SEGREGATION OF RECYCLABLE WASTE MATERIALS

Mrs .Mary Victoria[1], Ms.Bhuvaneshwari.M[2], Ms.Gayathri.S[3], Ms.Ramya.M[4]

[1]*Lab Instructor,ECE,Panimalar Institute Of Technology,TAMIL NADU,INDIA*

[2]*UG Scholar,ECE,,Panimalar Institute Of Technology,TAMIL NADU,INDIA*

[3]*UG Scholar,ECE,,Panimalar Institute Of Technology,TAMIL NADU,INDIA*

[4]*UG Scholar,ECE,,Panimalar Institute Of Technology,TAMIL NADU,INDIA*

ABSTRACT

The aim of this project is to successfully design, build, and test a system that identifies and segregates recyclable waste materials like glass, plastic, metal, paper and wood into their proper bins. The process of waste material segregation is based on their physical properties like dielectric strength, reflective, absorption and inductive properties and this process is fully automated .The complete status of this process is monitored using a remote terminal unit (RTU) or a PC. One of the most common areas where this method can be put into practice is in recycling plants where segregation of recyclable waste materials is essential. The implementation of such an arrangement essentially involves sensors such as capacitive proximity sensor, inductive proximity sensor, IR sensor and microcontroller. Here the objects are moved forward on a conveyor belt which is driven by a geared dc motor. The objects being moved are sensed by the respective sensors based on their physical properties and segregated accordingly into their bins.

KEYWORDS: *Sensors, capacitive proximity sensor, Inductive proximity sensor, IR sensor, DC motor, wheels.*

1.INTRODUCTION

In all parts of the country, people by and large do salvage re-usable or saleable material from waste and sell it for a price, e.g. newspaper, glass bottles, empty tins, plastic bags, old clothes etc., and to that extent such reusable / recyclable waste material is not thrown out for disposal. However, a lot of recyclable dry waste such as waste paper, plastic, broken glass, metal, packaging material etc., is not segregated and is thrown on the streets along with domestic / trade / institutional waste. Such waste is picked up to some extent by poor rag picker for their livelihood. At times they empty the dustbins and spread the contents around for effective sorting and collection. By throwing such recyclable material on the streets or into a common dustbin, the quality of recyclable material deteriorates as it gets soiled by wet waste, which often contains contaminated and hazardous waste.Segregation of recyclable waste at source is thus not seriously practiced by households and establishments, who throw such waste on the streets or in the municipal bins un segregated. At least 15% of the total waste can conveniently be segregated at source for recycling, which is being thrown on the streets in absence of the practice of segregation of waste at source. Part of this waste is picked up by rag-pickers in a soiled condition and sold to middle men at a low price, who in turn pass on the material to the recycling industry at a higher price after cleaning or segregation and the waste that remains uncollected finds its way to the dumping grounds.It is essential to save the recyclable waste material from going to the waste processing and

disposal sites and using up landfill space. Profitable use of such material could be made by salvaging it at source for recycling. This will save national resource and also save the cost and efforts to dispose of such waste.

2.WORKING

The microcontroller initializes all the port pins, sets the sensor pins as input, driver pins as output and sets the baud rate to 9600. Once initialization is done, a "proceed" message is displayed at the terminal. When the object is passed through the conveyor if it is a metal object it will be sensed by the inductive proximity sensor else when the object moves further it will be sensed by capacitive proximity sensor and IR sensor. If the object is sensed by capacitive sensor alone the object is glass and if the object is sensed by IR sensor alone the object is paper. In case, if the object is sensed by both the sensors it is wood. If the object is not sensed by any of these sensors then it is plastic.

Once the object is sensed the microcontroller gives the command signal to the gate driver. This in turn opens the gate and object falls to the respective container. The status of the system is sent to the PC through wireless trans-receiver. The position of the gate and the conveyor motor can be controlled by PC terminal. In case of any malfunction the conveyor stops automatically and gives warning message to the terminal.

