VIVEKANAND EDUCATION SOCIETY'S POLYTECHNIC

SINDHI SOCIETY, CHEMBUR, MUMBAI-400071 2019-20

DEPARTMENT OF

INSTRUMENTATION ENGINEERING

PROJECT ON

"Automatic Waste segregator using 8051µc"

SUBMITTED BY

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In partial fulfillment to the requirement of the Diploma in Instrumentation Engineering

Under The Guidance Of

Ms. Bindu Ramesh(HOD)

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION

CERTIFICATE

This is to certify that

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Mr. Mohammad Fadhil (Roll no.8)

has satisfactorily carried out the project work entitled "**Automatic Waste Segregation System Using 8051uc"** in partial fulfillment of diploma in **INSTRUMENTATION ENGINEERING** of Maharashtra State Board Of Technical Examination, Mumbai, for the year 2019-2020

PRINCIPAL **HEAD OF DEPARTMENT**

PROJECT GUIDE **EXTERNAL EXAMINER**

Seal of Institution

Acknowledgement

We express our gratitude to everyone who supported us throughout the course of this project. We are thankful for their aspiring guidance and friendly advice during the project work. We are sincerely grateful to them for sharing their truthful and illuminating views on a number of issues related to the project.

We express our warm thanks to Mrs.Bindu Ramesh, for her support and guidance at Vivekanand Education Society of Polytechnic. We are also grateful for Mr. Vishal Arekar and Mr. Kamlesh Tarkar Lab Assistant of Vivekanand Education Society of Polytechnic that they collaborated with us and helped us to execute as well as complete our project under his guidance.

We would also like to thank our guide **H.O.D** Mrs. Bindu and all the people who provided us with the facilities being required for our project and also for guiding us in manner such that we were successful to complete our project on time

Abstract

Our project mainly concentrates on offering an easy, reliable solution to the common problem of inefficient garbage disposal faced within schools at present, which also implies that the main users of our product would be school children. For this, we have decided to implement a remote control, fully automated, line following garbage bin. In this system, there are two main devices.

A remote controller device equipped with a real time clock sets the initiation time and then compares it with the real time and triggers the garbage collection process via radio signal. The other device is the garbage collector, which starts its process after receiving the radio signal from the remote controller device. Here, the process includes the garbage collector moving through a series of classrooms within the school, while stopping at each to collect garbage. This is the main process of the system.

The rising population of India poses serious threats with regard to the availability of living space, utilization of natural resources and raw materials, education and employment. But another serious peril that follows is the escalating amount of waste generated each minute by an individual. An astounding 0.1 million tonnes of waste is generated each day in India. Sadly, only 5% of this colossal amount of waste is recycled. One possible solution for this problem could be segregating the waste at the disposal level itself. In India, the collection, transportation and disposal of MSW are unscientific and chaotic. Uncontrolled dumping of waste on outskirts of towns and cities has created overflowing landfills which are not only impossible to reclaim because of the haphazard manner of dumping but also has serious environmental implication in terms of ground water pollution and contribution to Global warming.

This has found to reduce the average life span of the manual segregators. Developing a mechanized system to help save the lives of many and making the world a cleaner and a greener place is the noble objective of our project. We have thus proposed an automatic waste segregator that aims at segregating the waste at the disposal level itself. It is designed to sort the waste into 3 major categories, namely metallic, wet and dry, thereby making waste management more effective. To set the ball rolling, we have proposed this project to give back to our nation, making our India a “Swachh Bharath“.

Content

Figures

Chapter 1

Introduction:

In India about 60 million tonnes of waste is being generated every year. Ten million tones' of garbage is generated in metropolitan cities. The landfills of most of these cities are overflowing with no space for fresh garbage waste. The philosophy of "waste management hierarchy" has been adopted by most nations as the step for developing municipal solid waste (MSW) management strategies. According to a sanitation survey called "Swachh Survekshan-2016" conducted by the ministry of urban development under the swachh bharat mission, it was found that about 50% people in India face the problem of improper waste collection and management. According to centre of science and environment, innovative disposal and recycling methods must be introduced instead of landfill sites.

Thus, we have proposed a cost effective "Automatic waste segregator and monitoring system" for proper management of waste. Automatic waste segregator categorizes the waste as plastic, metallic or organic. The monitoring system helps to monitor the waste collection process. The common method of waste disposal is by unplanned and uncontrolled dumping at landfill areas. This method is hazardous to human health, plant and animal life. When the waste is segregated into basic streams such as plastic, metallic and organic, the waste has a higher potential of recovery, and then, recycled and reused.

The organic waste is converted either into compost or methane-gas or both. Compost can replace demand for chemical fertilizers, and biogas can be used as a source of energy. The metal waste could be reused or recycled. Even if there are large scale industrial waste segregators present, it is always feasible to separate the waste at the source itself. The benefit of doing so is that the occupational hazard for waste workers is reduced. Also, the separated waste could be directly sent to the recycling and processing plant instead of sending it to the segregation plant then to the recycling plant.

Chapter 2

Literature Survey:

https://www.javatpoint.com/embedded-system-8051-microcontroller

www.elprocus.com/8051-microcontroller...

https://www.electronicshub.org/8051-microcontroller-introduction/

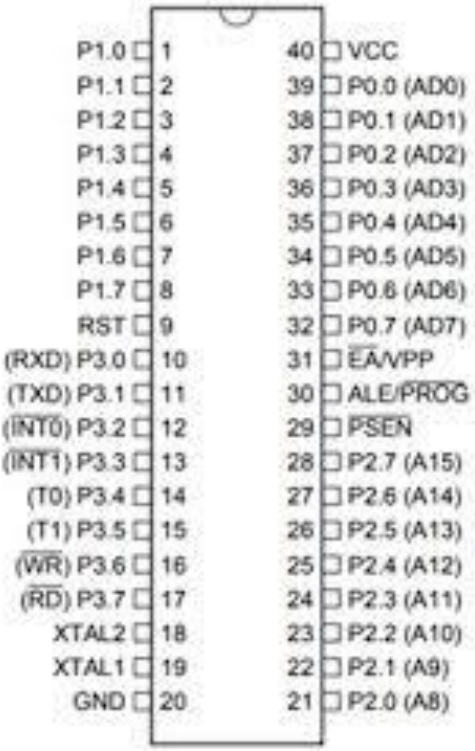
Microcontroller (8051)

A microcontroller (MCU for microcontroller unit) is a small computer on a single metal-oxidesemiconductor (MOS) integrated circuit chip. In modern terminology, it is similar to, but less sophisticated than, a system on a chip (SoC); a SoC may include a microcontroller as one of its components. A microcontroller contains one or more CPUs (processor cores) along with memory and programmable input/output peripherals. Program memory in the form of ferroelectric RAM, NOR flash or OTP ROM is also often included on chip, as well as a small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications consisting of various discrete chips.

