AUTOMATIC INSPECTION CONVEYOR USING IR SENSORS

Shivayogi B H[1], Arun kumar M T[2], Hanuman D V[3], Siddesh A K[4], Guruswamy Y[5],

Department of Mechanical Engineering ,
Jain Institute of Technology Davanagere, India

ABSTRACT

The "INSPECTION CONVEYOR" is an advanced system utilized in modern engineering industries for material inspection and handling. It incorporates sensors to measure material dimensions, with the signals transmitted to a control unit. The control unit then provides appropriate instructions to a pneumatic cylinder, which serves as a collection mechanism for oversized materials. This conveyor system offers numerous advantages in material handling. It is driven by a motor, ensuring seamless transfer of materials from one location to another. Equipped with sensors positioned along the top, it accurately measures dimensions such as length, breadth, and height. Consequently, the belts move smoothly, delivering materials to their designated destinations promptly. One of the key benefits of this equipment is its efficiency in dimension checking. It eliminates the need for manual labour by automating the inspection process. By reducing errors that may occur during manual inspections and saving time, the inspection conveyor enhances productivity and accuracy within engineering industries. In instances where a defective workpiece is detected, an adjacent pneumatic cylinder is activated to remove it. This feature guarantees that only compliant materials continue along the conveyor, upholding the overall production quality. In summary, the inspection conveyor is a highly valuable tool for modern engineering industries. It automates material inspection, ensures precise dimension measurements, facilitates efficient material handling, and minimizes errors during manual inspections.

INTRODUCTION

1.1 Automation

In the present age of automation, the term encompasses the substitution of manual labour with mechanical power across all levels of automation. While the operation remains a crucial aspect of the system, the required physical input undergoes changes as the level of mechanization increases.

There are two types of automation degrees:

1. Full automation

2. Semi-automation

This differentiation in the degrees of automation signifies the varying levels of human involvement and the extent to which mechanical power is utilized. With ongoing technological advancements, there is a growing inclination towards achieving full automation, leading to more efficient and streamlined processes across diverse industries.

1.1.1 Need for Automation

Automation offers various methods such as computers, hydraulics, pneumatics, and robotics to accomplish its goals. Among these options, pneumatics stands out as an attractive and cost-effective medium for automation. The key advantages of pneumatic systems are their simplicity and economic efficiency. Within mass production, automation plays a significant role. In the manufacturing process of a product, the sequence of machining operations determines the order of operations. Transfer machines are specifically designed to produce a particular product efficiently. These machines facilitate the automatic movement of components from storage bins to different machines in a sequential manner. Furthermore, the final components can be separated for packaging purposes. Automation enables the smooth transfer of materials between moving conveyors and workstations, streamlining the production process. Quality control and inspection are critical factors in factory design. Automation plays a vital role in achieving mass production objectives. The sequence of machining operations dictates the manufacturing process, and transfer machines are specifically engineered for the production of a particular product.

Pruthvi Kumar S et al.[1] "Automated Bottle Cap Inspection Using Machine Vision system.

This paper presents a comprehensive design of an automated bottle cap inspection system utilizing machine vision technology. It delves into the operational principles and hardware structure of the system. The inspection process involves capturing images of the bottle cap on the production line and analysing them through image processing techniques facilitated by a machine vision system. The key components of the system include the inspection unit responsible for image analysis and the rejection unit for identifying and removing defective caps. A microcontroller is employed to control the overall system, coordinating the mechanical and electronic components. The image processing tasks during the inspection process are programmed using MATLAB algorithms, which serve as the programming language for this purpose. In order to detect the presence of bottles on the conveyor, an IR module is utilized as a sensing mechanism. Additionally, an automatic rejection system is integrated into the setup, featuring an arm connected to a DC motor. This system effectively replaces traditional sensor-based and manual inspection methods. The implementation of this automated bottle cap inspection system holds significant practical value, as it enhances productivity, improves the quality of inspection, expands product variety, and increases profitability. By streamlining the inspection process, it offers numerous benefits in terms of efficiency and accuracy, making it a valuable solution for the industry.

