ICEST-2K24 [International Conference on Engineering, Science and Technology]
In Association with
International Journal of Scientific Research in Science, Engineering and Technology
Print ISSN - 2395-1990 | Online ISSN : 2394-4099 (www.ijsrset.com)

Design and Development of Packaging line 3-DOF Robotic Arm and Conveyor for Sorting

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ABSTRACT
Sorting color objects is crucial in the packaging industry, especially during final dispatch. This involves classifying products by color, dimensions, and form to meet customer demands and streamline operations. This project provides small-scale businesses with a cost-effective bottle sorting solution using servo motors, an Arduino Mega 2560 microcontroller, a robotic arm, and a color sensor. An interactive TFT display enhances user engagement and provides real-time sorting feedback. The robotic arm, controlled by servo motors, sorts bottles precisely based on color, with the Arduino coordinating movements and the color sensor detecting bottle colors. The TFT display shows real-time data on sorted bottles and their colors, simplifying monitoring and configuration. This economical system optimizes sorting, reduces manual labor, and improves efficiency, making it ideal for small-scale operations. This project offers an affordable, effective solution for bottle sorting and packaging, enhancing productivity and reducing costs.
Keywords— Robotic arm, Sorting, Conveyor, Auduino,

I. INTRODUCTION

In today's rapidly evolving industrial landscape, automation and robotics have become integral components of production processes, revolutionizing the way products are manufactured, handled, and packaged. This shift towards automation enhances efficiency, precision, and consistency in various industrial tasks. The integration of robotic systems in packaging lines exemplifies this transformation, offering advanced solutions to streamline the packaging of diverse products.

In this context, we introduce a cost-effective, energy-efficient component sorting system designed to operate based on color detection. This system is positioned on a continuously moving conveyor belt powered by a D.C. motor. The primary goal of this project is to automate the sorting process according to the color of the components.

Our proposed solution aims to revolutionize the testing of manufactured components by replacing manual methods with automated procedures. This approach minimizes human involvement, reducing labor costs and potential errors. Additionally, this automated system is expected to enhance productivity and accuracy levels beyond what manual operations can achieve.

II. LITERATURE SURVEY

[1] Rahul Basu and Swathi Padage discusses the development of a robot arm-gripper for sorting tasks and investigating RTM concepts. The paper emphasizes the importance of efficiency and ergonomics in the factory workplace and highlights the role of robotic units in replacing human sorters for production line work.The authors address the concept of economy of motion in robotic assembly lines and various applications of robotic technology in industries such as microelectronics, medical, and space applications. They also mention the use of AI programs to enable discrimination of objects and sorting in production lines, showcasing the potential for automation and improved efficiency .Furthermore, the paper touches upon the principles of Work Study by Gilbreth and Therbligs, emphasizing the need to reprogram automated assemblies to reduce energy consumption and improve ergonomics in the factory workplace.

[2] Gabriel Garcia et al presents a novel approach to inspecting belt conveyor structures using robotic technology. The system described in the paper consists of a mobile platform capable of navigating various terrains, a robotic manipulator with six degrees of freedom, and a set of sensors including microphone, accelerometers, laser, and cameras. The authors conducted preliminary field tests to validate the system for mining operations and identified areas for improvement in platform mobility and control strategy.

[3] K.R. Sughashini et al presents a novel approach to automated material handling and sorting using a pneumatic robotic arm integrated with a chromatic sensor module. The research addresses the inefficiencies and costs associated with manual material handling in manufacturing and distribution processes by introducing a smart robotic solution.

Key points highlighted in the paper include:The significance of material handling in manufacturing and distribution processes, with a focus on the high costs and inefficiencies involved .The use of automated robotic arms in industries like auto-manufacturing to improve efficiency and precision in tasks such as object sorting . The implementation of a pneumatic robotic arm for sorting objects based on color identification, showcasing the potential for increased productivity and reduced costs in various industries .The working methodology of the pneumatic robot arm, including the use of color sensors, conveyors, and programmable logical controllers for efficient object sorting. The potential applications of this technology in industries such as food and automobile manufacturing, highlighting its versatility and adaptability .

