Automated Conveyor for Size-based sorting of Fasteners

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Abstract—We are building an automated conveyor system that sorts fasteners, screws, nuts, and bolts all by size, with almost no need for people to step in. In factories, sorting these tiny parts by hand slows everything down, and mistakes creep in, which kills efficiency. Instead, this system relies on a straightforward mechanical setup and a conveyor belt. The design makes sure each part drops into the right bin, all by itself. No complex electronics. Just smart, reliable mechanical engineering and automation that gets fasteners where they need to be quickly and accurately. For small and mid-sized businesses, it's affordable and keeps things running smoothly. The whole project shows how automation really cuts down on manual labour, boosts accuracy, and keeps production humming along.

Index Terms—Automation, Conveyor Belt, Sorting System, Sensors, Fasteners, Industrial Automation, Size Detection

I. INTRODUCTION

Automation and conveyor systems have become the backbone of modern industry. They ramp up productivity, save workers from endless repetitive tasks, and keep manufacturing outputs consistent. Take industries that deal with fasteners, screws, nuts, and bolts by the thousands. Sorting by hand? It's slow, eats up manpower, and, honestly, even the most careful worker can miss tiny variations between pieces. This project tackles the problem head-on. The goal is to build an automated conveyor system with a built-in mechanical sorter that organises fasteners by size. Here's how it works: a conveyor moves the fasteners while special mechanical features identify and separate them, guiding each one into its matching collection bin. It's a purely mechanical solution not packed with intricate electronics or advanced controls. So it's robust, straightforward, and keeps costs in check. The heart of the work lies in designing and fabricating both the conveyor's framework and the actual sorting mechanism. It's all about keeping things running smoothly: minimising jams, maintaining flow, and making sure sorted pieces end up exactly where they belong. With this setup in place, the system saves people from tedious labour, nails down sorting accuracy, and keeps factory lines humming along. Industries that manufacture fasteners, run assembly lines, or handle bulk packaging can put this kind of system to good use, especially where speed and precision matter most. You get reliable, quick sorting without the headache of managing a complex, expensive control system.

II. PROPOSED SOLUTION

The proposed system takes a hands-on approach to sorting fasteners, think screws, nuts, and bolts, by size using a conveyor setup. The core idea is pretty straightforward: rely on basic mechanical and electrical components to keep things running smoothly without much need for human intervention. Here's how it unfolds. First, you load a mix of fasteners onto the conveyor belt. This belt doesn't just sit still; it's powered by a 12V wiper motor with battery backup. That keeps everything moving at a steady pace. The engineering here isn't fancy; it just works. As the fasteners travel along the conveyor, they hit the sorting section, which is where the real magic happens. Alongside the conveyor, there's a support strip with mechanical obstacles basically, blocks or barriers fixed at certain points. These obstacles are positioned based on the sizes you want to sort out. So, small fasteners slip through gaps designed just for them, while the bigger ones run into the obstacles. When that happens, the larger fasteners get nudged off onto another path. Eventually, everything falls into separate collection bins, effectively splitting them into small and large piles. The whole method is all mechanical; there is no need for complicated programming or tech-heavy actuators. It's low tech, but clever. But that's not the end of it. There's also an IR sensor and a little counting circuit in the mix. Each time a fastener crosses in front of the sensor, it momentarily interrupts an infrared beam, triggering a pulse. The system's counter circuit picks up on this, adding one to the tally, which you can check on a simple three-digit display. The electronics rely on a regulated power supply, which keeps everything stable so you don't get any weird miscounts or glitches. One of the big wins here is the system's simplicity. The build isn't complicated, which means costs stay low. Maintenance is a breeze, and just about anyone can learn to use it. By keeping the sorting mechanical instead of digital, you cut out a lot of potential headaches while still getting reliable results. Whether you're setting it up in a classroom, a small machine shop, or a basic factory, it gets the job done without a lot of fuss and without a big price tag. This project shows that with a little engineering know-how, you can build a practical, affordable sorting system that handles the basics with impressive efficiency.