Devendra Kumar et al.[2] "Analysis & Prospects of Modification in Belt Conveyors. Belt conveyor systems have become indispensable equipment not only in mining industries but also in various sectors such as cement, power plants, food production, and more. They play a crucial role in internal material transportation in modern industrial settings. This paper provides a comprehensive review of the design modifications and latest technologies used in belt conveyor systems across different applications. The aim is to minimize failures, reduce maintenance costs, and prevent equipment-related accidents during operation. The focus areas include design modifications, drum and pulley failures, belt design and failure analysis, energy efficiency, friction, inspection techniques, operation and maintenance practices, as well as fire and safety considerations. The analysis highlights the varying design parameters required for specific applications like coal mines, cement industries, and food production. It underscores the importance of each parameter and its impact on different applications. By understanding and optimizing these design parameters, the performance, reliability, and safety of belt conveyor systems can be significantly improved, leading to enhanced operational efficiency and reduced costs. Overall, this paper serves as a valuable resource for professionals and researchers seeking to enhance the design, performance, and safety of belt conveyor systems across diverse industrial applications.

prof. D. B. Rane et al.[3] "Automation of Object Sorting Using an Industrial Roboarm and MATLAB Based Image Processing"In recent years, the significance of process automation has significantly increased as it directly impacts the efficiency and success of various industries. To ensure precise outputs and accuracy in industrial processes, sophisticated robots equipped with advanced sensors are employed. Furthermore, the application of image processing has emerged as a dominant technology in modern industrial processes. This paper focuses on the development of a colour-based object sorting system that leverages machine vision and image processing operations. The objective is to create a compact, user-friendly, and highly accurate machine that can sort objects based on their colour using real-time colour image processing techniques. The system continuously evaluates and inspects the colour deformities of objects using a camera-based machine vision setup. Based on the quality evaluation, the objects are sorted into predefined quality groups using a pick and place robot arm. Any object that fails to meet the specified quality standards is rejected by the system. The proposed system holds significant potential for a wide range of applications in various fields where continuous evaluation of quality is essential. By utilizing real-time colour image processing and robotic automation, the system offers improved efficiency, accuracy, and reliability in object sorting processes. Overall, this research work contributes to the advancement of quality control and sorting systems, showcasing the capabilities of machine vision and image processing technologies in industrial applications.

1.2 Conveyor System

A conveyor system is a commonly used mechanical handling equipment that facilitates the movement of

materials from one location to another. It offers several benefits in industrial settings:

Efficient Material Transportation: Conveyor systems provide a safe and efficient means of transporting materials from one level to another. This eliminates the need for strenuous and costly manual labour.

Versatility in Load Handling: Conveyor systems are designed to handle loads of various shapes, sizes, and weights. They can accommodate a wide range of materials, ensuring smooth and reliable transportation. Additionally, many conveyor systems incorporate advanced safety features to prevent accidents and ensure worker safety.

Diverse Operating Options: Conveyor systems offer a variety of operating options to suit different needs. They can be powered by hydraulic, mechanical, or fully automated systems, providing flexibility in operations and enabling customization based on specific requirements.

Easy Installation and Safety: Conveyor systems can be installed in various locations within a facility, making them highly adaptable to different layouts and processes. Furthermore, they provide a safer alternative to using heavy machinery or forklifts for material movement, reducing the risk of accidents and injuries.

