

Automatic Infra-red Sensing System

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Abstract — An experiment has been carried out in order to sort objects by height by using a 2 link robotic arm along with a conveyor. The conveyor belt carries the object to be sorted and the simulation of a production line is done by the conveyor belt. The flexibility of the system is increased because systems sensing capability permits the object to be anywhere on the conveyor belt. The source to find the possibility of such automated sorting system is the combination of sensor system and hardware along with the software. The concern regarding the use of IR (Infra-red) range sensor in determining the location of the object is discovered by testing it for repeatability. Thus, in other aspects except this the system proves to work well and it has some possible uses where automated sorting is preferred. A process in which a finished product is produced much faster than handcrafting-type methods by adding the parts to the product in a chronological order is called as assembly line. The important part of an assembly line is conveyor belt system which performs the function of conveying goods from one place to another. In this investigation an improvised conveyor belt is developed which separates material according to its size and return the unwanted goods outward. Infra-red sensors have certain advantages such as consumption of electricity is low and provides longer life.

Keywords — conveyor belt, infra-red, assembly line, flexibility, sorting, repeatability, robotic arm.

I. INTRODUCTION

The organization of workers, tools or machines, and parts is done chronologically by the conveyor belt. Due to this there is a minimisation of the motion of workers. The conveyors or motorised vehicles are used to handle all the parts or assemblies. In 1913, while performing an investigation with mounting body on Model T chassis various assembly methods were tested by Ford in order to improve the measures before fitting the equipment permanently. In order to mount the body an actual assembly line was used. Adam Smith converses about the separation of workers in the production of pins in The Wealth of Nations which was published in 1776. In between the year 1801 and 1803 Portsmouth Block mills was built which was the first continuous straight line process. For manufacturing the parts for the blocks used by Royal Navy various types of machine tools were designed by Marc Isambard Brunel (father of Isambard Kingdom Brunel), along with Henry Maudslay and others. It was in use till 1960 and still has a workshop at HM

Dockyard in Portsmouth. Bridgewater Foundry was known for its easy material handling. This factory was surrounded by Bridgewater canal, Liverpool and Manchester Railway. Eli Whitney in 1801 by applying the principles of separation of labour and engineering tolerance in order to generate assemblies from parts discovered the armoury system of manufacturing. In 1916 Roe named the automatic flour mill built by Oliver Evans in 1785 as the handling of materials in bulk. Different parts of this mill are bucket elevator having a leather belt, screw conveyors, canvas belt conveyors. In the last part of 19th century for the loading and unloading of ships steam powered conveyor lifts were used. The concept of modern assembly line is attributed to Ransom Olds which helped him to manufacture the first mass-produced automobile, the Oldsmobile Curved Dash. The same concept was used by Olds in his Olds Motor Vehicle Company Factory in 1901. On December 1, 1913 assembly line of Ford Model T came into operation. William “Pa” Klann presented the concept of assembly line to Ford Motor Company when he saw the butchering of animals while moving along a conveyor during a visit to Swift & Company’s slaughterhouse in Chicago. In 1956 Charles E. Sorensen, in his book My Forty Years with Ford, introduced a new form of development which was not related to individual inventors.

II. EXPERIMENTAL SETUP AND WORKING

The setup consists of two circuits which are arm circuit and conveyor belt circuit. The arm circuit consists of 9 resistances, 104 pico-farad capacitor, variable resistance, electrolyte capacitor(10 V, 50 micro-farad), pre-coded 555 timer IC circuit, 5 n-p-n junction transistors(BC 548), 6 V DC relay and 9 V DC battery. The conveyor belt circuit consists of 2 lead acid batteries of 4 V each, 2 electrolyte capacitor, 4 IN 4007 diodes, 4 resistances, 2 LED and 1 sliding switch. The setup involves the sorting of objects according to size with the help of a 2-link arm. This arm has certain advantages over conventional systems such as workspace is increased and it has the capability of placing objects anywhere. The system consists of four major components. The first component is mechanical and system hardware. Sensing is another component of this system. Sensing is classified into three major categories. One aspect is determining a method in order to sense the position of an object on the conveyor belt because the width of the conveyor belt is more than the object due to which there are various places where an object can be. IR