Fig (2.1)

FEATURES:

- 8 – Bit ALU: ALU or Arithmetic Logic Unit is the heart of a microcontroller. It performs arithmetic and bitwise operation on binary numbers. The ALU in 8051 is an 8 – Bit ALU i.e. it can perform operations on 8 – bit data.
- 8 – Bit Accumulator: The Accumulator is an important register associated with the ALU. The accumulator in 8051 is an 8 – bit register.
- RAM: 8051 Microcontroller has 128 Bytes of RAM which includes SFRs and Input / Output Port Registers
- ROM: 8051 has 4 KB of on-chip ROM (Program Memory).
- I/O Ports: 8051 has four 8 – bit Input / Output Ports which are bit addressable and bidirectional
- Timers / Counters: 8051 has two 16 – bit Timers / Counters.
- Serial Port: 8051 supports full duplex UART Communication.
- External Memory: 8051Microcontroller can access two 16 – bit address line at once: one each for RAM and ROM. The total external memory that an 8051 Microcontroller can access for RAM and ROM is 64KB (216 for each type).



Chapter 3

Scope of the project:

- With rapid urbanization, the country is facing massive waste management challenge.
- Over 377 million urban people live in 7,935 towns and cities and generate 62 million tone's of municipal solid waste per annum.
- Only 43 million tone's (MT) of the waste is collected, 11.9 MT is treated and 31 MT is dumped in landfill sites.
- Solid Waste Management (SWM) is one among the basic essential services provided by municipal authorities in the country to keep urban centers clean.
- However, almost all municipal authorities deposit solid waste at a dump yard within or outside the city haphazardly.
- Experts believe that India is following a flawed system of waste disposal and management.

Chapter 4

Methodology (Block diagram):

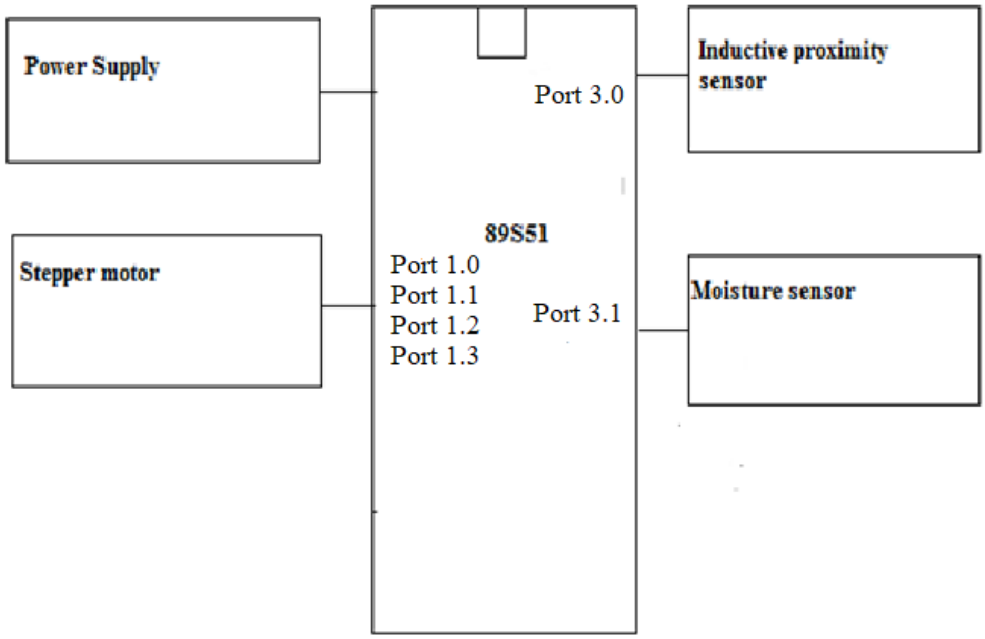


Fig no. (4.1)

The above fig. show the block diagram of automatic waste segregation using 8051 microcontroller to detect the wet waste, dry waste and metal waste by using the inductive proximity sensor and moisture sensor

Conveyor Belt:

It carries the waste from inlet to outlet sections. Four 12 V DC geared motors are used to move the belt. A conveyor belt is the carrying medium of a belt conveyor system (often shortened to belt conveyor). A belt conveyor system is one of many types of conveyor systems. A belt conveyor system consists of two or more pulleys (sometimes referred to as drums), with an endless loop of carrying medium—the conveyor belt—that rotates about them.

One or both of the pulleys are powered, moving the belt and the material on the belt forward. The powered pulley is called the drive pulley while the unpowered pulley is called the idler pulley. There are two main industrial classes of belt conveyors; Those in general material handling such as those moving boxes along inside a factory and bulk material handling such as those used to transport large volumes of resources and agricultural materials, such as grain, salt, coal, ore, sand, overburden and more.

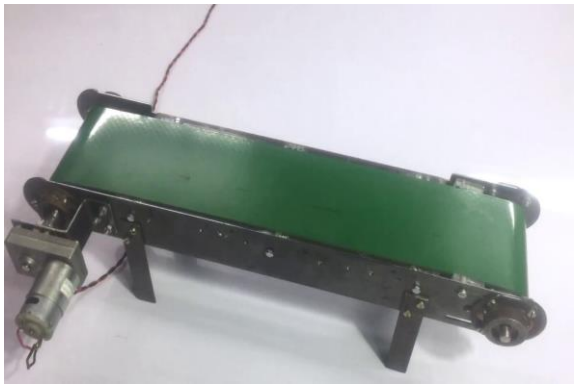


Fig no. (4.2)

Inductive Proximity Sensor:

Inductive proximity sensor based on the eddy current principle is fixed in the ending of the conveyor belt part to identify the presence of metals in the waste. The NPN sensor gives a logical 0 output in the presence of metal and logical 1 output in the absence of metal. This is fed as input to the micro-controller.

Fig no. (4.3)

When a piece of conductive metal enters the zone defined by the boundaries of the electromagnetic field, some of the energy of oscillation is transferred into the metal of the target. This transferred energy appears as tiny circulating electrical currents called eddy currents. This is why inductive proxes are sometimes called eddy current sensors. The oscillation produces an electromagnetic field in front of the sensor, because the coil is located right behind the "face" of the sensor. The technical name of the sensor face is "active surface".

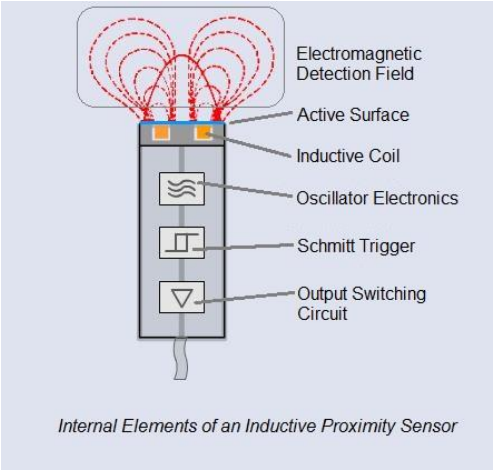


Fig no. (4.4)

Micro-controller:

8051 micro-controller is designed by Intel in 1981. It is an 8-bit micro-controller. It is built with 40 pins DIP (dual inline package), 4kb of ROM storage and 128 bytes of RAM storage, 2 16-bit timers. It consists of are four parallel 8-bit ports, which are programmable as well as addressable as per the requirement. An on-chip crystal oscillator is integrated in the micro-controller having crystal frequency of 12 MHz.

