Smart Waste Sorter Machine

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Abstract

Waste management and its disposal is one of the greatest challenges faced by the world today. It is of vital concern to manage the municipal waste. By effective handling of waste material and by proper recycling, a country can progress in the right direction. In this work, a smart waste sorting machine is developed. It can sort out a variety of waste materials like metal, glass, etc. by using an electro-mechanical system. Conventional sensors are used for sorting out metal and glass and for paper and plastic, LASER and LDR is used. A weight sensor and counter is used to find out the amount of waste sorted. By using this sorting procedure and with proper recycling, the problem of waste management will be solved to some extent. This smart system will, thus help to properly dispose waste and avoids any environmental problems.

Keywords- Microcontroller, Operational Amplifier, Sensor, Waste management, LDR

I. INTRODUCTION

From the beginning of the human civilization, people used various methods of waste disposal to get rid of unwanted material. Sometimes it was buried in the land, thrown in the sea, fed to the animal or burnt. Getting rid of unwanted material is always a major concern for the modern society. Trash has played a tremendous role in history. The Bubonic Plague, cholera and typhoid fever, to mention a few, were diseases that altered the populations of Europe and influenced monarchies. They were perpetuated by filth that harbored rats, and contaminated water supply [1]. When wastes are not properly managed then it may cause serious hazard, as seen in 1350. "Black plague" erupted and more than 25 million people from all over Europe fall victim to it in just five years [2]. There is an increasing rate of waste generation in India and at present, it is about 1, 00,000 metric tons per day. The Waste Generation Rate (kg/cap/day) is expected to increase by 1.3%. A significant percentage of the population has zero access to proper waste disposal services, which will in effect lead to the problem of waste mismanagement. The total waste collection rate in major cities of India such as Delhi is only 37%. When waste is not properly collected, it will be illegally disposed of and this will pose serious environmental and health hazards to the people of India. This is not the only problem of Delhi city but also for other big cities around the world. With so much concern recently about being greener and economically friendly, waste management has become a very important topic. People and companies are starting to realize that the things they use and the way they dispose of them can make a big impact on our world. Proper management of waste plays a vital role in global environment. That is why a waste sorting system is designed which can be used in houses, offices, industries as a part of smart waste management system.

II. PRESENT SCENARIO OF WASTE GENERATION

The present status of solid waste generation can be described from different point of views. The generation and management of wastes is described from World's and India's perspective.

A. World Scenario

Confederation of European Waste to Energy Plants (CEWEP) and European Environment Agency (EEA) provides sound, independent information on the environment.

