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AUTOMATION AND ROBOTICS IN PRODUCT PROCESSING

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Abstract- Automatic product processing is a combined process of packaging, grouping, placing, distribution and sorting of products which is necessary for protection, distribution, quality control, storage, sell and use. Automation and robotics is highly effective for industries in product processing. It is very easy to analyze a product by using advance technology. Weight sensors, LASER, IR sensor, X-ray, bar code reader, color sensor are used to analyze different properties of the products. The responses of the sensors are manipulated by computer to take decision and to control the whole system e.g. speed of conveyor belts, distribution lines, assembly lines, grouping and regrouping of products. If this system is implied in the industry, time will save as the processing speed increase because of quick and accurate analyzing and it will reduce the labor cost and enhance the efficiency of production.

Keywords: Product Processing, Automation, Robotics, Labor Cost, Processing Speed, Efficiency.

1. INTRODUCTION

Products can be processed both manually and automatically but manual product processing systems requires relatively more time than automatic product processing system. This also results in an extra labor cost. Automatic product processing is a fast and efficient way where physical & barrier protection, security and perfect distribution of products can be ensured. The main packaging system where products are packed into packages which is known as primary packaging system. In secondary packaging system primary packages are placed into a box or carton. Then the tertiary packaging is used to combine the entire secondary packages into a pallet [1]. In this system the products on the conveyor belt are analyzed and counted by several sensors e.g. weight sensor, IR sensor, X-ray, bar code reader, color sensor etc. with the help of robotics technology. Then the sensor response is captured by microcontrollers. Microcontroller analyzes the received data to take decision and give corresponding output. These outputs are sent to motor controller, communication devices, computers etc. So the products can be analyzed quickly as well as the processing speed increase. This system is fast enough to reduce labor cost.

Because of automatic product processing, from 1950 the number of workers employed by the U.S. steel industry dropped by 74%, from 289,000 to 74,000, while output increased by 36 percent, from 75 million tons to 102 million tons [2]. Automation can directly impact quality and efficiency, increase control and improve viability because one robot can perform the work of three to five people. Direct labor costs are greatly reduced.

For a brief period, Ford Motor Company's top executives and its public relations department touted automation as a revolutionary development in American manufacturing [3]. In this 21th century every industry should include automation and robotics in processing different products to increase production.

2. FEATURES OF T SYSTEM

The main features of this processing system in industries that can be enhanced by using automation and robotics technology are discussed below.

2.1 Grouping

Products of the same kind are required to be grouped or regrouped in a packet in primary packaging. Then the same kinds of packet need to be grouped in the carton/box in secondary packaging as well as the cartons are grouped also in tertiary packaging.

2.2 Physical Protection

The products require protection from compression, shock, vibration, heat and etc. In manual process this protection can't be ensured.

2.3 Barrier protection

Barrier from water vapor, dust, air and etc., is needed for the products to extend its shelf life.

2.4 Security

Security risks of shipment & distribution can be reduced by automatic processing. Proper shipment of the products and supply of the products is ensured soon enough by this processing system.

2.5 Convenience and others

Some significant feature can be added on the products

e.g. handling, stacking, display, sale, opening, reclosing, use, and reuse, adding convenience in distribution by using this kind of processing system.

3. DESCRIPTION OF A PROTYPE OF THE SYSTEM

In this prototype there are only two features.
1. Grouping
2. Counting

Below the description of the process to make this processing system is described.

On a wooden platform the other parts are attached by nuts & bolts. There are two conveyor belts: one carries foods and other carry packets. The belt which carries packets is attached on the wooden platform. The other belt which carries food is implemented on the platform by four lags. The motor's shaft is coupled with gear concentrically which is connected with the shaft of the conveyor belt by toothed belt. Motors are mounted on the wooden platform. Angle brackets are used to mount the motors on the platform. Circuit board is also placed on the platform.
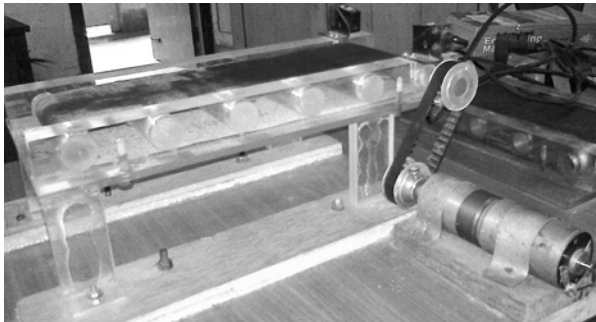