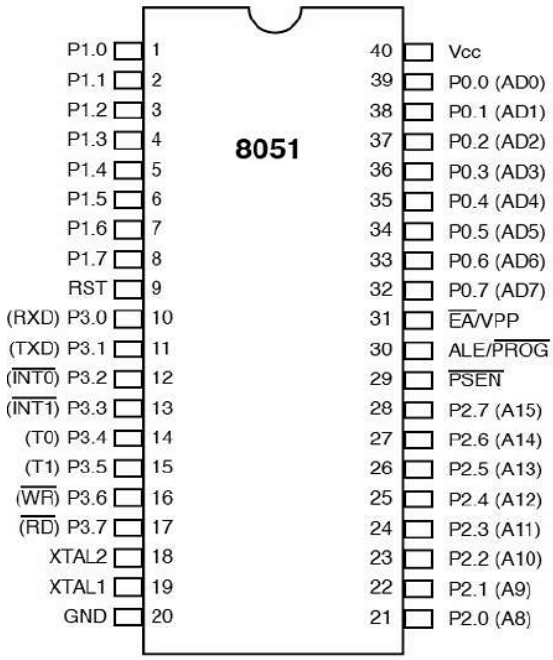


Fig no. (4.5)

Input Configuration:

If any pin of this port is configured as an input, then it acts as if it "floats", i.e. the input has unlimited input resistance and in-determined potential.

Output Configuration:

When the pin is configured as an output, then it acts as an "open drain". By applying logic 0 to a port bit, the appropriate pin will be connected to ground (0V), and applying logic 1, the external output will keep on "floating". In order to apply logic 1 (5V) on this output pin, it is necessary to build an external pull-up resistor.

Moisture Sensor:

As the name indicates, this sensor is used to measure the moisture content in a given material. These sensors use the volumetric water content indirectly by making use of some other properties like electrical resistance, dielectric constant. In general cases, the sensor generates a voltage proportional to the dielectric permittivity and therefore measures the moisture content of a material. The soil moisture sensor is one kind of sensor used to gauge the volumetric content of water within the soil. As the straight gravimetric dimension of soil moisture needs eliminating, drying, as well as sample weighting. These sensors measure the volumetric water content not directly with the help of some other rules of soil like dielectric constant, electrical resistance, otherwise interaction with neutrons, and replacement of the moisture content.

Fig no. (4.6)

Stepper Motor:

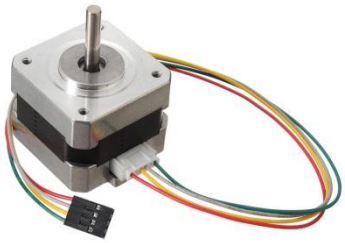


Fig no. (4.7)

The motor operates by accurately synchronizing with the pulse signal output from the controller to the driver, achieving highly accurate positioning and speed control. Stepper motors feature high torque and low vibration at low-speeds, ideal for applications requiring quick positioning in short distance.

Types of Stepper Motor:

There are three main types of stepper motors, they are:

1. Permanent magnet stepper
2. Hybrid synchronous stepper
3. Variable reluctance stepper

Advantages

- Low cost for control achieved
- High torque at startup and low speeds
- Ruggedness
- Simplicity of construction
- Can operate in an open loop control system

The basic construction

I'm going to simplify stepper motors here to illustrate the simple, central idea: the (inside) rotor of a stepper motor turns by small, discrete amounts (steps) because the (outside) stator applies magnetic impulses that pull and push it around.

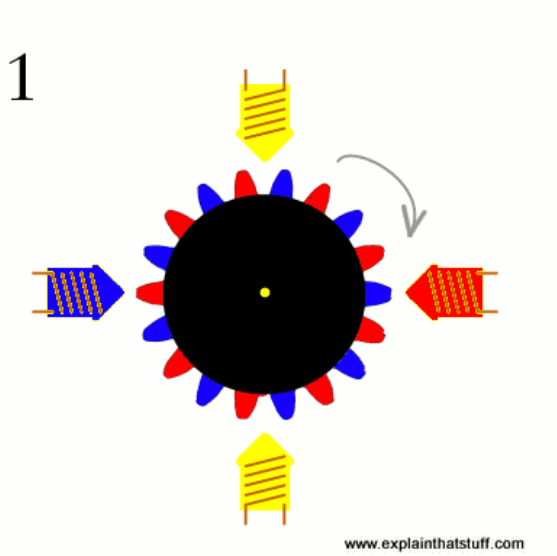


Fig no. (4.8)

How it rotates

1. The right electromagnet is energized and becomes a north pole (red) and the left electromagnet becomes a south pole (blue). This pulls the rotor around by one step so a blue tooth on the rotor snaps toward the right electromagnet and a red tooth snaps toward the left electromagnet.
2. Now the bottom electromagnet becomes a north pole, the top magnet becomes a south pole, and the two horizontal magnets are switched off. Again, the teeth of the rotor are pulled around by one step.
3. The vertical magnets are now switched off and the horizontal magnets are switched on again, but with the opposite polarity (pattern of magnetism) that they had before. The teeth of the rotor advance by one more step.
4. Finally, the vertical magnets are switched on again, in the opposite polarity to before, and the horizontal magnets are switched off. The rotor mores around one more step. The whole cycle then repeats.

Chapter 5

Details of design, working and processes

The main goal of the project is to design and develop a sorting system that sorts and waste automatically into three categories namely dry waste, wet waste and metal waste.

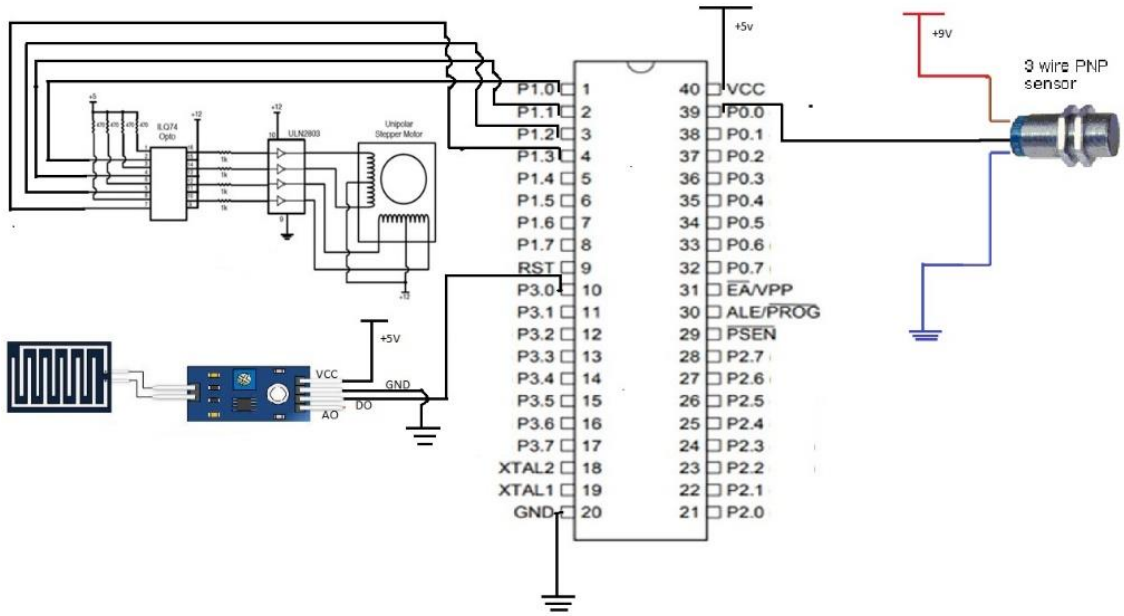


Fig no. (5.1)

A. Controller unit:

8051 microcontroller is designed by Intel in 1981. It is an 8-bit microcontroller. It is built with 40 pins DIP (dual inline package), 4kb of ROM storage and 128 bytes of RAM storage, 2 16-bit timers. It consists of are four parallel 8-bit ports, which are programmable as well as addressable as per the requirement.