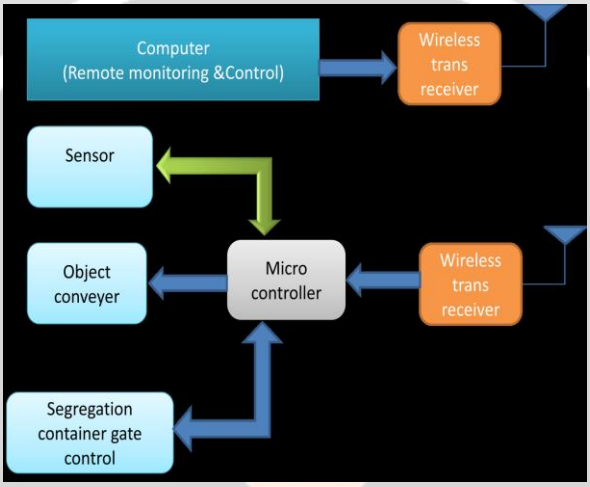

FIG 2.1 BLOCK DIAGRAM

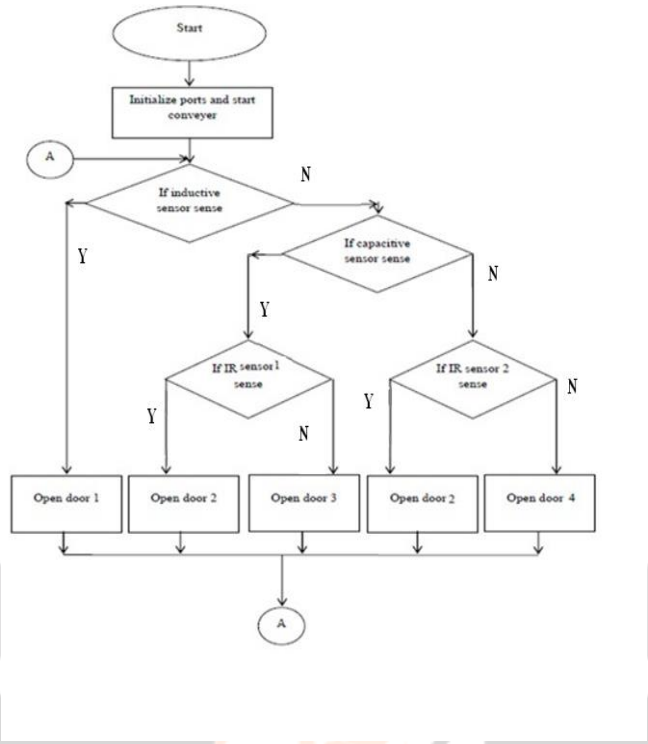

FIG 2.2 FLOW CHART

3.HARDWARES REQUIRED

3.1 SENSORS

The sensors used in this project are capacitive proximity sensor, inductive proximity sensor, and IR sensor. These sensors are mounted on the conveyor nearby the passage path of the object such that the object gets sensed by the sensors when it passes through them. Materials like paper, wood, glass, plastic and metal are segregated based on their physical characteristics by the respective sensors. Here capacitive proximity sensor is used for glass and wood segregation, inductive proximity sensor is used for metal segregation, and IR sensor is used for paper and wood segregation.

3.1.1 CAPACITIVE PROXIMITY SENSOR

Capacitive proximity sensors use the face or surface of the sensor as one plate of a capacitor, and the surface of a conductive or dielectric target object as the other. The capacitance varies inversely with the distance between capacitor plates in this arrangement, and a certain value can be set to trigger target detection.

FIG 3.1.1.1 CAPACITIVE PROXIMITY SENSOR

3.1.1.1 OPERATION

The sensing surface of a capacitive sensor is formed by two concentrically shaped metal electrodes of an unwound capacitor. When an object nears the sensing surface it enters the electrostatic field of the electrodes and changes the capacitance in an oscillator circuit. As a result, the oscillator begins oscillating. The trigger circuit reads the oscillators amplitude and when it reaches a specific level the output state of the sensor changes. As the target moves away from the sensor the oscillator's amplitude decreases, switching the sensor output back to its original state.