1.2.1 Belt Conveyor

A conveyor belt is a continuous moving belt that efficiently transports materials or packages from one location to another. It consists of an endless belt made of resilient material connected between two flat pulleys, with one pulley being rotated by an electric motor. Typically, the material is fed onto the belt near the opposite end pulley. To prevent sagging of the belt due to its self-weight and payload, a series of rollers called idlers are installed on both the carrying side and the return side of the belt. As the belt is always under tension, it may elongate over time, leading to slackness over the pulleys and a decrease in tension and power. To counter this, a tensioning device known as a take-up arrangement is incorporated into the system. This simple yet effective device helps maintain the proper tension of the belt. Belt conveyors have become the preferred method for transporting bulk materials due to several inherent advantages. They offer economical and safe operation, reliability, versatility, and a wide range of capacities. Additionally, belt conveyors can perform various processing functions while facilitating a continuous flow of material between operations. These factors contribute to their widespread use in different industries.

1.2.2 Properties of convey or belt

The important properties of conveyor belt are

- High tensile strength
- High impact resistance
- Low elongation
- Tear resistance
- Superior heat resistance

1.3 Actuators

An actuator refers to a type of motor that is responsible for controlling or moving mechanisms or systems. It utilizes various sources of power, such as hydraulic fluid, electric current, or other energy sources, to convert the energy into motion. Actuators are highly valuable devices with a wide range of applications in fields like engineering and can be found in various machinery like printers, cars, or disk drives. They commonly produce linear, rotary, or oscillatory motion. There are four main types of actuators: manual, pneumatic, hydraulic, and electric actuators. Among these, pneumatic actuators are utilized, which convert energy from pressurized air into mechanical motion. Pneumatic actuators are typically straightforward in design and rely on their ability to convert potential energy into kinetic energy. They usually consist of a cylinder that contains regular air, pressurized gas, or a combination of both. As the gas expands within the cylinder, a pressure difference is created between the inside of the cylinder and the atmospheric pressure, resulting in the accumulation of energy. The controlled release of the gas directs it towards a piston, gear, or another mechanical device. The piston then carries out the desired mechanical work. In summary, an actuator is a motor-like device that drives mechanisms or systems. Pneumatic actuators, which use pressurized air, are commonly employed and convert potential energy into kinetic energy to facilitate motion. They consist of a cylinder where the gas expands, generating energy that is then directed towards a piston or other mechanical components to perform the necessary work.

1.4 SENSORS

A sensor is a device that identifies and registers alterations in electrical, physical, or other quantities, subsequently generating an output as an acknowledgment of the change in the measured quantity. It functions by detecting and responding to various inputs from the surrounding environment. These inputs can include light, heat, motion, moisture, pressure, or a wide range of other environmental factors. The output produced by the sensor is typically a signal that can be converted into a human-readable display at the sensor's location or transmitted electronically over a network for reading or further processing.

1.4.1 IR SENSORS

- An infrared sensor is an electronic device designed to perceive specific attributes of its environment by emitting or detecting infrared radiation. The infrared spectrum is divided into three regions, each with its own range of wavelengths and applications:
- 1. Near-infrared region (700nm to 1400nm): This range is utilized for applications such as IR sensors and fiber optics.
- 2. Mid-infrared region (1400nm to 3000nm): In this range, infrared sensors are commonly used for heat sensing purposes.
- 3. Far-infrared region (3000nm to 1mm): This region is employed for thermal imaging applications, enabling the visualization of thermal patterns and variations.
- Overall, infrared sensors are valuable tools that exploit different portions of the infrared spectrum to sense and detect various characteristics of their surroundings.

1.4.2 IR Transmitters

An infrared transmitter refers to a type of electronic component known as a light emitting diode (LED) that emits infrared radiation. Due to this characteristic, they are commonly referred to as IR LEDs. Although IR LEDs may physically resemble regular LEDs, the radiation they emit falls within the infrared spectrum, making it invisible to the human eye.