The paper also provides references to related works in the field of robotics and automation, demonstrating a thorough review of existing literature and research . Overall, the paper presents a promising solution for enhancing material handling processes through the integration of pneumatic robotic technology with advanced sensor modules, paving the way for increased efficiency and cost-effectiveness in industrial operations.

[4] Ashraf Elfasakhany et al work focuses on creating a robot arm that can perform simple tasks efficiently and at a low cost, making it a valuable asset in industrial settings. The robot arm was designed with four degrees of freedom and talented to accomplish accurately simple tasks, such as light material handling, which will be integrated into a mobile platform that serves as an assistant for industrial workforce. The robot arm is equipped with several servo motors which do links between arms and perform arm movements. The servo motors include encoder so that no controller was implemented. To control the robot author used Labview, which performs inverse kinematic calculations and communicates the proper angles serially to a microcontroller that

drives the servo motors with the capability of modifying position, speed and acceleration. Testing and validation of the robot arm was carried out and results shows that it work properly.

[5] Mohammadreza Lalegani Dezaki et al presented the design and development of a pneumatic conveyor robot specifically engineered for color detection and sorting applications. The authors have made significant contributions by integrating pneumatic technology with advanced color detection algorithms to create an efficient sorting system. The innovation lies in combining the speed and simplicity of pneumatic systems with the precision of modern sensors, offering a robust solution for industrial sorting applications. The paper details the construction of the pneumatic conveyor robot, which includes a thorough explanation of the hardware components, such as actuators, sensors, and the conveyor mechanism. The authors have employed advanced color sensors to accurately detect and classify objects based on their colors. The integration of these sensors with pneumatic actuators ensures quick and reliable sorting.

The experimental results demonstrate that the pneumatic conveyor robot is capable of sorting items with high accuracy and speed. The authors report impressive sorting accuracy rates, validating the effectiveness of their design. The system's performance in real-world scenarios indicates its potential for deployment in various industrial settings.

This research addresses the need for efficient and cost-effective sorting solutions in industries where color detection is crucial. The use of pneumatic technology not only reduces the complexity and maintenance requirements but also enhances the system's operational speed. This makes it particularly suitable for high-throughput environments.

[6] Kunto Aji W et al presented an innovative approach to object sorting using a 4-degree-of-freedom (DoF) robotic arm, leveraging color detection and inverse kinematics algorithms. This study significantly contributes to the fields of robotics and industrial automation by addressing the need for efficient, automated sorting systems.The research outlines a comprehensive methodology that integrates hardware and software components. The robotic arm, equipped with a color sensor, detects the color of objects and sorts them accordingly. The use of the inverse kinematics algorithm is crucial as it allows the precise calculation of joint angles to position the robotic arm accurately.The robotic arm's design includes detailed descriptions of the servos, joints, and sensors used, providing a solid foundation for replicating the system.The inverse kinematics algorithm is well-explained, highlighting how it calculates the necessary joint angles to achieve the desired end-effector position. This is essential for the accurate sorting of objects based on their detected color. The experiments conducted demonstrate that the 4-DoF robotic arm can accurately sort objects by color, showcasing high precision and reliability. The use of inverse kinematics significantly enhances the arm's ability to reach and manipulate objects in a confined space, proving the system's effectiveness in practical applications. This paper addresses the practical challenges faced by small and medium-sized enterprises (SMEs) in automating their sorting processes. By providing a cost-effective and efficient solution, the research has substantial implications for improving productivity and reducing labor costs in various industries.

III.METHODOLOGY

The "Design and Development of Packaging line 3-DOF Robotic Arm and Conveyor for Sorting" project involves a combination of mechanical, electrical, and software components that work in tandem to achieve efficient bottle sorting and packaging. The project can be broken down into several key elements.

A. Mechanical Setup:

The mechanical infrastructure supporting the Arduino Mega controlled conveyor belt aims to ensure stability, accuracy, and reliability in sorting bottles by color. This system integrates key components such as the conveyor belt, TCS3200 color sensor, IR sensor, and robotic arm. The mechanical framework is designed for seamless integration of these components, enabling smooth operation and efficient sorting, thereby enhancing productivity.