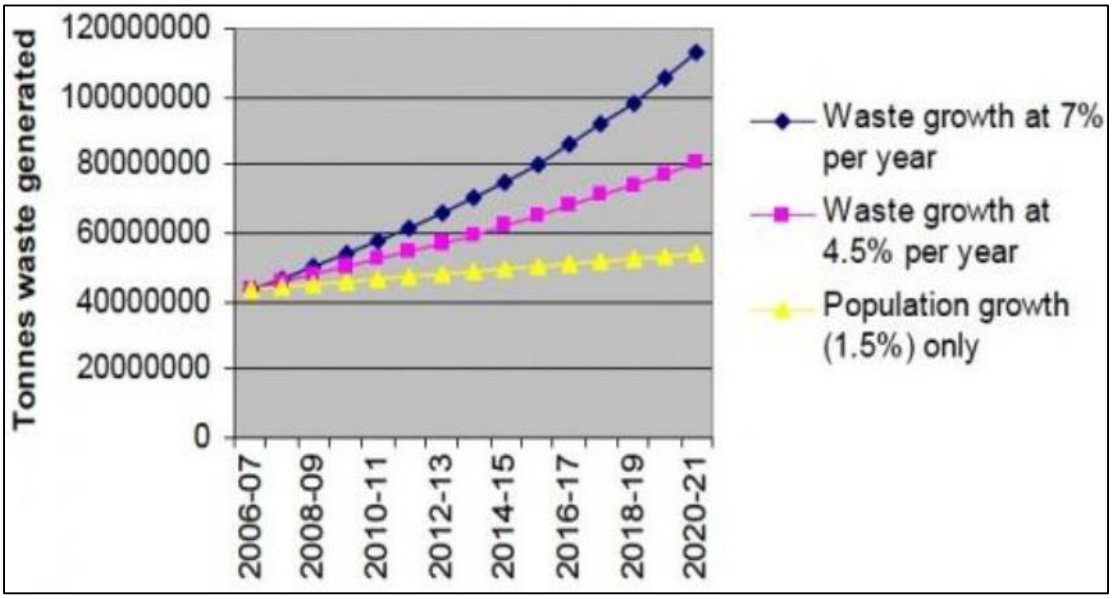

Fig. 1: Comparative waste generation 2006-07 to 2020-21

Fig. 1 has been generated from the corresponding data from CEWEP and EEA. Considering present condition, waste growth at 7% per year is plotted. Considering future waste reduction, waste growth at 4.5% per year is plotted. Fig. 1 illustrates the fact about the total generation of wastes around the word. The total amount is increasing day by day and hence the waste management is becoming a challenge for both the developed and developing countries. Hence, recycling is becoming very important. Recycling is a resource recovery practice that refers to the collection and reuse of waste materials such as empty beverage containers. For recycling the waste is required to separate into various different bins. As it enables us to convert waste into a valuable resource, gradually this practice is gaining popularity.

B. India Scenario

India generates approximately 133 760 tonnes of MSW per day, of which approximately 91 152 tonnes is collected and approximately 25 884 tonnes is treated. MSW generation per capita in India ranges from approximately 0.17 kg per person per day in small towns to approximately 0.62 kg per person per day in cities.

Waste generation rate depends on factors such as population density, economic status, level of commercial activity, culture and city/region. The Figure provides data on MSW generation in different states, indicating high waste generation in Maharashtra (115 364–19 204 tonnes per day), Uttar Pradesh, Tamil Nadu, West Bengal (11 523–15 363 tonnes per day), Andhra Pradesh, Kerala (7683–11 522 tonnes per day) and Madhya Pradesh, Rajasthan, Gujarat, Karnataka and Mizoram (3842–7662 tonnes per day). Lower waste generation occurs in Jammu and Kashmir, Bihar, Jharkhand, Chhattisgarh, Orissa, Goa, etc (less than 3841 tonnes per day)

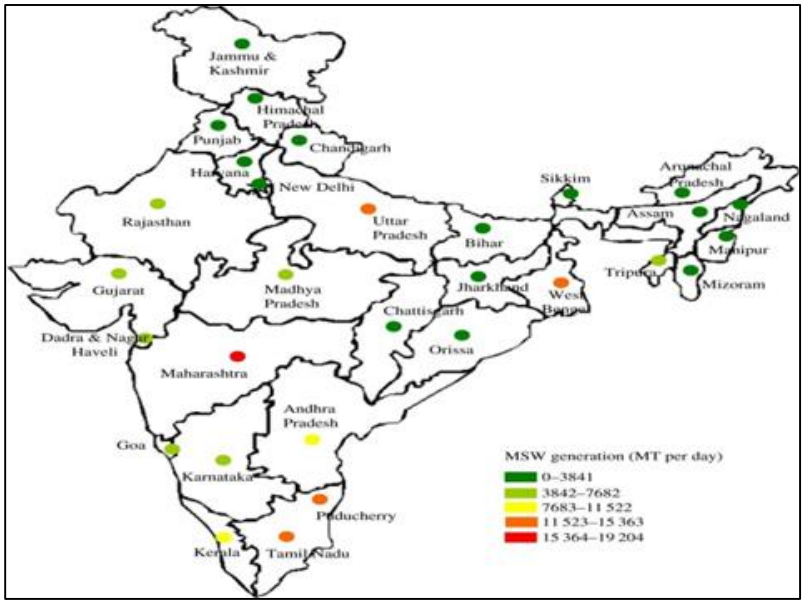

Fig. 2: State-level statistics of MSW generation in India

III. METHODOLOGY

The machine activates when some sort of material is being put on the system tray. The material is detected by IR sensor. Then, firstly the weight sensor activates and calculates the weight of material. Afterwards, the metal sensor and glass sensor start their functioning. If material is detected as metal by the metal sensor, then servo motor will place that material into bin 3. Same is the case with glass sensor, in which case the material will be put into bin 4. If both the sensors fail to detect, the LASER and LDR activates. If LASER passes through the material, it means that it is transparent and moved to bin 2. If not, then material is decided as paper and moved to bin 1.

