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OBJECT SENSING CUM ENERGY STORING CONVEYOR BELT

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Abstract: There are wide varieties of Conveyor systems are in use in industries for moving materials from one location to another. But the one which we designed here is a unique conveyor belt that generates electric energy without any additional mechanism. In general, any conveyor belt system uses metal drums or rollers to move the belt, out of so many, one roller will be coupled with the shaft of drive motor and it is called as power drive roller and the remaining rollers are idle. If a dynamo is attached to the idle roller, it generates electric energy without any extra efforts. Since idle rollers may be plenty according to the length of conveyer belt, all of them can be constructed with dynamos. But since it is a prototype model, little length of conveyor belt mechanism will be constructed with two roller drums for demo purpose. One roller is made as power driven and the other one is made as power generator. The power-driven roller is constructed with 60 RPM DC motor, and power generator motor is built with 100 RPM motor and this motor is used as dynamo. To increase shaft speed of 100 Rpm motor, spur gears are used.

Another important aspect of the system is that the mechanism is made as automatic such that by sensing the object put over the belt, then only the belt will be moved and otherwise it remains in off condition. The object can be a small carton box and the sensing circuit is constructed with IR sensors. 89c51 microcontroller chip is used to control the mechanism. The dc motor used to generate the power can generate little energy which can be used to charge a low power battery of 4v. To prove whether we are getting energy or not, hear a small LED lamp load built with 10 high glow LED’s is used. Mode switch is used to select either lamp load or charging option.

***Index Terms* -** Conveyor Belt Energy Generation, Power-Generating Conveyor System, Automatic Object Sensing Conveyor, Energy-Harvesting Conveyor Belt, and Microcontroller Controlled Conveyor System.

I. INTRODUCTION

This project sets out to develop a fully automated system for handling materials, using a combination of IR sensors and a Micro Controller Unit (MCU) to precisely manage objects on a conveyor belt. By tapping into the energy generated by the motion of idle rollers through dynamo mechanisms, the system can generate electricity, which is then stored in batteries for various applications like powering lights. This integration of electronic, mechanical, electrical, and control technologies is at the core of Mechatronics, with a microcontroller serving as the central brain of the operation. A prototype has been built to showcase the system's functionality, with potential for scalability to real-world applications. The project relies on an ATMEL 89C51 microcontroller for control, reflecting the growing trend towards using microcontrollers for their efficiency and adaptability. Ultimately, the project seeks to explore control theory applicable to microcontroller-based systems, underscoring the importance of fully utilizing the capabilities of such systems.

II. FUNCTIONAL DESCRIPTION OF THE PROJECT

This section of the project aims to elucidate the functional operation of the system in a step-by-step manner, breaking it down into comprehensible blocks. Through a thorough examination of this explanation, readers can grasp the foundational aspects of the project. Let's delve into the essence of each block, illuminating the core concepts behind the project's functionality.

2.1 IR Sensing Circuit

The obstacle sensing circuit employs IR sensors positioned at the start and end of the conveyor belt. These sensors utilize the LM567 IC, serving as a tone decoder and frequency generator, to identify obstacles. IR sensors are employed as both transmitters and receivers, with the LM567 IC facilitating their operation. By emitting infrared signals, the sensors detect interruptions caused by objects, triggering a response in the form of a low signal to the microcontroller. This signal prompts the controller to activate the conveyor belts DC motor via a relay. Subsequently, when the second IR sensor is obstructed, the DC motor ceases operation, allowing for object sorting. Infrared sensors play a vital role in this system, detecting infrared radiation to sense characteristics of the surroundings, including heat and motion. Operating beyond the visible light spectrum, infrared waves are transformed into electrical signals by the sensors, facilitating their detection and interpretation by the circuitry.

2.2 Function of LM 567 Tone Decoder Chip

The LM567 IC serves as a tone decoder in the circuit, detecting input signals within its pass band and providing a saturated transistor switch response. Its operation involves two-phase detectors driven by a voltage-controlled oscillator (VCO), which determines the center frequency. External components allow independent setting of center frequency, bandwidth, and output delay. By configuring the IC with resistors and capacitors, the VCO generates a specific frequency output. A PNP transistor amplifies this signal to drive an IR transmitting LED, which emits modulated IR signals with amplified strength. The IR receiver, connected to the IC's input pin, detects these signals, which may contain noise. A capacitor filters out noise before the signal is compared with the generated frequency. The I-phase detector compares the received and generated frequencies; if they match, the IC's output pin is enabled, producing a logic low signal. When obstacles interrupt the IR signal, frequency matching fails, resulting in a logic high signal. Placing IR sensors facing each other or side by side alters signal reception, influencing output logic. A LED connected to the output pin indicates the logic state.