B. Conveyor Belt System

Serving as the primary conduit for bottle transportation, the conveyor belt comprises a robust belt made of materials like rubber or PVC, supported by rollers or pulleys.A motor, regulated by the Arduino Mega board, drives the conveyor belt. The mechanical framework for the conveyor belt includes a sturdy frame structure, ensuring rigidity to prevent deformation during operation. Tensioning mechanisms are incorporated to maintain belt tautness, ensuring smooth operation without slippage.

C. Mounting of TCS3200 Color Sensor and IR Sensor

The TCS3200 color sensor and IR sensor are strategically positioned along the conveyor belt to detect bottle color and presence, respectively. Sturdy mounting brackets securely hold these sensors, maintaining alignment and minimizing interference. The mounting locations are optimized for enhanced detection accuracy while reducing external interference. The mechanical support for these sensors allows for easy adjustment and calibration to meet sorting requirements.

D. Integration of Robotic Arm

The robotic arm, positioned adjacent to the conveyor belt, sorts bottles based on color and IR sensor feedback.

A dedicated mounting platform securely attaches the robotic arm, incorporating precision positioning mechanisms for accurate sorting. The platform design withstands dynamic robotic arm movements while minimizing vibrations that may affect sorting accuracy. Efficient cable management solutions organize and protect electrical connections between the Arduino Mega board, sensors, and robotic arm.

E. Adjustable Speed Control

Mechanisms for adjusting conveyor belt speed, based on color detection and IR sensor feedback, are integrated into the mechanical framework. Variable speed drives or pulley systems, controlled by the Arduino Mega board, facilitate smooth speed adjustments. Design considerations prevent sudden speed changes, reducing the risk of bottle jams and operational disruptions.

F. Structural Integrity

The entire mechanical support system is engineered for robustness and durability, suitable for continuous industrial operation. High-quality materials such as steel or aluminum are utilized, providing strength and longevity. Structural elements feature reinforcements and bracing to withstand operational loads and stresses.

Regular maintenance protocols are established to sustain optimal performance, maximizing operational uptime and efficiency. The establishment of a solid mechanical foundation for the Arduino Mega controlled conveyor belt system ensures precise and reliable bottle sorting, ultimately enhancing productivity and efficiency in industrial sorting operations.

G. Microcontroller (Arduino Mega)

The Arduino Mega serves as the central control unit for the entire system. It collects data from the color sensor and IR sensors and processes this information. The Arduino Mega also coordinates the movement and actions of the 3-DOF robotic arm, ensuring that it responds to the color and count data effectively.

H. User Interface (TFT Display)

A TFT display is seamlessly integrated with the Arduino Mega, serving as an intuitive user interface for monitoring the system's operation in real-time. This display interface offers operators a comprehensive overview of the sorting and packaging process, presenting detailed information regarding the count of bottles for each distinct color category. By providing real-time updates on bottle quantities, the TFT display empowers operators to effectively manage production flow and optimize resource allocation. Moreover, the user-friendly nature of the TFT display ensures ease of navigation and accessibility, allowing operators to quickly access pertinent data and make informed decisions. With its clear and concise presentation of information, the display facilitates efficient communication between operators and the automated system, fostering seamless collaboration and enhancing overall productivity. Additionally, the TFT display's capability to showcase real-time data enables operators to promptly identify and address any irregularities or issues that may arise during operation. This proactive approach to monitoring ensures timely intervention and minimizes potential disruptions, ultimately contributing to the system's reliability and performance consistency.

In summary, The integration of the TFT display with the Arduino Mega not only enhances the user experience but also plays a crucial role in optimizing operational efficiency and facilitating informed decision-making in the sorting and packaging process.