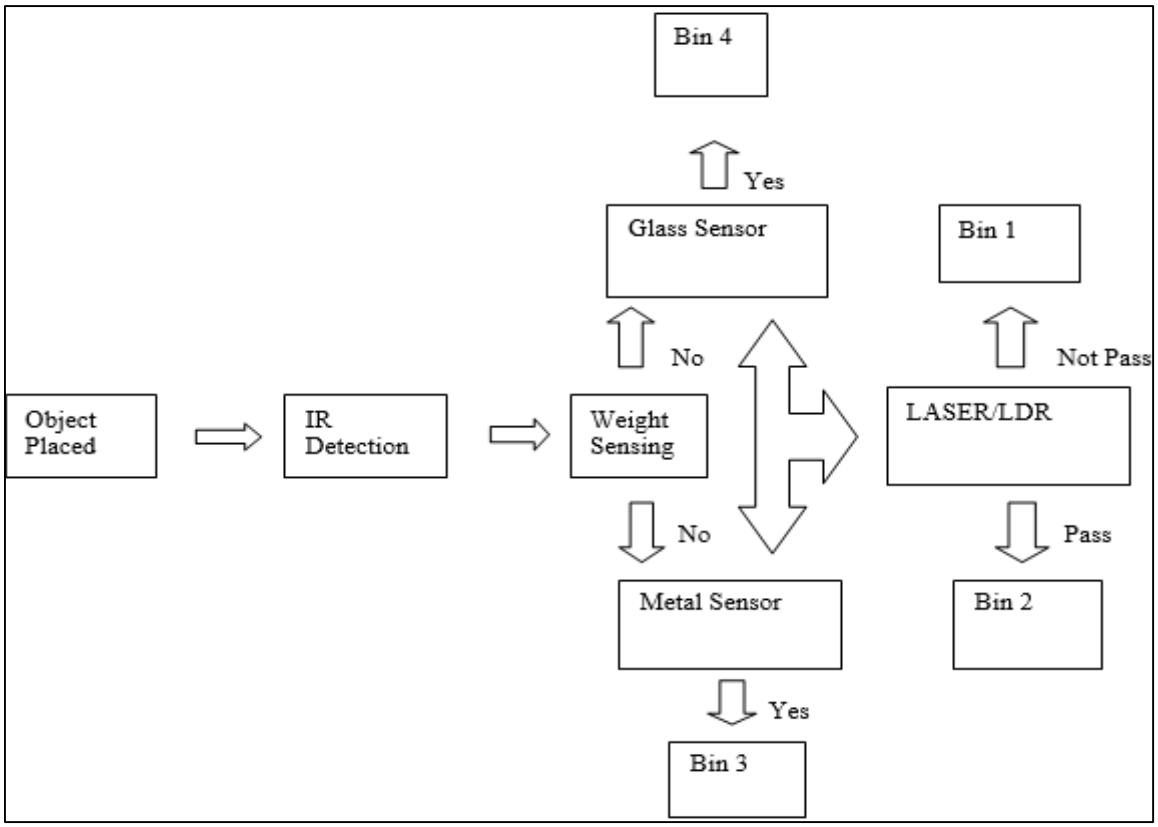

Fig. 3: Sequential Logic Flow Chart

IV. SYSTEM DETAILS

The sorting system consists of Light Dependent Resister (LDR), LASER, Infrared (IR) transmitter and receiver, Metal Sensor (Capacitive proximity sensor E2K-C) [9], glass sensor (Omron E3SCR67C), Weight Sensor (MLC900 micro weight sensor) [10] and a Liquid Crystal Display (Alpha-numeric 16*4 LCD). The whole program is run by a microcontroller (PIC 16f877A) [11].