B. Sensing unit:

This project required two sensors Inductive proximity sensor and moisture sensor :

- **Inductive proximity sensor :** Inductive proximity sensors are used for non-contact detection of metallic objects. Their operating principle is based on a coil and oscillator that creates an electromagnetic field in the close surroundings of the sensing surface.
- **Moisture sensor :** In the this Moisture sensor is used to measure the water content(moisture) waste .When the waste is having content of water output module is at high level, else the output is at low level. This sensor reminds the operator that wet waste is detected.

C. Power supply unit:

In this project, circuits, sensors and motors are used, which require +12V & +5V (DC) supply. To fulfill this requirement we have used following circuit of power supply which provides regulated +12V & +5V (DC).

We are using 12V (DC) Power supply for conveyor belt.

5.1: Circuit diagram & explanation

Stepper motor interfacing with 8051uc:

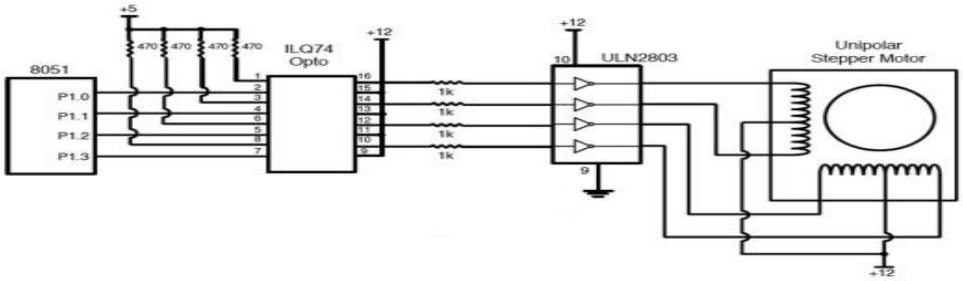


Fig no. (5.1.1)

The circuit consists of AT89S51 microcontroller, ULN803 and ILQ74 Motor. AT89S51 is low power, high-performance, CMOS 8bit, 8051 family microcontroller. It has 32 programmable I/O lines. It has 4K bytes of Flash programmable and erasable memory. An external crystal oscillator is connected at the 18 and 19 pins of the microcontroller. Motor is connected to the port2 of the microcontroller through a driver IC.

ULN2803A is a 50V, 500mA Darlington transistor array. It consists of 8 NPN Darlington pairs that feature high voltage-outputs with common-cathode clamp diodes for switching inductive loads. All units feature a common emitter and open collector outputs. It is capable of high-voltage outputs (50V). The collector-current rating for each Darlington pair is 500mA. It is possible to parallel the Darlington pairs for higher current capability. Each Darlington pair has a series base resistor (2.7kΩ) allowing operation directly with TTL or CMOS operating supply voltages of 5V or 3.3V.

ULN2803A can be used in applications such as relay drivers, stepper and DC brushed motor drivers, lamp drivers, display drivers (LED and Gas Discharge), etc. Stepper motor has 6 pins. In these six pins, 2 pins are connected to the supply of 12V and the remaining are connected to the output of the stepper motor. Stepper rotates at a given step angle. Each step in rotation is a fraction of full cycle. This depends on the mechanical parts and the driving method.

Similar to all the motors, stepper motors will have stator and rotor. Rotor has permanent magnet and stator has coil. The basic stepper motor has 4 coils with 90 degrees rotation step. These four coils are activated in the cyclic order

Inductive Proximity Sensor Interfaced with Microcontroller

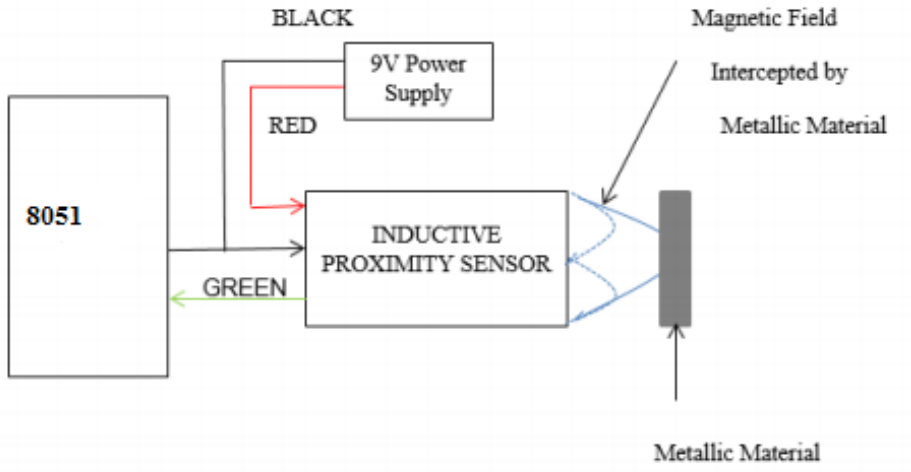


Fig no. (5.1.2)

The block diagram of the Inductive Proximity Sensor interfaced with Microcontroller is shown above:

The Sensor comprises of 3 terminals i.e. Red, Green and Black. The Red terminal is the Vcc terminal of the sensor and is connected to a 9V Power Supply. The Black terminal depicts the ground of the sensor. It is connected to the the GND pin of the Microcontroller and simultaneously shorted with the The block diagram of the Inductive Proximity Sensor interfaced with Microcontroller is shown above. The Sensor comprises of 3 terminals i.e. Red, Green and Black. The Red terminal is the Vcc terminal of the sensor and is connected to a 9V Power Supply. The Black terminal depicts the ground of the sensor. It is connected to the the GND pin of the Microcontroller and simultaneously shorted with the

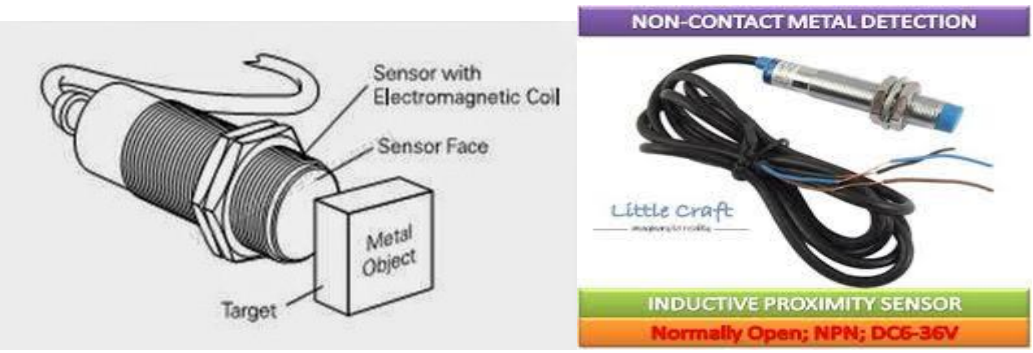


Fig no. (5.1.3)