I. Control Logic

The control logic embedded within the Arduino Mega represents the central intelligence of the system, orchestrating a seamless integration of inputs from both the color sensor and IR sensors. These sensors work in tandem to provide comprehensive data on the color composition of each passing bottle, as well as their precise location along the conveyor belt. Leveraging this wealth of information, the control logic meticulously categorizes the bottles based on color and maintains an accurate count for each color category. Drawing upon this color and count data, the control logic then issues precise instructions to the robotic arm, dictating its movements with utmost precision. The robotic arm's actions are choreographed to perfection, ensuring that bottles are picked and placed in their designated packaging areas with meticulous care and efficiency.

Moreover, the coordination of the arm's movements is calibrated to ensure optimal grouping of bottles based on color similarity. This strategic grouping enhances the efficiency of downstream packaging processes, minimizing sorting time and maximizing throughput.

In essence, the control logic within the Arduino Mega serves as the brain of the operation, orchestrating a harmonious symphony of sensor inputs and robotic actions. Its ability to process complex data in real-time and translate it into actionable instructions underscores its pivotal role in the seamless operation of the bottle sorting and packaging system.

J. Safety Measures

Ensuring the safe operation of the robotic arm is paramount, and to achieve this, a comprehensive array of safety measures is integrated into the system. These measures encompass various elements designed to mitigate potential risks and safeguard both equipment and personnel. Emergency stop buttons are strategically positioned within easy reach, providing an immediate means to halt arm movement in case of emergency or unforeseen circumstances. Additionally, sensors are deployed along the arm's path to detect obstructions or obstacles, triggering automatic halts or redirections to prevent collisions and minimize damage. Protocols are also implemented to establish clear guidelines for safe operation, including training programs for personnel and regular maintenance checks to ensure optimal functioning of safety systems. In summary, the intricate workings of this project involve the seamless integration of sensor technology, a 3-DOF robotic arm, and sophisticated control electronics. This synergy creates a cohesive and efficient packaging system capable of sorting and packaging bottles based on their colors with precision and accuracy. The synchronized operation of these components ensures the systematic and reliable sorting and packaging of products, ultimately contributing to heightened efficiency and enhanced quality in the industrial production process. By prioritizing safety measures and leveraging advanced technology, this project sets a new standard for automated packaging systems, offering reliability, efficiency, and peace of mind for operators and stakeholders alike.

K. Circuit Diagram

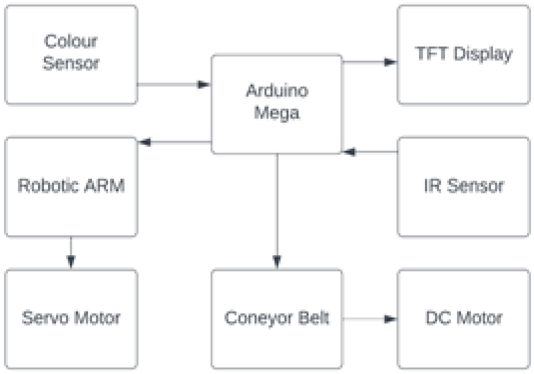

Fig. 1 Block diagram of the circuit

In fig. 1 block diagram of circuit is shown. Color sensor and IR sensor giving the input signal to Arduino Mega. Arduino mega giving output signal to robotic arm, TFT display and conveyor belt.