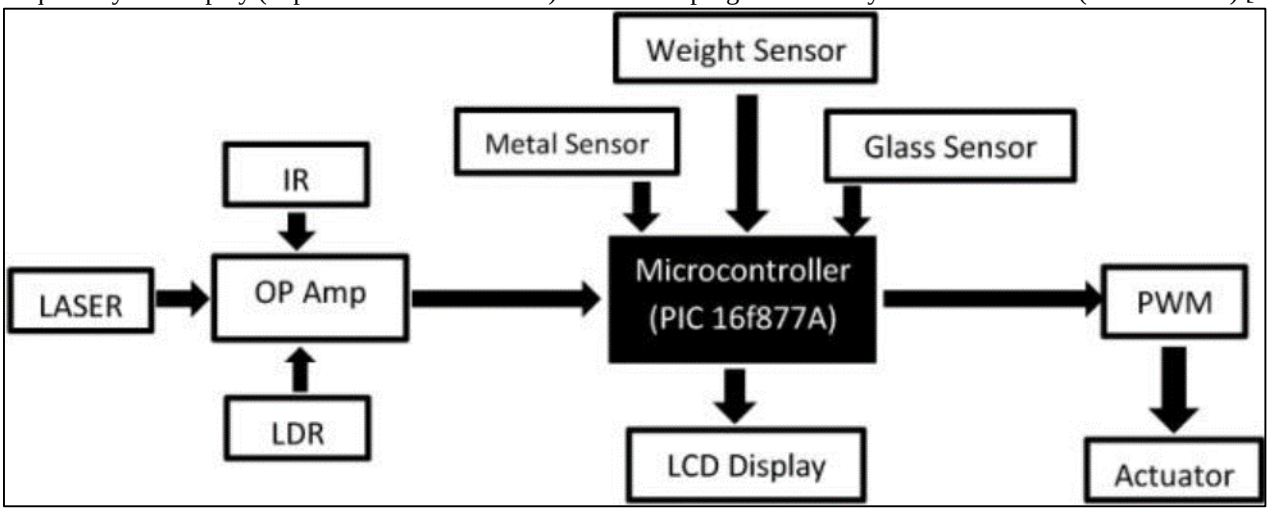

Fig. 4: Block Diagram of Sorting System

A servomotor (HS-65MG, Mighty Metal Gear Feather Servo) based electro-mechanical system works as an actuator which puts trash in the desired bin. The microcontroller will count the trash sequence number and also the total weight of definite type of wastes.

V. ELECTROMECHANICAL SETUP

The machine setup consists of four bins. Each bin is used to store different materials. Bin 1 is for Paper, Bin 2 is for Metallic elements, Bin 3 is for Plastic elements and Bin 4 is for Glass particles. Initially, the material is placed at detection zone. The sensor detects the material and sensing signal is sent to microcontroller and the final output coming from it runs the servomotor in a definite direction based on the material being sensed.

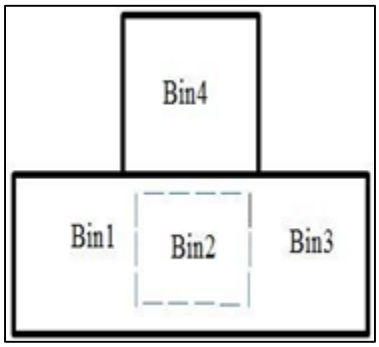

Fig. 5: Top view of the Sorter

Servomotor is a part of servomechanism. The servomotor is paired with some type of encoder to provide position feedback. It helps to provide precise control of mechanical degree of freedom driven by motor. The Servo motor is controlled by sending a pulse of variable width by the microcontroller. The control wire is used to send this pulse. The parameters for this pulse are that it has a minimum pulse, a maximum pulse, and a repetition rate. Given the rotation constraints of the servo, neutral is defined to be the position where the servo has exactly the same amount of potential rotation in the clockwise direction as it does in the counter clockwise direction. It is important to note that different servos will have different constraints on their rotation but they all have a neutral position, and that position is always around 1.5 milliseconds (ms). The angle is determined by the duration of a pulse that is applied to the control wire. This is called Pulse width Modulation. The servo expects to see a pulse every 20 ms. The length of the pulse will determine how far the motor turns. For example, a 1.5 ms pulse will make the motor turn to the 90 degree position (neutral position). When these servos are commanded to move they will move to the position and hold that position. If an external force pushes against the servo while the servo is holding a position, the servo will resist from moving out of that position. The maximum amount of force the servo can exert is the torque rating of the servo. Servos will not hold their position forever though; the position pulse must be repeated to instruct the servo to stay in position.