Interfacing moisture sensor with microcontroller

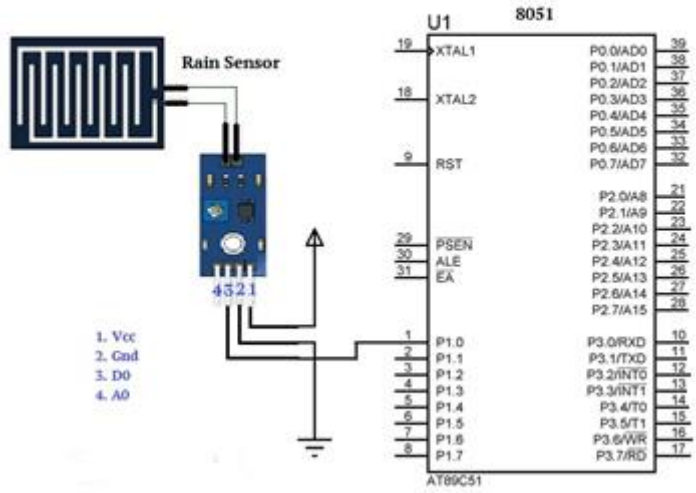


Fig no. (5.1.4)

The moisture sensor used is composed by two parts. The first one is the effective sensor, which is a plaque that is exposed to the rain. This plaque has two strips of conductive material, very close to each other, but without touching.
So, if we apply a voltage between the the two strips, it will be an open circuit. Nevertheless, when we expose this surface to the rain, the water that falls closes the circuit between the strips and a different voltage can be measured.

Keep in mind that when the rain drops the two strips will not be short circuited because water is not a perfect conductor. So, this sensor will act as a variable resistor, which will be lower when more water falls on the surface, connecting the stripes in more points. I've tested the resistance of the sensor with a multimeter after applying some water drops and it was about 65 kΩ.

The second part is the electronic circuit board responsible to process the signal from the plaque and expose it as two signals, one digital and another analog.
So, we have a digital output pin, which operates as active-low, indicating that rain is being detected or not. Since this pin is active-low, it will have a value of GND when rain is detected, and VCC when rain is not detected.
Since, as stated, the rain sensor will act as a variable resistor, it's output will be an analog voltage that needs to be converted to this digital one. So, the electronic circuit uses a LM393 comparator to compare this analog voltage to a certain threshold and output GND or VCC accordingly.

The PCB of this electronic circuit has a potenciometer that we can change to adjust this threshold, making the sensor more or less sensible to the rain drops.
Additionally, the sensor has an analog output with a variable voltage that depends on the resistance of the sensor and thus, on the amount of water on it.

This module can work with voltage supplies of both 3.3 V and 5 V. Just keep in mind that there can be different versions from different manufacturers.

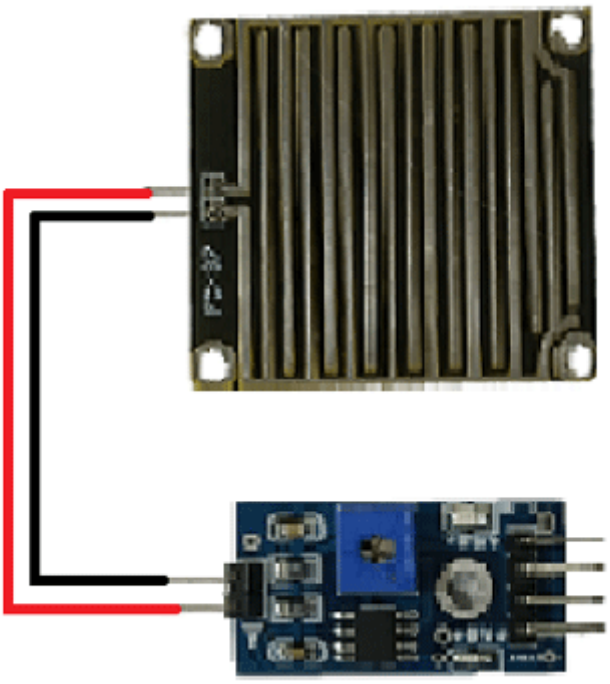


Fig no. (5.1.5)

Using the sensors with micro controller:

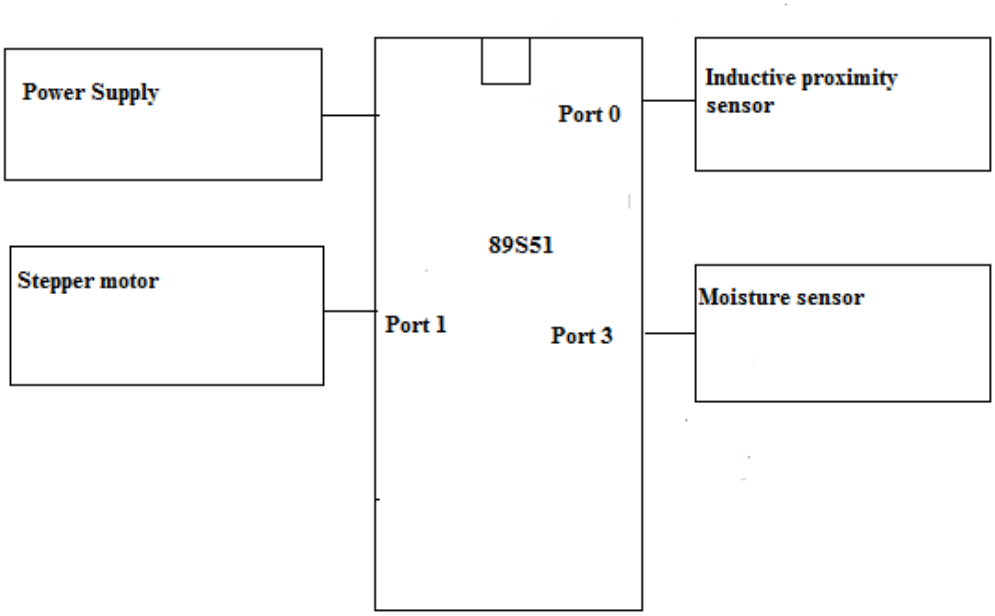


Fig no. (5.1.6)

In the above circuit we are using inductive proximity sensor, moisture sensor and stepper motor.