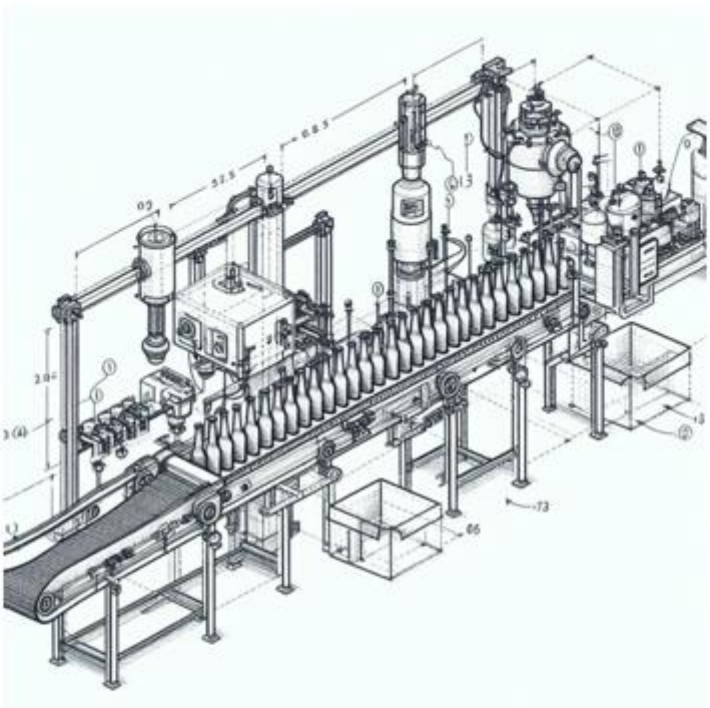

Fig 2 visual representation of future application

The theoretical framework of our system is elucidated through the visual representation depicted in the fig.2. In this schematic, our system employs a conveyor belt as the central component, orchestrating the smooth movement of bottles along the packaging assembly line. This conveyor belt acts as a vital link in the chain of operations, facilitating the seamless transportation of unsorted bottles towards crucial elements including the robotic arm, IR sensor, and color sensor. The color sensor assumes the pivotal role of identifying the color composition of each passing bottle, employing advanced technology to accurately discern various hues and shades. Simultaneously, the IR sensor functions as the guiding force, pinpointing the precise location of the detected bottles within the conveyor belt's trajectory. This real-time positional data is then swiftly relayed to the Arduino micro-controller, forming the foundation for subsequent decision-making processes. Upon receipt of data from the sensors, the Arduino Mega springs into action, leveraging a meticulously crafted algorithm to execute the intricate task of sorting the bottles according to predefined criteria. This algorithm, intricately designed and finely tuned, takes into account factors such as color, size, and shape to make informed decisions regarding the optimal placement of each bottle. Once sorted, the bottles are methodically positioned into designated storage boxes, adhering to the prescribed organizational structure. As each bottle finds its rightful place within the storage boxes, it triggers a series of events orchestrated by the IR sensor. This sensor, functioning as the sentinel of the packaging line, detects the presence of the sorted bottles and initiates their onward journey along the conveyor belt. Simultaneously, the IR sensor data is transmitted back to the Arduino Mega, where it is meticulously compiled and analyzed. The culmination of these meticulously orchestrated processes culminates in the comprehensive presentation of production and packaging metrics on the TFT display connected to the Arduino Mega. This real-time display provides invaluable insights into the efficiency and efficacy of the packaging line, offering stakeholders a clear understanding of operational performance and productivity. In essence, the integration of this sophisticated system promises to revolutionize packaging line management, ushering in an era of enhanced efficiency, streamlined operations, and unparalleled productivity.

L. Design of Conveyor Belt.

The conveyor belt material is composite of pvc & Polyster Canvas. Length (L) of belt is 0.45m, width (b) is 0.13m, Belt thickness = 2.1mm. we have referred belt design book to determine properties of belt material. Density of belt material is 2.3kg / m^3. Coefficient of friction 0.2. Total load on Belt is 1kg (9.81N). Cycle time of conveyor assuming 30 seconds. Roller Diameter is 25.4 mm. Circumference of ro11er is 79.79mm

Mass of belt = Total area x unit density

Area of belt= $2 \times L \times b = 2 \times 0.45 \times 0.13 = 0.117\ m^2$

Mass of belt $= 0.117 \times 2.3 = 0.2691\ kg$

Total load on Conveyor $= 1+0.2691 = 1.2691\ kg$

speed of conveyor - Assume cycle time 30 second How much time take to flow material from one end Time 30 sec. for I Sec to other Length 0.45 m

Linear speed = Length of belt / Cycle time =0.015m/s.