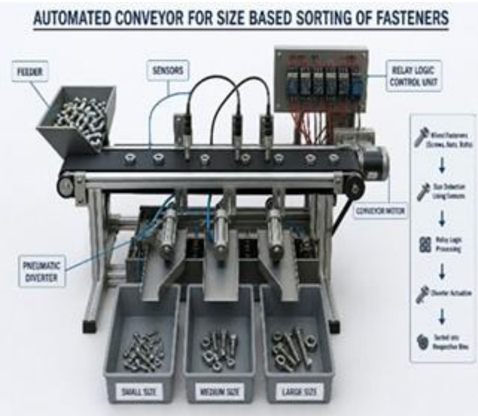

Figure 1. Conveyor System

III. MATH

1. Conveyor Belt Speed Calculation

The conveyor belt speed is calculated using the roller diameter and motor speed.
Formula: V = piDN / 60. where V = Belt speed (m/s)
D = Roller diameter (m)
N = Motor speed (RPM).

2. Conveyor Belt Length Calculation Formula: 2C+pi/2(D+d)+(D-d)^2/4C Where:

L = Belt length
C = Centre distance between rollers
D = Diameter of drive roller d = diameter of driven roller

3. Motor Torque Calculation

Formula: T = P*60/2πN where T = Torque (N-m) P = Power (w)
N = Motor speed (RPM)

4. Time Taken by Fastener to Travel on Conveyor Formula: t = d/V, where t = Time (s), d = Conveyor length (m), and V = Belt speed (m/s)

5. Sorting Efficiency Calculation

Formula: = Ns/Nt * 100 (where η = efficiency) Ns = Number of correctly sorted fasteners
Nt = Total fasteners tested

IV. UNITS

The International System of Units (SI/MKS) has been adopted as the primary unit system throughout this research work for the design, analysis, and implementation of the automated conveyor for size-based sorting of fasteners. The use of SI units ensures uniformity, dimensional consistency, accuracy in calculations, and easy interpretation of engineering parameters. All mechanical, electrical, and dimensional specifications associated with the system are represented using standard SI units.

The conveyor dimensions, including width, length, height, and roller diameter, are expressed in millimetres (mm), while conveyor motion parameters such as belt speed and travel distance are represented in metres (m) and metres per second (m/s). The rotational speed of the DC motor is specified in revolutions per minute (RPM), and the motor torque is expressed in newton-metres (N·m). Electrical parameters related to sensors, relays, actuators, and power supply are represented using volts (V), amperes (A), and watts (W).

In order to maintain dimensional accuracy and avoid calculation errors, SI and CGS units are not combined within equations or performance analysis. Wherever compound engineering units are used, standard SI notation with a centre dot representation is followed, such as N·m for torque and A·m^2 for electrical quantities. The consistent application of SI units throughout the project enhances the technical clarity, standardisation, and industrial relevance of the proposed automated sorting system.

V. HELPFUL HINTS

1. System Architecture

Our proposed system is represented in the block diagram shown below in Figure 2.

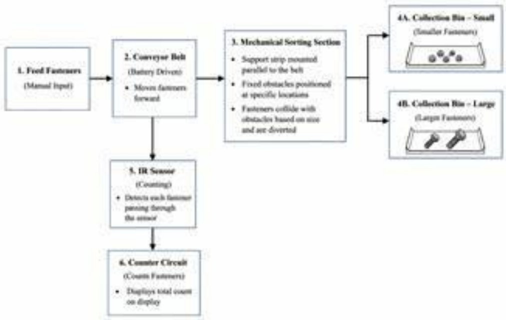

Figure 2: Block diagram of the proposed system.