2.3 Mechanical Section

The mechanical system in the project involves converting rotational motion into linear motion to operate the conveyor belt. This is done using DC motors with built-in reduction gear mechanisms, allowing for handling heavy loads despite the small motor size. Gear trains adjust shaft speed, and limit switches and magnetic switches control movement. The project sections focus on automatic object detection and transportation over the conveyor belt, with Arduino Micro Controller Unit coordinating operations. Industrial conveyors are defined by their automated control and versatility, considering factors like payload and accuracy. Overall, the mechanical system efficiently drives the conveyor belt, ensuring precise control.

2.4 Source of Voltage

In this project, the motors attached to the rollers function as voltage sources, generating electrical energy through the conversion of magnetic energy. Despite their ability to produce only small amounts of voltage and current, these motors can power small loads. Through testing, it was determined that each motor can generate approximately 30 milliamps of current at 6 volts, enough to illuminate three LEDs. However, the main goal is to charge a battery. To confirm energy generation, LEDs are connected to each motor individually, with any remaining energy used for battery charging. When the motor shaft rotates, the LEDs light up, indicating the delivery of charge. The conversion of energy into electrical energy in this project relies on magnetic energy. Generators, which are rotating machines, are crucial sources of electrical power. They operate by converting mechanical energy into electrical energy through the principle of magnetism. As conductors rotate within a magnetic field, voltages are induced in them due to magnetic induction.

2.5 Electric Motor that Generates Electrical Energy

An electrical motor is repurposed as a generator to convert mechanical energy into electrical energy. Operating akin to a standard generator, it adheres to Faraday’s laws of electromagnetic induction, using a DC motor for this purpose. The DC motor comprises an armature, magnetic field, commutator, and brushes. As the commutator rotates with the armature, brushes maintain contact, ensuring a consistent polarity for the output voltage. This produces a fluctuating yet polarized DC voltage. Applying a DC voltage across the brushes sets the armature in motion, generating torque. The strength of the magnetic field largely dictates the torque produced by the motor.

2.6 DC Motor

DC motors are versatile and commonly used due to their affordability, compact size, and ease of control, requiring only two signals for operation. They convert direct current voltages into rotational movement and can be powered directly from batteries or DC power supplies. In robotics, they're favored for their low cost, variable speed, and ability to handle high starting torque, making them suitable for frequent start/stop cycles and closed-loop positioning. These motors typically operate at voltages of 6V or 12V, with gear shafts enhancing their torque. They're reversible, allowing the direction of rotation to be changed by simply reversing the polarity of the voltage. The motor's speed, specified in rotations per minute (RPM), varies depending on load. To control the speed and direction of DC motors, a circuit with an L293D chip, known as an 'H' bridge, is commonly used. This project utilizes sensors to determine the drive sequence for independently controlling two motors in both directions.

2.7 Relay

Relays, stemming from Samuel Morse's innovations in the 19th century, remain crucial electrical components today, providing a simple, reliable means of controlling circuits. Acting as electric magnifiers, relays allow weak currents to activate stronger ones while ensuring complete electrical isolation between controlling and controlled circuits. In this project, relays are essential for driving the DC motor, as the controller alone lacks the power to do so. These electromagnetic switches operate via a coil-induced magnetic force, attracting an armature to close or open contacts. Energizing the coil closes the contacts, allowing current flow, while de-energizing opens them, interrupting the circuit. Relays are pivotal here because the DC motor exceeds the capacity of controlling transistors. By sending a signal to a transistor, which activates the relay's coil, the motor circuit is completed, enabling conveyor belt operation.

2.8 Spur Gear Mechanism

Spur gears, the most common and oldest gear type, are vital in mechanical engineering due to their versatility and simplicity. Their straight teeth and parallel shaft mounting allow for easy interlocking and transmission of rotary force. Spur gears are crucial in various applications, including speed adjustment, torque multiplication, and power conversion in machines like washing machines, clocks, and power stations. They're also essential for resolution enhancement and accuracy in positioning systems. Despite their efficiency and widespread use, spur gears can produce noise at high speeds due to teeth collision, making them unsuitable for automotive use. Understanding the dimension and mounting specifications of spur gears, including factors like diametral pitch and pressure angle, is essential for proper gear selection and functionality in diverse mechanical systems.