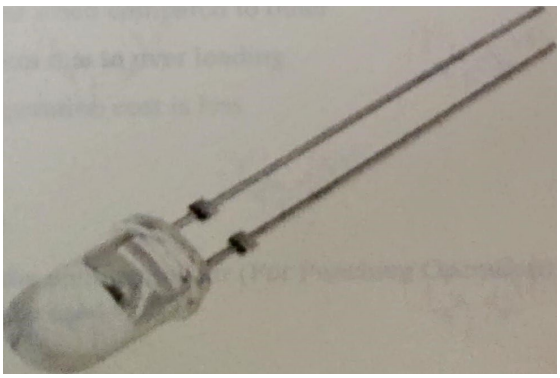
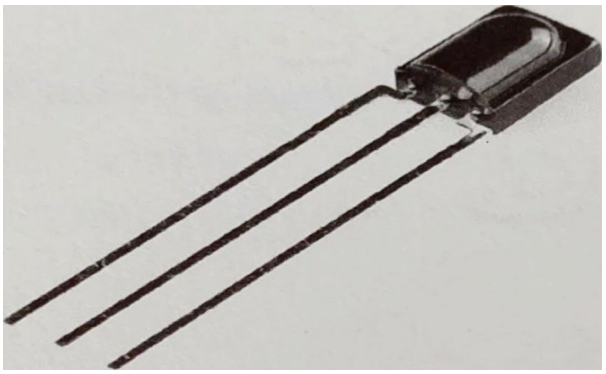


Fig 1.1 IR Transmitter

1.4.3 IR Receiver

An infrared receiver, also known as an infrared sensor, is a device that detects and receives the radiation emitted by an infrared transmitter. IR receivers are often implemented using components such as photodiodes or phototransistors. These devices are designed to sense and respond to the specific wavelength of infrared radiation transmitted by an IR transmitter, allowing for communication or detection of



signals in the infrared spectrum.

Fig 1.2 IR receiver

1.5 Advantages

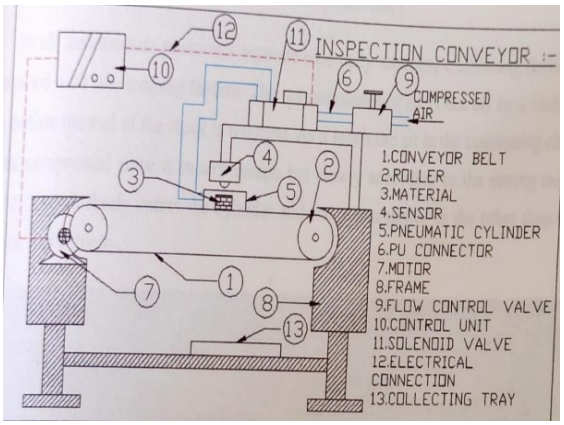
- The Inspection Conveyor is more efficient in the technical field
- Quick response is achieved • Simple in construction
- Easy to maintain and repair
- Cost of the unit is less when compared to other
- No fire hazard problem due to over loading Comparatively the operation cost is less.

1.6 Applications

The discharge of a workpiece is a crucial aspect in conveyor systems. The Conveyor Feed finds extensive applications in industries that employ low-cost automation. One such application is in automated assembly lines, where it facilitates the transportation of finished products from workstations to designated bins. Additionally, it can be utilized to retrieve raw materials and position them on the conveyor belts.

Furthermore, the Conveyor Feed system proves useful in addressing improper material removal situations. For instance, when there is a need to collect and remove faulty or unwanted materials, a solenoid-operated pneumatic cylinder is employed for this purpose. This mechanism aids in efficiently managing and discarding improper materials, ensuring the smooth operation of the overall system.

OBJECTIVES AND WORKING PRINCIPLE



3.1 OBJECTIVES

- To prepare the prototype of automatic conveyor system using IR sensors.
- Belt conveyor system is used to transfer machine components from one end to another end and for material handling.
- To inspect the dimensions of the machine components IR sensors are used.
- To segregate the defective components from the conveyor system double acting pneumatic cylinder is used.
- To detect the defective components of machine components during mass production

3.2 WORKING PRINCIPLE

The work material is passed on the conveyor, if the size of the work material is exact to the required dimensions then it is passed to next process using IR sensors. IR sensors are used for the inspection, IR transmitter which emits the infrared radiations and IR receiver receives the radiations and these sensors sends the signals to the pneumatic cylinder and oversized the material get rejected from the conveyor.