Here's how the conveyor-based sorting system for fasteners works, step by step. You start by feeding a mix of fasteners, things like screws, nuts, and bolts, into the system by hand. There's no fancy auto-loader. Here, just someone pouring the mixed parts onto the line. This belt keeps everything moving at a steady, continuous pace so nothing piles up or gets left behind. As the fasteners ride along, they approach the mechanical sorting section. It sounds high-tech, but it's actually pretty clever and straightforward. There's a support strip running right next to the belt and several fixed obstacles set up at just the right spots. The trick is all in the physical arrangement. When a fastener hits one of these obstacles, it's forced to change direction based on its size. No sensors or electronics are involved in this part, just pure mechanics. Smaller fasteners might sneak past one obstacle, while bigger ones get shunted off earlier. Thanks to this setup, each type of fastener ends up following a unique path and eventually drops into its own collection bin at the end. Now, to keep track of how many fasteners are moving through, the system doesn't rely solely on the mechanical setup. There's an IR sensor placed strategically at a certain point along the conveyor. Every time a fastener passes by that point, the sensor detects it and sends a quick signal to a counter circuit. This way, you always know the total number of pieces that have been sorted, which keeps everything organised and helps with inventory or quality checks. So, this sorting system combines basic engineering principles with simple electronics. You get a process that's easy to operate and maintain, free from complex controls or software. At the end of the day, you have a reliable way to sort fasteners by size, all while keeping things efficient and uncomplicated.

2. Hardware Configuration

The major components that this paper describes are as follows:

2.1 Conveyor Frame

The structural skeleton that supports the whole conveyor (bed, rollers, motor mounts, sensor mounts, and diverter mounts). Mild steel (MS) or aluminium extrusions (T-slot) are common. MS is strong and cheap; aluminium is lighter, corrosion-resistant, and easy to reconfigure.

Design details:

- conveyor dimensions
- Width 75mm X Length 450 mm X Height 50 mm
- Total height 400 mm
- conveyor roller Dia. 50 mm X 75 mm
- Flat belt width 75mm X length 1000 mm 1 no.
- conveyor middle support 16x16x75mm 3 nos
- conveyor side flat 50x8x450mm 2 nos
- Allen bolt M6x30: 3 nos
- Allen bolt M5 X 16 mm. 16 nos
- Hex bolt M8 X 75 mm, 2 nos
- Nut M8: 6 nos
- washers, 8 mm, 4 nos

Figure 3. Conveyor Frame

2.2. Belt and Motor

The conveyor belt is the moving surface on which fasteners (bolts, nuts, and screws) travel during the sorting process. It plays a crucial role in ensuring smooth and continuous movement.

Material: Typically made of PVC, rubber, or PU (polyurethane) to provide durability.

flexibility, and good grip.

Function: Carries fasteners from the feeding point to the sensing and sorting sections.

Surface: Smooth enough for free movement but with enough friction to prevent slipping.

Mounting: Looped around the conveyor's drive roller and idler roller.

Working Principle: When the motor rotates the drive roller, the belt moves in a continuous loop. Fasteners placed on the belt travel linearly past sensors and reach the sorting mechanism.

The motor is the power source that moves the conveyor belt. It provides the rotational energy needed to drive the rollers.

Types Commonly Used

DC Geared Motor – Provides high torque at low speed, suitable for small training projects.

AC Induction Motor – Used in industrial conveyors for heavy loads.

Stepper Motor / Servo Motor – Used where precise speed control is needed.

Motor Used in Your Project: For academic and small-scale automation projects, a DC geared motor or a servo motor is commonly used.

Details:

Speed: DC – between 1,500 and 6,000 RPM under load; Servo – between 2,000 and 4,000 RPM

Torque: Must be high enough to rotate the roller along with the load on the belt.

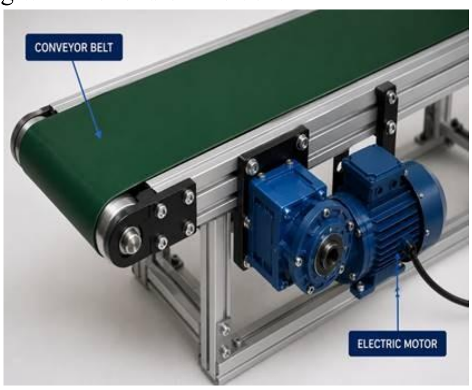

Figure 4. Belt and Motor

2.3. Actuators / Diverters

Types: pneumatic cylinder push-off/pop-up, solenoid plunger, servo/stepper flipper, and rotary actuator.

Pneumatic: Actuators are used to divert the fasteners into their respective bins. They operate quickly and respond accurately to the PLC signal. They are placed at the end of the conveyor where sorting takes place.