- We have divided stepper motor angle into three parts.
  One for the metal waste, second for dry waste and third for wet waste.
- The angle of stepper motor for dry waste section is kept as normal state
- As the dry waste appears on the conveyor belt it is ignored by inductive proximity sensor and moisture sensor and it will fall in dry section dustbin.
- As the Metal waste appears it is ignored by moisture sensor
  And detected by proximity sensor, according to program the stepper motor will change its angle and metal waste bin section will appear at end of conveyor belt.
- As the wet waste appears at conveyor belt it is detected by moisture sensor and ignored by proximity sensor ,according to program the stepper motor will change its angle and wet waste bin section will appear at end of conveyor belt

5.2 Program

```
#include<reg51.h>
sbit prox = P3^0;
sbit mois = P3^1;
void msdelay (unsigned char );
void main (void)
{
while(1)
{
if(P3^1==1)
{
unsigned int x;
for (x=0;x<13;x++)
{
P1=0x33;
msdelay(10);
P1=0x66;
msdelay(10);
P1=0xcc;
msdelay(10);
P1=0x99;
msdelay(10);
}
}
msdelay(5000);
for(x=0;x<13;x++)
```

```
{
P1=0x99;
msdelay(10);
P1=0xcc;
msdelay(10);
P1=0x66;
msdelay(10);
P1=0x33;
msdelay(10);
}
}
If(P3^0==1)
{
unsigned int z;
for(z=0;z<13;z++)
{
P1=0x99;
msdelay(10);
P1=0xcc;
msdelay(10);
P1=0x66;
msdelay(10);
P1=0x33;
msdelay(10);
}
Msdelay(5000);
For(z=0;z<13;z++)
```

```
{
P1=0x33;
msdelay(10);
P1=0x66;
msdelay(10);
P1=0xcc;
msdelay(10);
P1=0x99;
msdelay(10);
}
}
}
}
void msdelay(unsigned char k)
{
unsigned int a,s;
for(a=0;a<k;a++)
{
for(s=0;s<1275;s++);
}
}
```

5.3 Testing of the circuit/Program

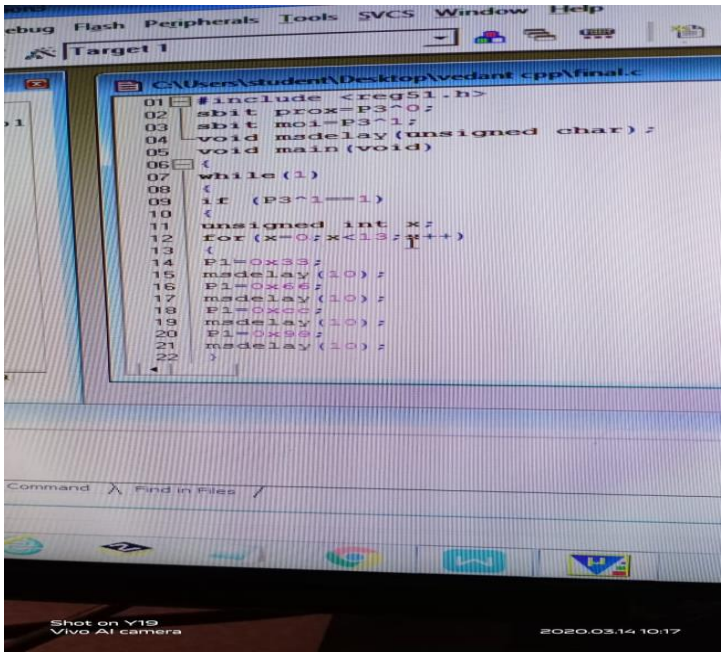


Fig no.(5.3.1)

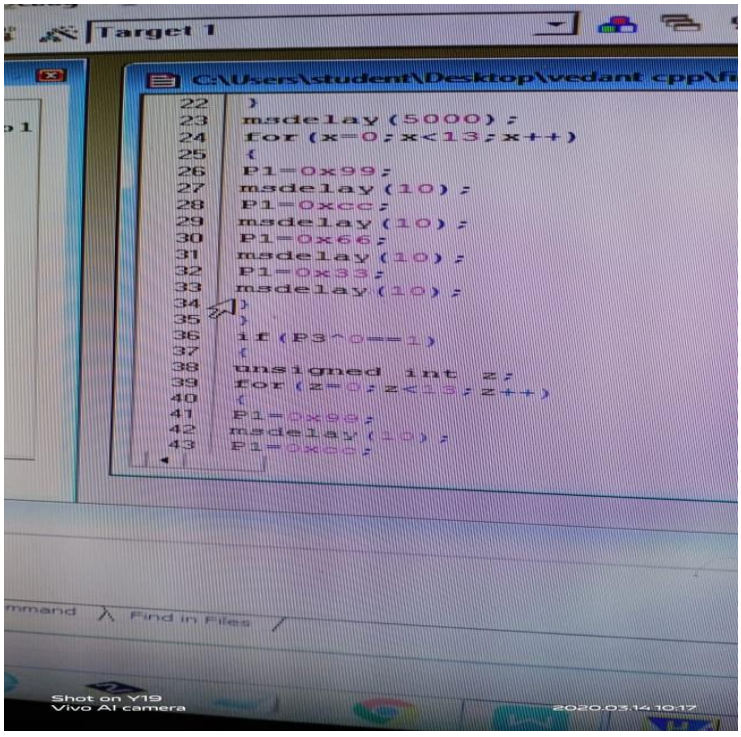


Fig no.(5.3.2)

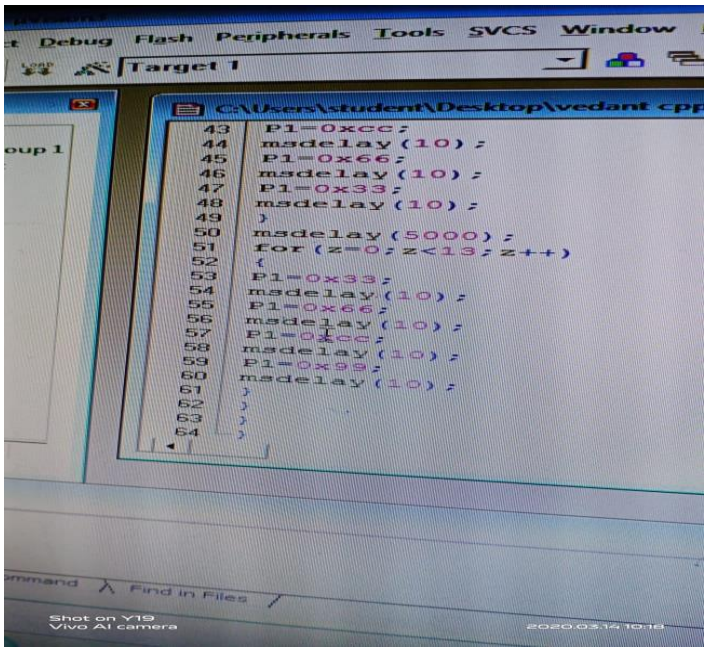


Fig no.(5.3.3)

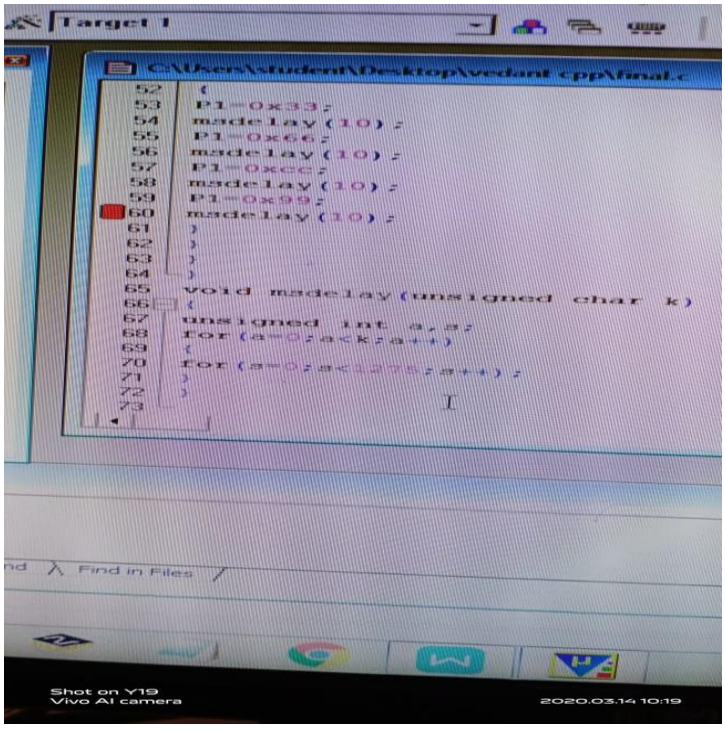


Fig no.(5.3.4)