Power required to drive the conveyor belt is given as

Power = Force × Displacement/time

Power = Force × velocity

AS force is pull force which is equal to frictional force between belt & belt support frictional force

Force $= 0.2 \times 1.269 \times 9.81 = 2.489\ N$

Power $= 2.489\ X\ 0.015 = 0.037\ W$

Circumference of ro11er is 0.0797m

It means once 1 rev. the roller rotate at the belt can 0.0797 m travel 0.0797 m distance

1 Rev 1m = 1/0.0797 Rev

therefore for motor

0.9/0.0797 × Rev ==11.29 Rev

Rotational speed of motor =11.29 Rpm

Power =Torque × Angular speed

Torque = Power /Angular speed

for angular speed Rpm into Rad Isec. we have to convert

Angular speed = 11.29 x 27 60 =1.182 rad/sec.

Torque = 0.037 (Nm/sec) / 1.182 rad/sec)

Torque 0.031 Nm.

M. Conveyor belt Auto CAD Diagram

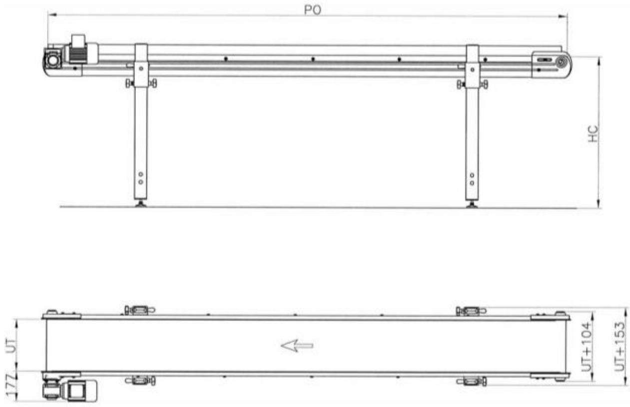

Fig. 3 Conveyor belt drawing

N. Sselection of components

1) Conveyor belt Components

Motor: Gear motor

Specifications

12 volt ,10 rpm, Power 12 watt,

2) Belt:

material of belt - composite of PVC and polyester canvas

Specifications:

Length -900 mm

Width -130 mm

Thickness - 2.1mm

3) Roller:

Length -130 mm

Diameter- 12.7 mm

4) Frame:

Length: 500 mm

Height: 100 mm

Aluminum is a material that has several benefits for robotic arms, and the choice of material is frequently determined by particular engineering specifications and factors. The following justifies the widespread use of aluminum in robotic arms

IV. WORKING PRINCIPLE

A. Base:

The robotic arm's base serves as its structural support. It houses the parts required for rotation and movement and offers stability. The arm can move horizontally through a rotating joint or a fixed base.

The points of articulation that provide the robotic arm its mobility are called joints. A 3-DOF robotic arm has three joints, each of which stands for a different degree of freedom.

B. Actuators and Motors:

Each joint's movement is propelled by either an actuator or a motor. Servo motors are utilized in rotational joints.

C. Links:

The stiff sections that join the joints are called links. Part of the robotic arm's overall reach and payload capacity is determined by the links' length and composition.

D. End effector:

The instrument or gadget affixed to the robotic arm's final link is known as the end effector.Depending on the use, it could be a gripper, a welding tool, a camera, or any other kind of tool. What interacts with the environment or carries out a particular activity is called the end effector.

E. Controller:

The robotic arm's "brain" is the controller. To produce the desired movement, it interprets commands input and signals the motors or actuators. The Arduino Mega 2560 is the controller in use.

F. Sensors:

By giving the controller feedback, sensors enable the robotic arm to sense its surroundings and modify its movements accordingly. The color sensor TCSS3200 is utilized in this instance to identify the bottle's specific color.nd IR sensor to tally the quantity of packed and sorted bottles.

G. Power Supply:

The robotic arm's power supply supplies the electricity required to run the motors and other electronic parts.

H. Frame/Structure:

All the parts are held together and supported by the frame or structure. For the robotic arm to move steadily and accurately, it must be strong and rigid.

I. Cabling and Wiring:

Connecting electronic components like motors, sensors, and controllers is done through wiring and cabling. The functioning and beauty of the robotic arm depend on the wiring being arranged properly.