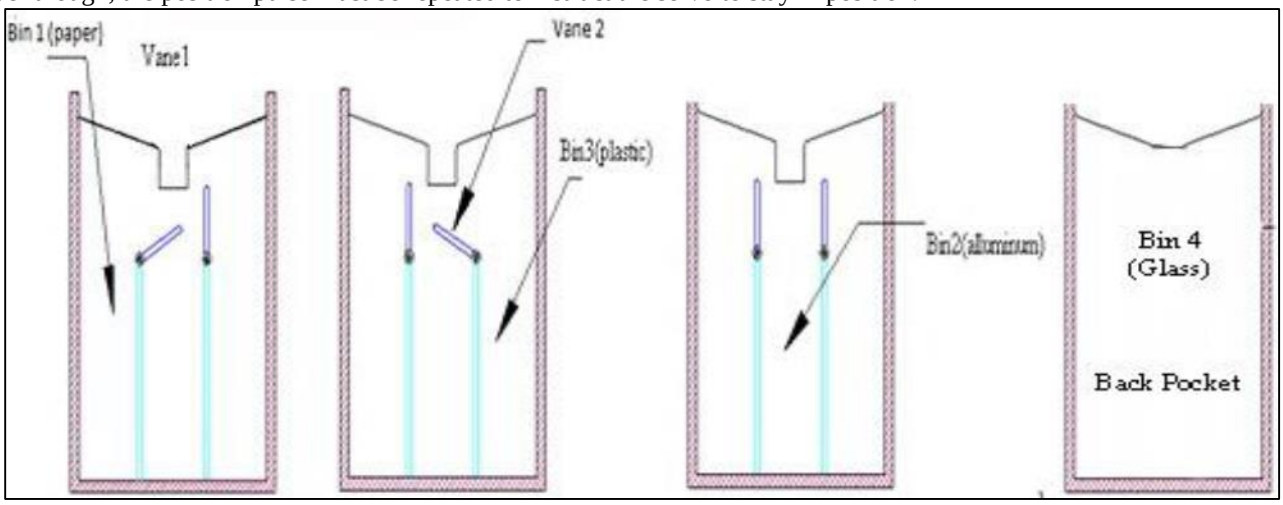

Fig. 6: Sorting Mechanism

VI. COMPARATIVE STUDIES

Comparison between the existing waste sorting bin and Automatic Sorter Machine for Smart Waste Management System is discussed below.

A. Automation

Most of the waste sorters available presently are manual, which are less user friendly. Automatic Sorter Machine for Smart Waste Management System is fully automated, which have made the whole sorting procedure very easy and effective.

Fig. 7: Manual Waste Sorting Bin

B. Cost Comparison

Many local and international companies manufacture trash can. Among them Carron Phoenix Disposal Products are worldwide famous. But at present the price of the trash cans, by Carron Phoenix, ranges from $120 to $250. The Automatic Sorter Machine for Smart Waste Management System will cost around $90. It is cheaper than other because a unique algorithm to sort paper and plastic is developed and the mechanical structure is very simple.

C. Bin Number

Presently available trash bins can sort out only two or three types of trash materials. But Automatic Sorter Machine for Smart Waste Management System can automatically sort out minimum four types of trash materials very easily and efficiently.

D. Unique Sensor Designing

Special type of sensor by using LDR and LASER is used in Automatic Sorter Machine for Smart Waste Management System. These have replaced the conventional sensors available in the market for sorting out paper and plastic.

E. Power Consumption

The power supply of Automatic Sorter Machine for Smart Waste Management System is driven by 9 V (DC). It can be driven by 220 V (AC) like the other available automatic trash bins.

VII. FUTURE SCOPE

The waste sorter machine can solve a lot of problems and bring a change in our daily life.

A. Health Service

Special type of sensor could be used to sort out the organic parts of the wastes. When the organic parts of the wastes are sorted out then they may be tested automatically to find out the food habit of the user and analyze it for the improvement of the user's diet. Another application of sorting out the organic parts of the wastes is, the organic parts may help to diagnosis several disease of the user. Thus the health issues of the user of Automatic Sorter Machine for Smart Waste Management System will be insured at some extent.

B. Sorting More Types of Waste

The machine developed can only sort upto 4 types of wastes. By using more sensors, its field of use can be increased. (Such as: Transparent and nontransparent plastics, Thick and thin papers, Semi-conductor and Conductors, Rubber materials, Organic etc.).

C. Increased Response Time

The response time of electromechanical system is relatively fast. But it can be improved by using industrial grade servomotor. When the said is used, the system should be synchronized to perform smoothly and faster.

D. Recycling

A recycling plant may be installed with the machine. This will ensure that a home user will practise recycling and reuse. The primary unit consists of only paper or plastic recycling unit.

VIII. CONCLUSIONS

In communities where appropriate sites are available, sanitary landfills usually provide the most economical option for disposal of solid waste. However, it is becoming increasingly difficult to find sites that offer adequate capacity, accessibility and environmental conditions. The amount of waste, which is being recycled or reused, stands for the reduction of waste to be managed by the authority. Proper management of waste plays a vital role to control global warming [1]. Automatic Sorter Machine for Smart Waste Management System is an excellent example of proper waste management. It will also ensure effective recycling system. Hence, the improvement of waste sorter will ensure economic and ecological development.

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