Steps Followed

- Assembly of the components was done.
- Mounted the components on PCB.
- Placed a Conveyor Belton the wooden board and used a drill to make a hole for mounting the components.
- Checked the connectivity of the circuit.
- Interface the microcontroller port with the system.
- Typed the program in the Keil compiler.
- Error occurred during programming was rectified by going through the program.
- Created a hex file of the typed program.
- Loaded the program in microcontroller 8051.
- Burned the IC.
- Got the output on the system.
- During sensing the metal it was not getting sensed as the range of the proximity sensor was less so we used a proximity sensor of higher range and also reduced the distance between the proximity sensor and the metal.
- During testing the moisture sensor the west waste was not getting sensed because of connection error, so we rectified the system and used a wet tissue and it was sensed properly.

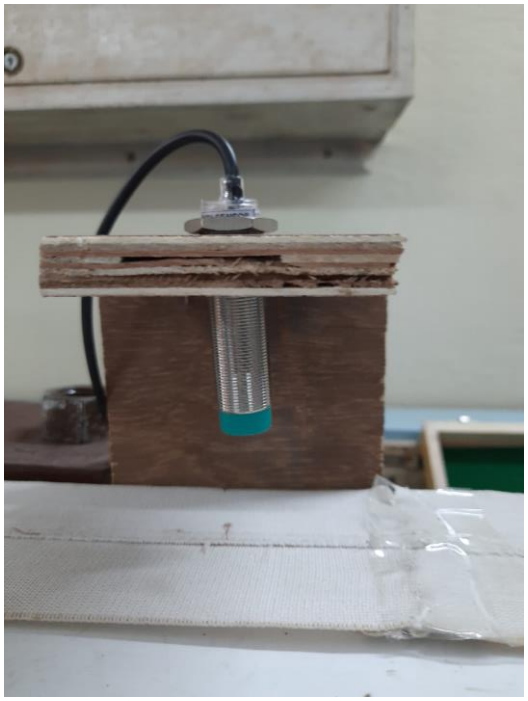


Fig no.(5.3.5)

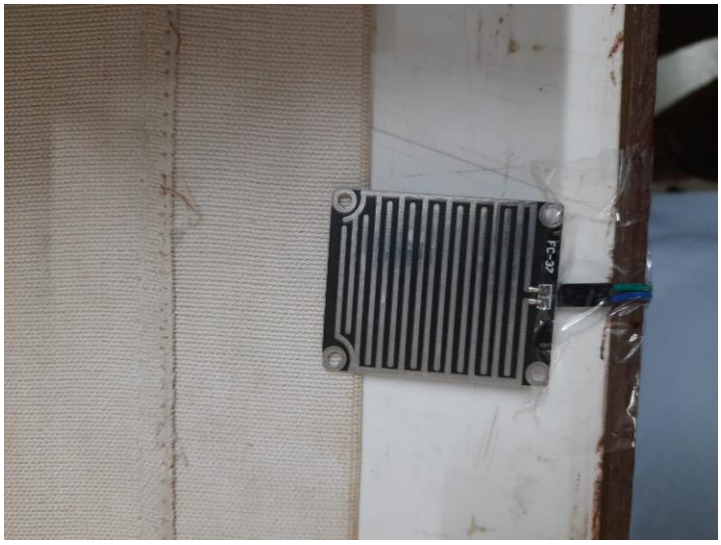


Fig no.(5.3.6)

Fig no.(5.3.7)

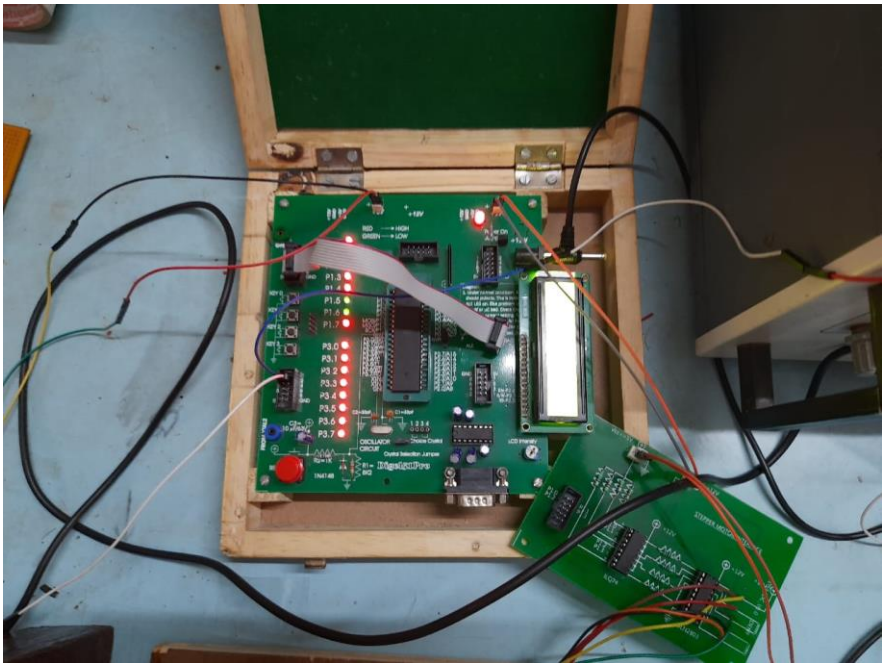


Fig no.(5.3.8)

Chapter 6

Results

The project has been tested for different categories of waste namely wet, dry and metal. Wet waste means organic wastes such as vegetable peel, garden wastes etc, dry waste include paper wastes, plastic bottles etc, and metallic waste include safety pins, foil paper etc. glass waste include frame glass, glass bottles etc.