Figure 5. Actuators / Diverters

2.4. Power Supply

Main supply: Shop standard - 230 V AC single-phase (lab) or 415 V AC three-phase (plant).

Control supply: regulated 24 V DC DIN-rail supply for PLC I/O, sensors, and solenoid valves. Size 3-10 A, depending on loads.

2.5. Sorting bins

Design: fixed bins or sliding trays aligned under diverter outlets; number depends on size categories (3–6 typical).

Material: plastic bins (ABS/HDPE) or MS boxes.

Mounting: adjustable mount or trolley for easy removal.

Figure 6. Sorting Bins

2.6. Relay

A relay is an electrically operated switch used to control circuits by opening and closing contacts in response to an input signal. In your sorting system, relay logic is used instead of a PLC to control the operation of sensors and actuators. The relay works on the principle of electromagnetism. When a small voltage is applied to the relay coil, it generates a magnetic field that pulls the internal contacts, either closing or opening the circuit. This allows a low-power signal from the sensor to control higher-power devices like motors or actuators. In your project, sensors detect the size of fasteners and send signals to the relay circuit. Based on the input, the relay activates the corresponding actuator (such as a solenoid or pneumatic cylinder), which then diverts the fastener into the correct bin. Each relay is configured to respond to a specific sensor output, forming a simple decision-making system. Relays are preferred in this project because they are cost-effective, easy to understand, and simple to implement. They do not require programming like PLCs and are suitable for small-scale automation systems. However, they are less flexible compared to PLCs when complex control logic is required. Overall, the relay acts as the control unit of the system, ensuring proper coordination between sensing and sorting operations.

Figure 7. Relay

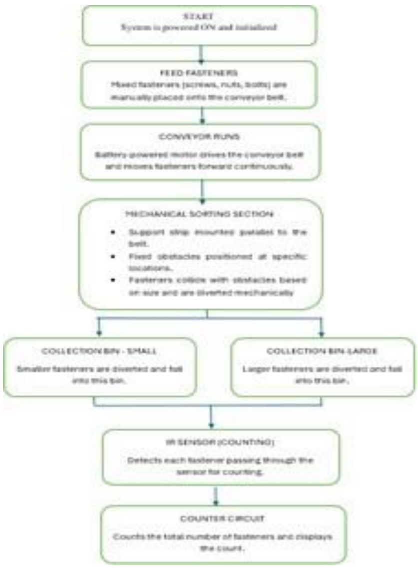

Figure 8. Process Flow Chart

Figure 9. Actual Implementation

VII. RESULTS

The system we built sorted small and large fasteners by size without any trouble. It kept the conveyor moving steadily thanks to the setup with the wiper motor and battery. With the mechanical obstacle arrangement in place, the system smoothly separated fasteners into their respective collection sections, making the whole process look clean and organised. The IR sensor and counter circuit did their job, handling both detection and counting reliably. It was easy to see the separate counts for small and large screws on the display units, giving clear feedback on how everything was running. Throughout our tests, The whole setup ran without hiccups, showing off a straightforward conveyor-based sorting method that’s not just easy to understand but also works well for demo purposes or small-scale operations. It's a simple solution, but it’s practical, and you can definitely see its real-world potential for quick sorting tasks.

VIII. CONCLUSION

The Automate Conveyor for Size-based Sorting of Fasteners project shows how you can handle materials efficiently without getting too complicated. The system uses a smart yet simple setup: fixed obstacles and guides run parallel to the moving belt, and they sort fasteners by size. No fancy tech, just straightforward mechanics doing the work. To keep tabs on what’s happening, there’s an IR sensor and a counter circuit tracking the data. The real magic, though, is in the simplicity. Those mechanical diverters mean fewer things that can break down, and maintenance stays easy. This project proves you don’t always need advanced electronics or expensive machines to sort materials reliably. It's cost-effective, saves energy, and fits right in with small or midsize factories. By cutting down on manual labour, this conveyor keeps things moving steadily and consistently. In the end, it's a great example of how good mechanical design can still drive practical automation, and you won't need a technician every time something goes wrong.

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