J. Conveyor belt Working

The sensor systematically switches between the primary colors of RGB (Red, Green, Blue), evaluating the intensity of light reflected from the surface of the detected object. This reflected intensity is then converted into an 8-bit value, providing insights into the predominant color. For instance, a surface appearing red will strongly reflect red light, while a yellow surface will reflect both red and green light. By applying the principle of color induction, which states that combinations of the primary colors generate a spectrum of hues, the system determines the color of the object under scrutiny.

K. Microcontroller Integration and Stepper Motor Control:

Upon identifying the RGB values indicative of the object's color, the microcontroller processes this data and transmits corresponding signals to specific stepper motors. These stepper motors function as pistons, facilitating the precise movement of objects along the conveyor belt. Before activation, an infrared (IR) receiver detects the presence of the object and assists in counting. The ULN2003A buffer IC serves to drive the stepper motors efficiently, ensuring seamless operation

L. Sorting Process and Data Transmission:

As an integral facet of the sorting mechanism, the microcontroller diligently awaits confirmation signals emanating from the IR receiver, which serve as indicators denoting the presence of a specific color-coded object on the conveyor belt. Upon the receipt of these crucial signals, meticulously processed by the microcontroller, a synchronized response is triggered, compelling the corresponding stepper motor into action. With precision and swiftness, the stepper motor initiates rotational movement, effectively displacing the identified object from the conveyor belt's trajectory. This seamless orchestration of actions ensures the efficient sorting of objects based on their predetermined color codes.

In tandem with the sorting operation, the system meticulously tallies the count of sorted objects, maintaining a meticulous record of the sorting process's efficacy. This valuable data is swiftly transmitted to a connected personal computer (PC), where it undergoes thorough analysis and interpretation. Facilitated by a dedicated Visual Basic (VB) program, the accumulated count of sorted objects is visually presented in real-time, offering stakeholders invaluable insights into the sorting process's efficiency and performance metrics. The dynamic display of this data empowers operators and supervisors to make informed decisions, fine-tune operational parameters, and optimize the sorting process for heightened productivity and accuracy. Thus, through the seamless integration of advanced technology and meticulous data tracking mechanisms, our system elevates sorting operations to new heights of efficiency and precision.

V. APPLICATIONS

In industrial settings, these systems offer the potential to automate the execution of repetitive tasks, ranging from bottle packaging and sorting to the meticulous packaging of diverse products. By leveraging advanced algorithms and sensor technology, these automated solutions streamline operations, enhance efficiency, and reduce labour costs.

Within warehouses, these systems play a crucial role in the selection, sorting, and picking of goods from distribution conveyors to fulfil consumer orders. Through the integration of intelligent robotics and machine learning algorithms, they optimize warehouse logistics, minimize errors, and expedite order fulfillment processes.

In the food industry, these systems are instrumental in developing consumables with consistent quality and quantity. By employing precise measurements, automated portion control, and adherence to stringent quality standards, they ensure product uniformity, safety, and compliance with regulatory requirements. Additionally, these systems enhance production throughput, minimize waste, and uphold the brand reputation for excellence in food manufacturing.