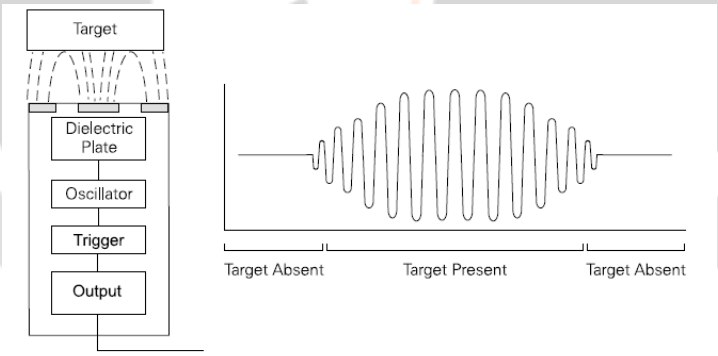

FIG 3.1.1.2 OPERATION AND CHARACTERISTICS OF CAPACITIVE PROXIMITY SENSOR

3.1.1.2 STANDARD TARGET AND DIELECTRIC CONSTANT

Standard targets are specified for each capacitive sensor. The standard target is usually defined as metal and/or water. Capacitive sensors depend on the dielectric constant of the target. The larger the dielectric numbers of a material the easier it is to detect. The following graph shows the relationship of the dielectric constant of a target and the sensor's ability to detect the material based on the rated sensing distance (Sr).

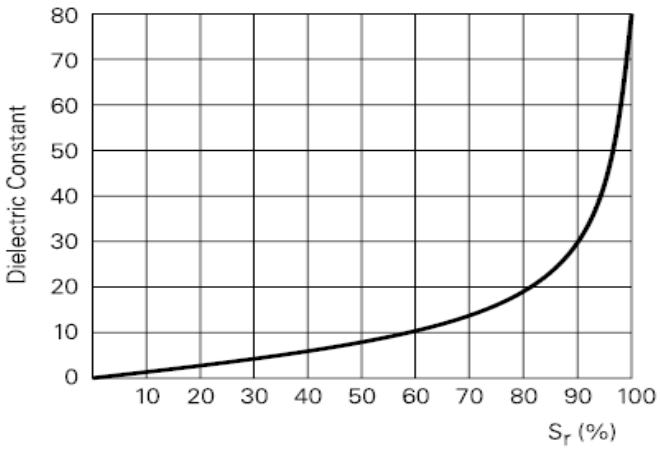

FIG 3.1.1.3 Standard target and dielectric constant characteristics

3.1.2 INDUCTIVE PROXIMITY SENSOR

Inductive proximity sensors operate under the electrical principle of inductance. Inductance is the phenomenon where a fluctuating current, which by definition has a magnetic component, induces an electromotive force (emf) in a target object. To amplify a device's inductance effect, a sensor manufacturer twists wire into a tight coil and runs a current through it.

An inductive proximity sensor has four components; the coil, oscillator, detection circuit and output circuit. The oscillator generates a fluctuating magnetic field the shape of a doughnut around the winding of the coil that locates in the device's sensing face.

FIG 3.1.2.1 INDUCTIVE PROXIMITY SENSOR

Inductive Proximity Sensors being contactless sensors can be used for position sensing, speed measurement, counting, etc. They can be used in extreme conditions, such as oily, dusty, corrosive environment. Their application ranges from Automobile Industries to Steel Industries, from CNC/NC machines to material handling equipment, process automation, conveyor systems, and packaging machines.

3.1.2.1WORKING

The inductive proximity sensor can be used to detect metallic targets only. The main components of the inductive proximity sensor are coil, oscillator, detector and the output circuit. The coil generates the high frequency magnetic field in front of the face. When the metallic target comes in this magnetic field it absorbs

some of the energy. Hence the oscillator field is affected. This is detected by the detector. If the oscillation amplitude reaches a certain threshold value the output switches.

The inductive proximity sensor works better with ferromagnetic targets as they absorb more energy compare to non-Ferromagnetic materials. Hence operating distance for sensor is more for Ferromagnetic targets.

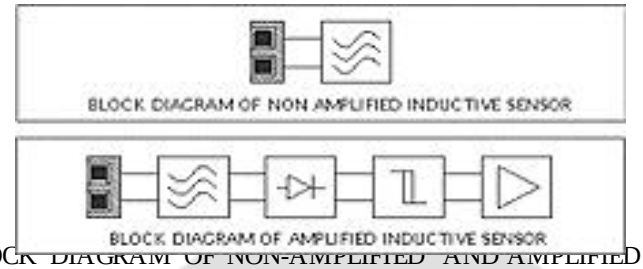

FIG 3.1.2.2 BLOCK DIAGRAM OF NON-AMPLIFIED AND AMPLIFIED INDUCTIVE SENSOR

3.1.3 IR SENSOR

An infrared sensor is a device (usually with supporting circuitry) that can detect infrared light (which is below the optical spectrum) for use to a purpose. Most of the remote controls for TVs and other entertainment equipment use infrared energy as the transmission medium to carry information between the control and the equipment to be operated. Infrared sensors also have important scientific, military, security and rescue applications since they can "see" the "radiant heat energy" which is infrared radiation. This electromagnetic energy is in the wavelengths from about 750 nm, which is the lower end of the optical spectrum, to well over 10,000 nm, deep in the infrared.