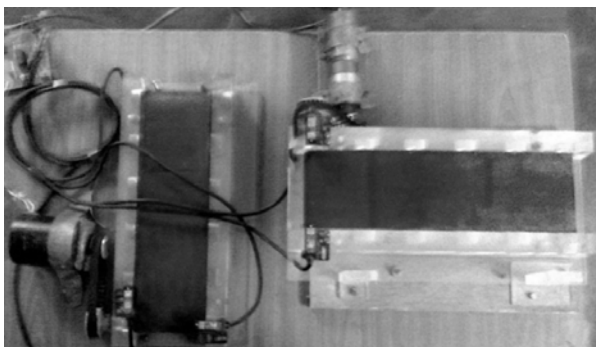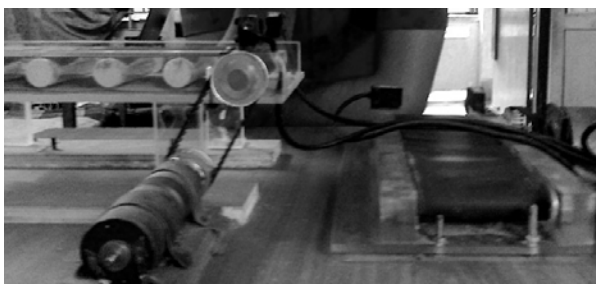Fig.1: Isometric view of the prototype

Fig.2: Top view

Fig.3: Side view

This model is specially designed to collect two same kinds of the products in a packet. Description of the main instruments that are used to make this prototype and operations of those instruments are given in this document.

4. ELECTRICAL PARTS

Circuitry of this prototype is designed on basis of the mechanical devices that are used to operate the products and packets.

4.1 Circuit Designing

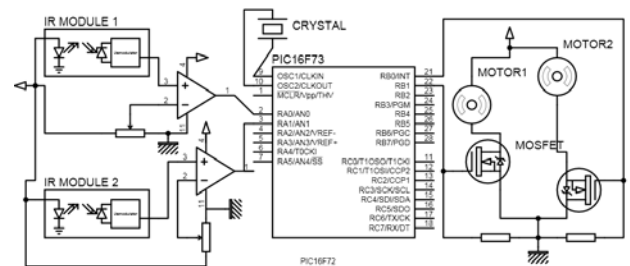The schematic diagram of the full circuitry is given below:

Fig.4: Simplified Schematic Diagram of the circuitry of the model (This diagram is drawn in Protius Simulation Software).

4.2 Microcontroller and interfacing

It is a small computer on a single integrated circuit. It contains a processor core, memory, and programmable input/output peripherals. This device mainly used in automatically controlled products and devices.

To make this model PIC16F73 is used which has three ports called PORTA, PORTB & PORTC. They all have several features in common [4]:

- For practical reasons, many I/O pins have two or three functions. If a pin is used as any other function, it may not be used as a general purpose input/output pin;
- Every port has its "satellite", i.e. the corresponding TRIS register: TRISA, TRISB, TRISC etc. which determines performance, but not the contents of the port bits.

Here RA0 & RA1 pin of PORTA are used as input pin and RB0 & RB1 pin of PORTB as output pin. This two pin handles the motors. Because of using digital input and output, Analog to Digital Converter Module of the microcontroller is disabled here. By setting ANCON1 register value to 0x06, every pin is declared as Digital I/O.
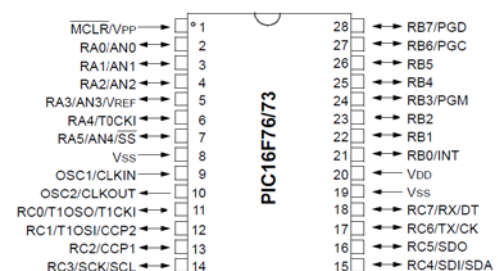

Fig.5: PIC16F73 Microcontroller Pin Diagram. [5]

4.3 Sensors

To detect objects on the conveyor belts IR sensors are used. Most common consumer electronic remote controls use infrared light. They typically generate infrared using light emitting diodes (LEDs), and the main component of a receiver unit is usually a photodiode. IR transmitter LED flashes invisible light, which is picked up and then turned into a change in the output voltage by the receiver module.[6] If there is a product in the line of sight of the transmitter LED and receiver module, infrared can't reach to the receiver module. This phenomenon is used to detect product on the conveyor belts. Industrially LASER can used to detect products.

Potentiometer is used to get a variable fraction of voltage. Generally a voltage is applied across the potentiometer then it deliver variable fraction of voltage. It is mainly used for to adjust the sensitivity for sensors.
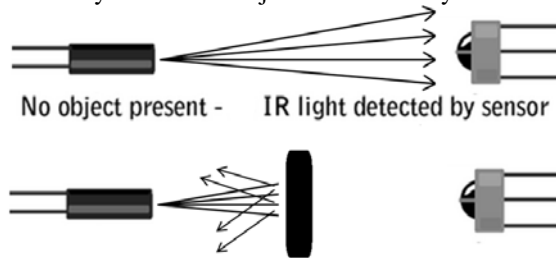

Fig.6: IR sensors working principle

4.4 Motor Controlling

In this model, the conveyor belts are operated by high torque motor which requires more current. To control large amount of current MOSFETs (metal – oxide – semiconductor field-effect transistor) are generally used [7]. MOSFET is used as a switch here. It just switches the current flow through the motors. DC gear head motor is used to operate conveyor belt.