III. WORKING PROCESS

The conveyor system operates through a clever roller setup: one roller propels the belt with a 60 RPM DC motor, while another, fitted with a 100 RPM dynamo, converts motion into electrical energy. It's like having a dynamic duo of rollers, one pushing forward and the other quietly generating power. When an object is placed on the belt, like a little carton box, smart sensors kick in, signaling the microcontroller to set things in motion. As the belt glides along, the dynamo roller springs into action, capturing kinetic energy and transforming it into electricity. It's a bit like turning motion into magic! This energy can then be used to light up a series of LED lamps or charge up a 4V battery, providing both illumination and backup power. It's a seamless dance of efficiency and sustainability, where every movement contributes to a greener tomorrow.

IV. APPLICATIONS

This innovative conveyor system, with its ingenious integration of energy generation, presents a sustainable solution for material handling across diverse industries. Specifically, it serves as a vital cog in manufacturing facilities, ensuring smooth transitions of raw materials, components, and finished products while also illuminating workspaces and powering auxiliary equipment. In warehouses and distribution centers, it orchestrates the efficient movement of goods, reducing operational costs and lessening dependence on external power sources. Moreover, in logistics and shipping operations, it becomes the silent hero, automating parcel handling and providing on-site energy for various facility needs. Likewise, in retail and e-commerce hubs, it quickens order processing while bolstering energy efficiency and resilience during power disruptions. Its applications extend gracefully into food processing and packaging domains, where it maintains the integrity of materials and contributes to sustainability objectives. Additionally, in bustling airport terminals, it ensures luggage glides effortlessly between gates, all while reducing environmental footprint. Furthermore, in rugged mining landscapes, it powers through bulk material movement, offering a reliable energy source in remote corners. Overall, this versatile conveyor system emerges as a beacon of efficiency, seamlessly blending functionality with sustainability across industries, ushering in a greener, brighter future.

V. LIMITATONS

While this conveyor system brings a host of benefits, there are certain limitations to consider. Firstly, getting started with this advanced system requires a significant initial investment. This includes not only the energy-generating components but also complex control systems, which can be pricier compared to traditional conveyor setups. Moreover, keeping the system running smoothly requires regular maintenance of its energy-generating components and control electronics. This upkeep ensures consistent performance but can also lead to higher maintenance costs and occasional downtime. Additionally, the system's energy output might not always match facility demands, especially in smaller-scale applications or during quieter periods, potentially leaving energy needs partially unmet. Integrating energy-generating components may also present challenges in facilities with limited space or intricate layouts, impacting installation feasibility. Environmental factors like temperature, humidity, and dust levels can further influence energy generation efficiency. Furthermore, considerations such as scalability, compatibility with existing infrastructure, and the reliability of energy generation and sensor-based activation mechanisms play crucial roles in determining the system's overall performance and operational feasibility.

VI. FUTURE SCOPE

Looking ahead, the future of energy-generating conveyor systems lies in overcoming current challenges while enhancing performance. Researchers anticipate a concentrated effort on refining these systems by tackling their limitations and optimizing their efficiency. This entails exploring innovative technologies to reduce costs, devising advanced energy storage methods, and seamlessly integrating renewable energy sources. Additionally, there's a keen interest in improving scalability and compatibility, ensuring these systems can adapt to various industrial settings with ease. To achieve these goals, fostering interdisciplinary collaboration among researchers, engineers, and industry players will be paramount. By joining forces, we can push the boundaries of innovation, driving the widespread adoption of energy-generating conveyor systems and ushering in a new era of sustainable material handling in industries.

VII. CONCLUSION

In closing, energy-generating conveyor systems hold immense promise for revolutionizing sustainable material handling practices in industries. These systems not only streamline material transportation but also ingeniously generate electricity onsite. While challenges like initial costs and maintenance persist, ongoing research aims to surmount these hurdles and boost system efficiency. Looking forward, the path ahead involves cost-saving innovations, cutting-edge energy storage solutions, renewable energy integration, and system scalability enhancements. Collaborative efforts among researchers, engineers, and industry leaders will be pivotal in propelling this technology forward. Together, we can pave the way for energy-efficient operations, cost reductions, and environmental stewardship across diverse industrial landscapes.

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