VI. PROTOTYPE

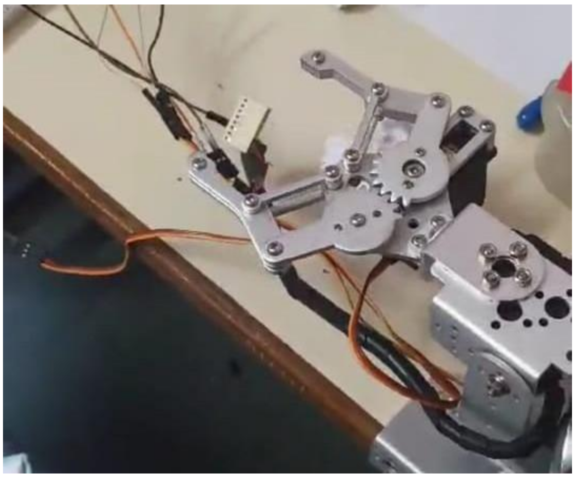

Fig 3. Prototype model of robotic Arm

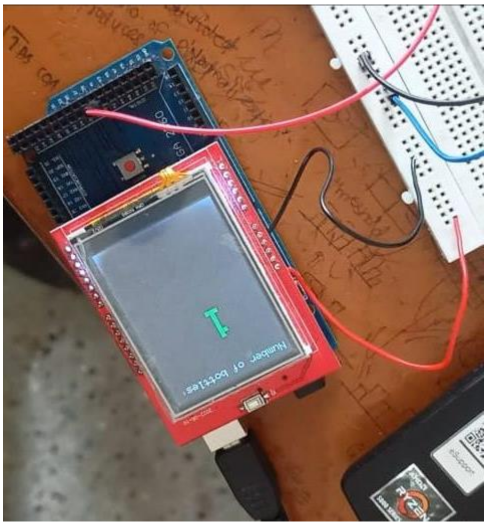

Fig 4. Bottle count displayed on TFT Display

Fig 5. Prototype model of Conveyor Belt

As depicted in the figure 3,4,5, there is a compelling opportunity to design and implement an affordable Arduino-based small-case bottle sorting and packaging line. This innovative solution presents a viable alternative to the expensive and complex PLC-based systems currently prevalent in industrial settings. By harnessing the versatility and cost-effectiveness of Arduino technology, coupled with sophisticated algorithms and sensor integration, we can develop a compact yet robust system capable of efficiently sorting and packaging bottles with precision and reliability.

Moreover, the Arduino-based approach offers greater flexibility and scalability, allowing for easier customization and adaptation to diverse production environments. This means that even small-scale enterprises with limited resources can benefit from the automation and efficiency afforded by our solution. Furthermore, the simplicity of the Arduino platform translates to lower maintenance costs and reduced reliance on specialized expertise, making it an attractive option for businesses seeking to streamline their operations while minimizing overhead expenses.

VII. CONCLUSION

The development of an Arduino-based small-case bottle sorting and packaging line represents a disruptive innovation poised to revolutionize industrial automation, offering a cost-effective and accessible alternative to traditional PLC-based systems.This will help in easy management of packaging efficiency and automate the production data accurately there by reducing the human errors.

VIII. REFERENCES

[1]. Rahul Basua, Swathi Padageb, Development of 5 DOF Robot Arm -Gripper for sorting and investigating RTM Concepts, 5th International Conference of Materials Processing and Characterization (ICMPC 2016), Elsevier, Materials Today: Proceedings 4, 2017,1634–1643.

[2]. Gabriel Garcia1, Filipe Rocha, Marcos Torre1 , Wenderson Serrantola , ROSI: A Novel Robotic Method for Belt Conveyor Structures Inspection,19th International Conference on Advanced Robotics (ICAR), IEEE Xplore, 2019.

[3]. K.R. Sughashini, V. Sunanthini, J. Johnsi, R. Nagalakshmi, R. Sudha, A pneumatic robot arm for sorting of objects with chromatic sensor module,Elsevier, Materials Today: Proceedings.

[4]. Ashraf Elfasakhany, Eduardo Yanez, Karen Baylon, Ricardo Salgado, Design and Development of a Competitive Low-Cost Robot Arm with Four Degrees of Freedom, Modern Mechanical Engineering, 2011, 1, 47-55.

[5]. Mohammadreza Lalegani Dezaki, Saghi Hatami, Ali Zolfagharianb, Mahdi Bodaghi , A pneumatic conveyor robot for color detection and sorting, Cognitive Robotics 2 ,2022, 60–72.

[6]. Kunto Aji W, Haryanto, Edi Nuralim, Riza Alfita, Rosida Vivin Nahari , Mirza Pramudia , Achmad Fiqhi Ibadillah, Implementation 4 – DoF Arm Robot Object Sorting Controlled Based On Color Using Inverse Kinemathics Algorithm, International Conference on Science and Technology (ICST 2018), Atlantis Highlights in Engineering (AHE), volume 1, 2018, 539-544.