 2013.
[10] Introduction and Objective Robotic Arm by (Abdul Zahier Ismail)
[11] Intuitive Human Robot Interaction and Workspace Surveillance by means of the Kinect Sensor KlaudiusWerber, Department of Automatic Control, Lund University
[12] MAKYusoff, RESamin, mobileroboticarm. Procedia Engineering. 2012.
[13] Moshe Shoham: Textbook of Robotics: Basic Concepts. Anchor Brendon Ltd.
[14] Motion Control of Robot by using Kinect Sensor by: Mohammed A. Hussein, Ahmed S. Ali, Department of Electronics Technology, Faculty of Industrial Education, Beni-Suef University, Egypt.
[15] Patil, C.,Sachan, S., Singh, R.K., Ranjan,K.,& Kumar,V.(2009). Self and Mutual learning in Robotic Arm, based on Cognitive systems. West Bengal: Indian Institute of Technology Kharagpur.
[16] Robot arm control with Arduino by an imn Mohamed Ahmed ghiet MECHANICAL AND AERONAUTICAL ENGINEERING.
[17] Robotic Arm & Controller Manual & User's Guide by Images SI Inc. Pages: [10-30].
[18] Robot Obstacle Avoidance using the Kinect (RASOULMOJTAHEDZADEH)
[19] Richard D. Klafter: Robotic Engineering. Prentice- Hall of India.
[20] R Krishna, GSBala, SSASC, BBPSarma Design and implementation of a robotic arm based on haptic technology. Int. J. of Eng. Research. 2012.
[21] The development of six D.O.F. robot arm for intelligent robot tJie-TongZou; Dept. Of Aeronaut. Eng., Nat. Formosa Univ., Huawei Township, Taiwan; Des-Hun Tu.
[22] The use of a 3D sensor (Kinect™) for robot motion compensation, Martin Kvalbein
[23] , Faculty of Mathematics and Natural Sciences University of Oslo.
[24] WMHWKadir, RESamin, BSKIbrahim. The Internet controlled a robotic arm. Procedia Engineering. 2012.