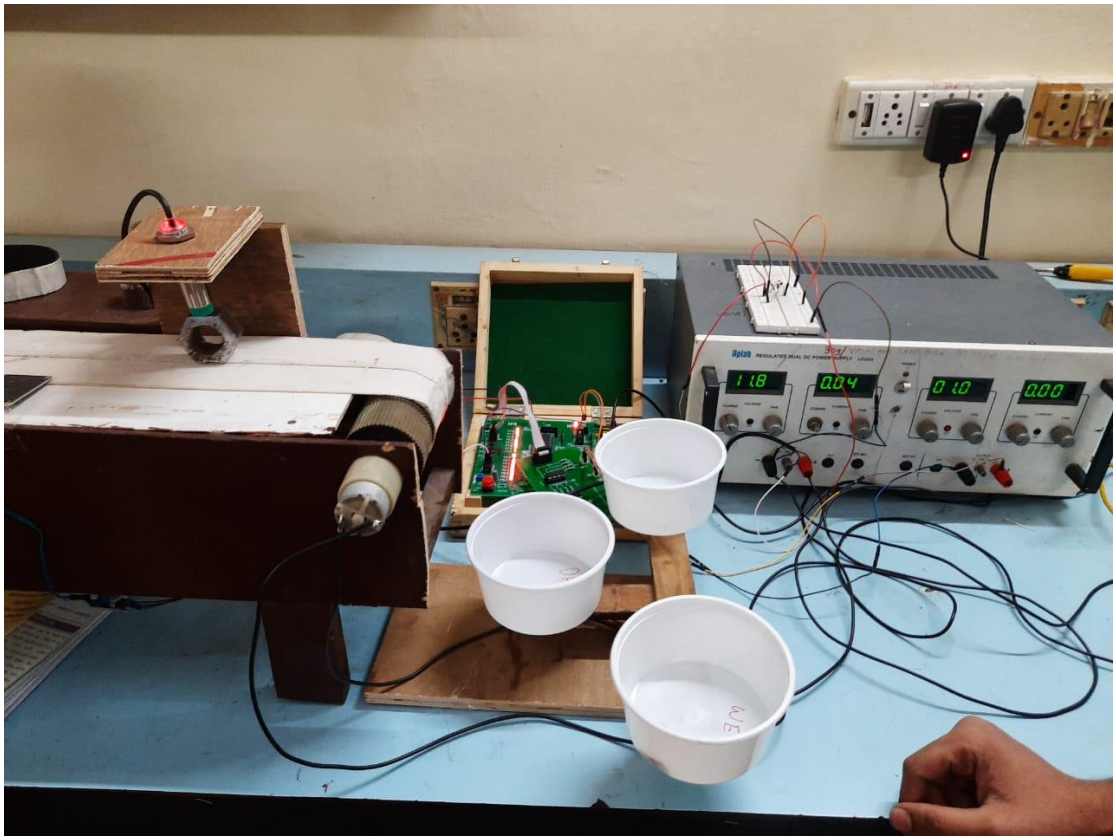


Fig no.(6.1)

Application:

This type of product can be used in housing societies, offices, etc. Since it is cost effective, it can be implemented on a large scale as well with some modifications. Using a robotic arm along with a conveyor belt will make the process of segregation easier. Also, more sensors can be used to segregate bio-degradable and non-bio-degradable waste, plastics, recyclable waste, e-waste, and medical waste.

Chapter 7

Conclusion:

The waste segregator as the name suggests, segregates the waste into three major classes: dry, wet, metallic.

Implementation of this system at a local level like societies, educational institutes, etc. can reduce the burden on the local authorities. The automatic waste segregator is one small step towards building an efficient and economic waste collection system with a minimum amount of human intervention and also no hazard to human life. Using a conveyor belt makes the system far more accurate, cost-effective and also easier to install and use at a domestic level. Segregating all these wastes at a domestic level will also be time-saving. While implementing our system we came across many problems like the sensing range of inductive proximity sensor, the accuracy of the moisture sensor, adjusting the range of IR sensors and some more, but using some modifications we tried the make the system as reliable as possible but not completely perfect.

Future Scope:

This type of product can be used in housing societies, offices, etc. Since it is cost effective, it can be implemented on a large scale as well with some modifications. Using a robotic arm along with a conveyor belt will make the process of segregation easier. Also, more sensors can be used to segregate bio-degradable and non-bio-degradable waste, plastics, recyclable waste, e-waste, and medical waste.

8.APPENDIX

Component List:

Sr.no	Name	Specification	Qty	Price
1.	Stepper Motor	4 coil,6 Wire	1	375
2.	Moisture Sensor	FC37	1	90
3.	Inductive Proximity sensor	12 v	1	350
4.	IC 1	ILQ 74	1	90
5.	IC 2	ULN 2803	1	40
6.	Resistor 1	100 Ohms	4	10
7.	Resistor 2	1K Ohms	4	10
8.	Resistor 3	4.7K Ohms	4	10
9.	IC holder	16 pin	1	5
10.	IC holder	18 Pin	1	5
11.	Microcontroller Kit	89S51	1	250
12.	Microcontroller	89S51	1	80
12.	Conveyor Belt	12V	1	500

Table no. (8.1)

Total cost = 1,815/-

Data Sheet

ILQ 74 (4-channel Phototransistor Output Opt coupler) :

ABSOLUTE MAXIMUM RATINGS					
PARAMETER	**TEST CONDITION**	**PART**	**SYMBOL**	**VALUE**	**UNIT**
INPUT					
Peak reverse voltage			V_R	3.0	V
Forward continuous current			I_F	60	mA
Power dissipation			P_{diss}	100	mW
Derate linearly from 55 %				1.33	mW/°C
OUTPUT					
Collector emitter breakdown voltage			BV_{CEO}	20	V
Emitter collector breakdown voltage			BV_{ECO}	5.0	V
Collector base breakdown voltage			BV_{CBO}	70	V
Power dissipation			P_{diss}	150	mW
Derate linearly from 25 °C				2.0	mW/°C
COUPLER					
Isolation test voltage	t = 1.0 s		V_{ISO}	5300	V_{RMS}
Isolation resistance	V_{IO} = 500 V, T_{amb} = 25 °C		R_{IO}	$\geq 10^{12}$	Ω
	V_{IO} = 500 V, T_{amb} = 100 °C		R_{IO}	$\geq 10^{11}$	Ω
Total package dissipation		IL74	P_{tot}	200	mW
		ILD74	P_{tot}	400	mW
		ILQ74	P_{tot}	500	mW
Derate linearly from 25 °C		IL74		2.7	mW/°C
		ILD74		5.33	mW/°C
		ILQ74		6.67	mW/°C
Creepage distance				≥ 7.0	mm
Clearance distance				≥ 7.0	mm
Storage temperature			T_{stg}	- 55 to + 150	°C
Operating temperature			T_{amb}	- 55 to + 100	°C
Lead soldering time at 260 °C				10	s

Table no. (8.2)

ULN 2803(high current Transistor)

Absolute Maximum Rating

		MIN	MAX	UNIT
V_{CE}	Collector-emitter voltage		50	V
V_I	Input voltage(2)		30	V
	Peak collector current		500	mA
I(clamp)	Output clamp current		500	mA
	Total substrate-terminal current		–2.5	A
T_J	Junction temperature	–65	150	°C
T_{stg}	Storage temperature	–65	150	°C

Table no. (8.3)

ESD Rating

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	±2000	V
		Charged device model (CDM), per JEDEC specification JESD22-C101(2)	±500	

Table no. (8.4)

Recommended Operating Condition

		MIN	MAX	UNIT
V_{CE}	Collector-emitter voltage	0	50	V
T_A	Ambient temperature	–40	85	°C

Table no. (8.5)

Thermal Information

THERMAL METRIC(1)		ULN2803A DW (SOIC) 18 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	66.4	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	29.5	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	33.0	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	6.0	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	32.5	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	N/A	°C/W

Table no. (8.6)

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