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The "heart" of the system per the question is a photo detector or photo sensor. And it does its thing based on black body radiation, which it the emission of energy based on the temperature of the object. As the radiant energy is a direct function of temperature, even the slightest difference in temperature results in the radiation of a slightly different wavelength of infrared light. The infrared radiation falls on the sensor (there are a bunch of different kinds and a range of operating frequencies and bandwidths depending on application) and, through photoelectric effect, changes the "nature" of the chemistry/physics of the photosensitive material. This is seen by supporting electronics as a change of resistance which changes current or voltage in the circuitry according to the way it was designed.

3.1.3.1 WORKING PRINCIPLE

An IR proximity sensor works by applying a voltage to a pair of IR light emitting diodes (LED's) which in turn, emit infrared light. This light propagates through the air and once it hits an object it is reflected back towards the sensor. If the object is close, the reflected light will be stronger than if the object is further away. The sensing unit in the form of an integrated circuit (IC) detects the reflected infrared light, and if its intensity is strong enough, the circuit becomes active. When the sensing unit becomes active, it sends a corresponding signal to the output terminal which can then be used to activate any number of devices.

3.1.3.2 PIN DIAGRAM

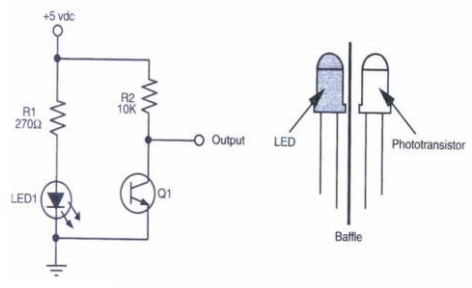

FIG 3.1.3.2BASIC DESIGN OF IR SENSOR

3.2 MICROCONTROLLER:

A microcontroller is small computer onF a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. Program memory in the form of NOR flash or OTP ROM is also often included on chip, as well as a typically small amount of RAM. Microcontrollers used for this application is AURD

3.3 GEARED DC MOTOR

In a gear motor, the energy gear train. There are a number of different types of gear m) and DC (direct current).

In a gear motor, the magnetic current (which can be produced by either permanent magnets or electromagnets) turns gears that are either in a gear reduction unit or in an integrated gear box. A second shaft is connected to these gears. The result is that the gears greatly increase the amount of torque the motor is capable of producing while simultaneously slowing down the motor's output speed. The motor will not need to draw as much current to function and will move more slowly, but will provide greater torque.

3.4 L293D MODULE

This is L293D based H-Bridge motor driver board for driving DC motors and is ideal for robotics applications.

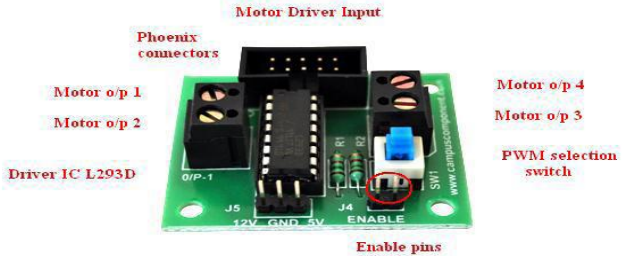

FIG 3.4.1 L293D

3.5 7MM DIA WHEEL

FIG 3.5.1 WHEEL

It is a 7mm diameter wheel. Here three 7mm diameter wheels are used to make a conveyor roller.

3.6 12V RELAY

A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and most have double throw (changeover) switch contacts,.Relays allow one circuit to switch a second circuit which can be completely separate from the first. For example a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside the relay between the two circuits; the link is magnetic and mechanical.

4.CONCLUSION

The design of a system that segregates recyclable waste materials has been done successfully following various approaches in the past attempts. Even in the past the segregation process was done manually. So in order to fully automate this process various sensors have been integrated together to form a single system for the segregation process. Each of the components used is individually tested for circuit errors. Test run of the working model was done and result was obtained as expected.

At present the working system is capable of segregating recyclable waste materials autonomously into their respective bins. The system can be further modified for industrial applications.

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