The Motor controller works as follows:

Table 1: Motor Controller

Signal A	Signal B	Condition of Motor
0	0	Motor stops
0	1	Motor rotates clockwise
1	0	Motor rotates anti-clockwise
1	1	Motor stops

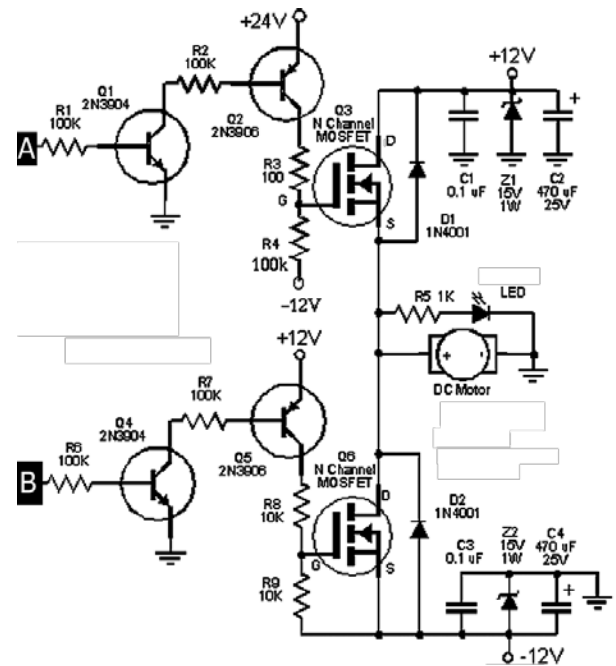The following circuit is used to make the motor controller [8].

Fig.7: Motor Controller using MOSFET

In this motor controller cut-off and saturation characteristics of MOSFET are processed to make this behaved like a switch.

5. MECHANICAL UNITS

Mechanical units consider the matters of strength, shape, torque, materials, joining and assembling. Mechanical components that that used to build the prototype are described below:

5.1 Wood

Wood is a hard, fibrous structural tissue found in the stems and roots of trees and other woody plants [9]. It has been used for thousands of years for both fuel and as a construction material.

5.1 Plywood

Plywood is a manufactured wood panel made from thin sheets of wood veneer. It is one of the most widely used wood products. It is flexible, inexpensive, workable, and re-usable, and usually can be manufactured locally. It is been used for thousands of years for both fuel and as a construction material.

5.2 Rack and pinion

A rack and pinion is a type of linear actuator that comprises a pair of gears which convert rotational motion into linear motion. A circular gear called "the pinion" engages teeth on a linear "gear" bar called "the rack"; rotational motion applied to the pinion causes the rack to move, thereby translating the rotational motion of the pinion into the linear motion of the rack.

5.3 Nut

A nut is a type of fastener with a threaded hole. Nuts are almost always used opposite a mating bolt to fasten a stack of parts together.

6. PROGRAMMING UNITS

The program used for the model is written in C language for MikroC® Pro for PIC compiler. MikroC® Pro for PIC is a compiler which is used for coding PIC microcontrollers. Code is written in C language where basic rules of C programming language are maintained in this compiler. Library functions of this compiler are called to code the program. This compiler generates the hex file of the program which was uploaded in the PIC microcontroller model number PIC16F73 using PICKIT® 2.

6.1 Programing Algorithm

Programing algorithm is the way to describe how the devices will be controlled and worked.
The following flow chart represents how the program for the model is working. Here this algorithm shows to count two same kinds of products and to put the products in one packet.
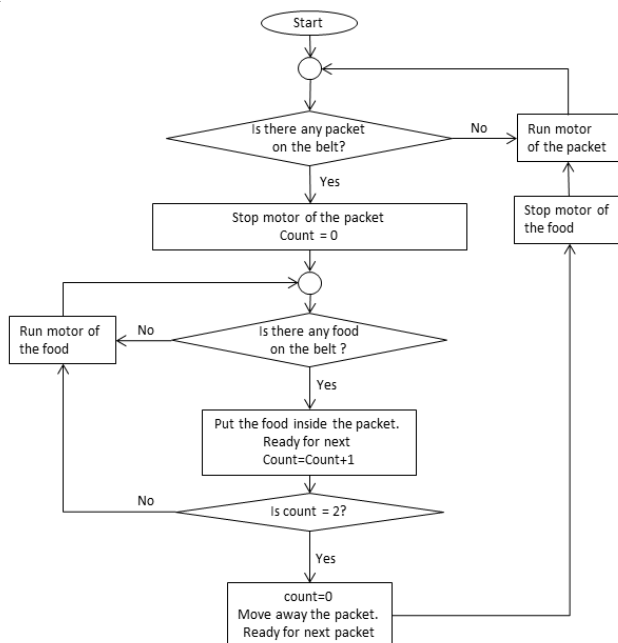

Fig.8: Flow Chart of the Program algorithm

It will not show the operations performed in detail but just the main operation how, where and the products is processed.

7. CONCLUTION

By using advance technology and robotics processing speed of the products is getting faster day by day. As the conventional methods of processing are slow and unhygienic, this automatic system should be implemented in the industries.

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