sensor is used to perform the function of sensing the position. Another aspect of sensing is the measurement of joint angles of each link of the arm. For controlling the movement of arm to different locations and determining the joint angles of each link inverse kinematics are used. A two link serial manipulator with parallel plate gripper as the end effector, conveyor belt moving at a constant speed and at the start of the conveyor belt an infrared rangefinder is connected. All this components constitute the hardware. With the help of a standoff (15 cm) the IR rangefinder is connected to the conveyor belt because it enhances the working space. For providing stability, the arm is connected to another end of the conveyor belt with the help of its own standoffs. End effector has a workspace of 8.8 cm and in order to achieve a required movement along the x-axis of the manipulator the former distance is combined with the distance from the origin of the arm to the edge of the conveyor belt i.e. 21 cm. The distance from the origin of the arm to the conveyor belt i.e. 10 cm and the height of each object i.e. 6.5-7 cm are used to determine the control for the y-axis of the manipulator. The primary objective of the system is to keep the conveyor belt driven by motor in continuous motion. In order to handle the objects on the conveyor belt a parallel plate gripper is used. To control the servomotors of conveyor belt and gripper the coprocessor of the RBE Development Board is used. The process for sorting of objects is described as follows: with respect to the base of the robot determine the position of each object on conveyor belt; find the joint angles of each link of the arm by using inverse kinematics; find the exact timing for lifting of object; lifting of object; based on weight find the object; and finally sorting of objects. In this system Vex sensors can also be used along with other sensors. As the object is detected by the IR sensor, the gripper at the other end of the belt lifts up the block. PIDCs are used to control the double link arm. Digital to Analog converter is used in the procedure of weighing of object. In order to run the Vex motors in the belt and gripper Vex interface is used. The control of the links of the arms and analysis of the output of IR sensor and potentiometers are performed by the board. An important factor in the measurement of the weight of the object is the torque on the arm. IR sensor, DAC, ADC, amplifiers and microprocessors are the major electrical components used in the system. Both microcontroller and co-processor are ATmega644PAs. The function of the main processor is to store and implement the program and it consists of ADC. The servo motors of both belt and gripper are controlled by PWMs and in order to create them co-processor is used. For controlling the two motors both DAC and amplifiers are used. The output voltage of DAC is from 0 to 2.5 V and it takes a number between 0 and 4095. Before sending the signal to the motor in order to drive it is multiplied by a factor of 6.1.