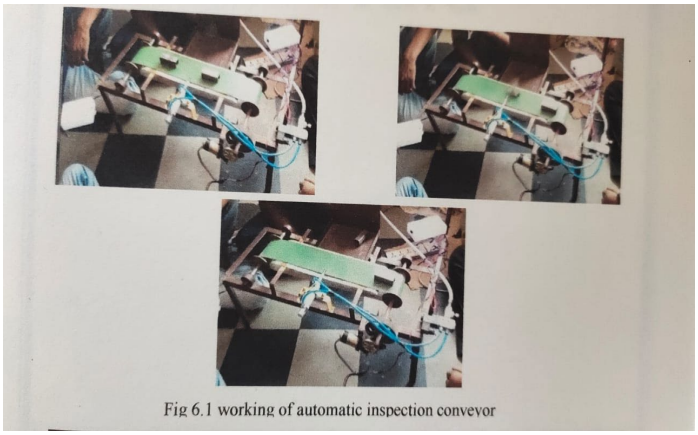


Fig 6.1 working of automatic inspection conveyor

Fig. 3.1 Block diagram of Automatic inspection conveyor

FABRICATION OF AUTOMATIC INSPECTION CONVEYOR BELT

The major parts "INSPECTION CONVEYOR" are described below

- Pneumatic single Acting Cylinder
- 5/2 Solenoid Valve
- Flow Control Valve
- Hose Collar and PU Connector
- Permanent Magnet D.C. Motor
- Electronic Control Unit
- IR Sensor
- Collecting Tray
- Conveyor Belt and Roller
- Frame Stand

WORKING OPERATION

A 12-volt power supply is utilized to power a permanent magnet DC motor. The conveyor system consists of two rollers fixed to the ends of a frame stand using end bearings (6202) and bearing caps. The shaft of the conveyor rollers is connected to the DC motor through a spur gear mechanism. This entire setup enables the transfer of materials from one location to another via the conveyor. A limit sensor switch is mounted vertically on a frame stand using a spur gear arrangement. This sensor is responsible for measuring any abnormal height variations in the material being transported. The height of the material can be adjusted using a rack and pinion mechanism, which allows for the up and down motion of the limit switch. To detect even minute height variations, an IR transmitter and IR receiver circuit are installed on the frame stand. This mechanism can be adjusted using bolts and nuts according to the requirements. Additionally, a pneumatic cylinder is attached to the frame stand at a right angle to the limit sensor frame stand. This cylinder arrangement is utilized for removing oversized materials from the conveyor. The pneumatic cylinder is controlled by a flow control valve, a single acting solenoid valve, and a control unit. In summary, this setup employs various components such as the DC motor, conveyor rollers, limit sensor switch, IR transmitter and receiver circuit, and pneumatic cylinder to enable the smooth operation of the conveyor system and ensure efficient material handling.

CONCLUSION

This project focuses on the quality control of machine components, specifically through dimensional inspection using IR sensors in a belt conveyor system. The automatic inspection conveyor system is considered the most effective method for inspecting component dimensions during mass production. The control unit is responsible for providing the necessary signals to the pneumatic cylinder. The pneumatic cylinder serves as the mechanism for collecting oversized materials. The inspection conveyor system plays a vital role in material handling within modern engineering industries. A motor is utilized to drive the conveyor, enabling the seamless transfer of materials from one location to another. At the top of the conveyor, sensors are employed to measure the dimensions of the components. This system ensures smooth operation and precise movement of the belts, enabling efficient processing of jobs within the desired timeframe.

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