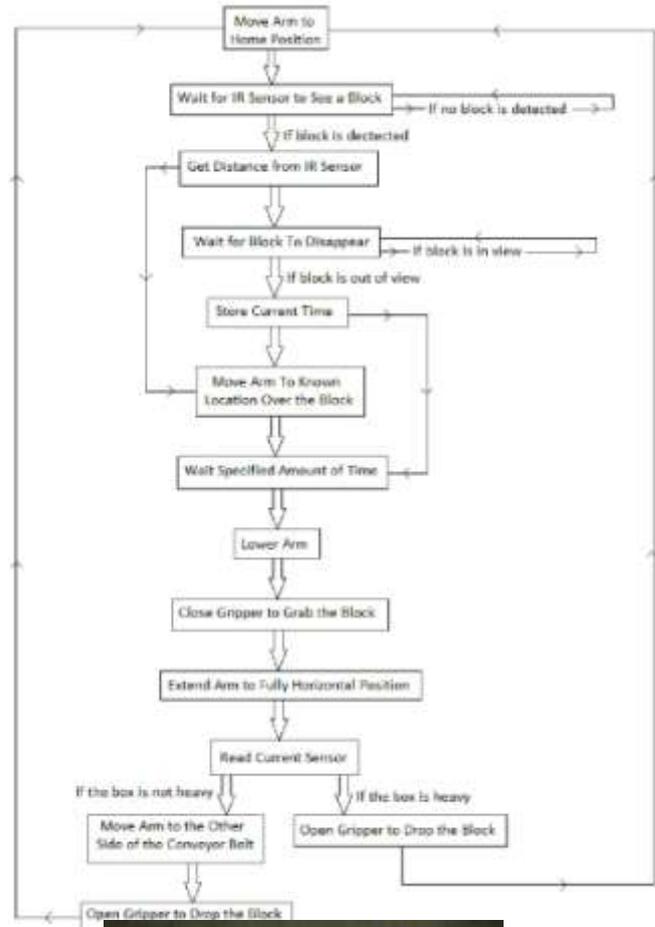


Fig. 1 Experimental Setup

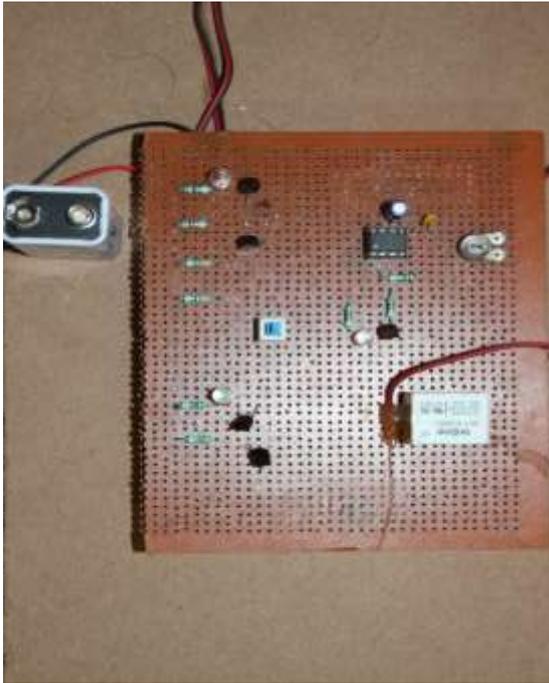


Fig. 2 Arm Circuit

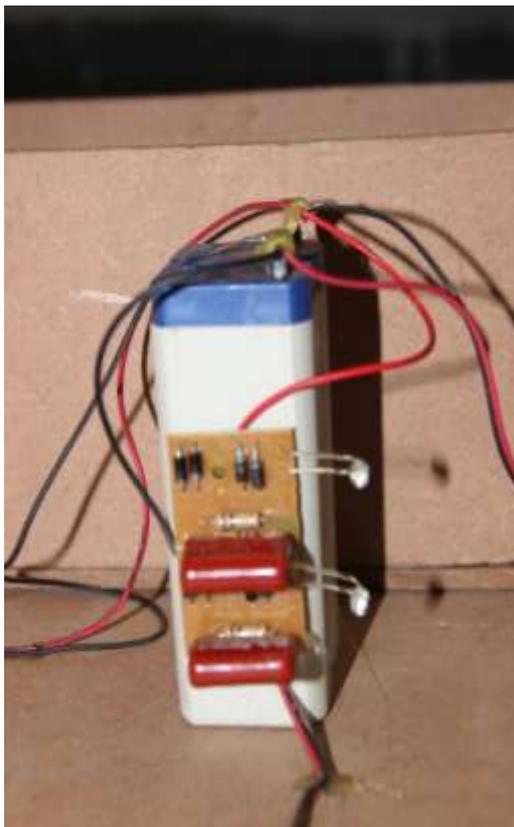


Fig. 3 Conveyor Belt Circuit

III. RESULTS

As the investigation is performed due to which the system along with the software is developed then evaluation of system is done in terms of consistency and utility. During the experiment it is observed that the success rate of lifting up of the object is

approximately 65% but there is a disadvantage regarding the ability of IR sensors. The object is sorted by the system about 90% of the time. Due to negligible difference in weights it becomes difficult for the arm to sense the difference in weight between light object and no object. Finally, the system performed very well as expected.

IV. CONCLUSIONS

Overall, the system was relatively successful in demonstrating the basic principles behind this method of automated sorting by weight. The major limitation is reliability of the IR sensor. Without good measurements from this sensor, the arm does not know where to pick up the object, which is the main reason behind most misses. Some possible causes could be sensitivity to the angle of the object, or sensitivity to the reflectiveness of the object. In either case, the IR sensor could not produce reliable data and is the main limitation of the system. If future work is considered for this type of system, an alternative method for sensing the object's location will be required. Possible replacements could be better quality laser range finders or various uses of digital sensors such as photo-interrupters. Another limitation of the system that is notable is the small workspace. The method of "DAC counting" performed very well and rarely got the weight wrong. This is definitely an advantage of the system as it provides a way to accurately measure weights without any additional sensors. PID and inverse kinematic control of the arm also performed well. Future work should focus on a new method of sensing where the object is on the conveyer belt.

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