Design and Development of Smart Waste Sorting System

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Abstract - Solid waste management is the pervasive problem now a days and rising continuously with rise in urbanization. Solid waste is always the mixture of different type of material. For ecologically sustainable development solid waste management is a vital requirement in many countries. It is very essential to sort the waste at base level so that there should be proper disposal of waste at the dumping sites. Sorting of waste requires more manpower and consumes more time too. Solid waste can be sorted and managed in numerous types of techniques but all of them are manual which makes it cumbersome. Also, it may be prove as hazardous if it contains some toxic substances, so there is a need of a smart waste sorting system. Solid waste can be categorized into two different type's; biodegradable and non- biodegradable waste. Biodegradable waste consists of vegetable waste, fruit waste, leaves, paper, etc and non- biodegradable waste consists of metal, foil paper, plastic bottle, glass bottles, etc. Biodegradable waste is the waste that can be decomposed while non- biodegradable waste is the waste which does not decompose. It should be noted that several non-biodegradable waste materials are harmful for both environment as well as human beings. So, there is a strong need to sort the waste automatically in such a way that it will not harm any individual.

Keywords - *Types of waste, metal sensor, IR Sensor, Waste Samples.*

I. INTRODUCTION

Waste management is the "generation, prevention, characterization, monitoring, treatment, handling, reuse and residual disposition of solid wastes". Many type of waste exists in our environment which includes solid waste, consisting municipal waste (institutional, residential, commercial), agricultural waste, and special waste (sewage sludge, household hazardous waste, health care). As urban population is rising continuously and their consumption patterns are changing this leads to increase in global concern due to which solid waste management has become an issue. So for easy disposal of waste, sorting of waste on the basis of its category is very important. Waste sorting is the method by which waste is separated into different elements. Waste sorting can be done manually at household level as well as commercial level and collected through curbside collection schemes, or can be separated automatically in materials recovery facilities or mechanical biological treatment systems. In history, hand sorting was the method used in sorting waste. Waste can also be sorted automatically. Different types of wastes are discussed below:

A. Municipal Waste

Municipal solid waste includes waste from streets, household waste, sanitation residue, and destruction and construction debris. Residential and commercial complexes are the main source of generation of municipal solid waste. The municipal waste is rapidly increasing and its composition is changing as the urbanisation is rising and the lifestyle is changing and food habits to.

B. Hazardous Waste

Industrial and hospital waste can be considered as hazardous because they consist of toxic elements. Many type of household waste can be hazardous. Hazardous waste can be very harmful to animal, plants and humans. Hazardous waste is highly inflammable, corrosive, and explosive; it reacts when come in contact to certain items e.g. gases. 7 million tonnes of this kind of wastes is generated by India every year. This kind of waste is found mainly in Bihar, Tamil Nadu, Uttar Pradesh and Andhra Pradesh.

C. Hospital Waste

In the process of treatment, immunization, or diagnosis of human beings or animals, hospital waste is generated. Also in production of biological or in research process of above activities the waste is generated. It may consist of wastes like soiled waste, sharps, disposables, cultures, anatomical waste, chemical waste, discarded medicine, etc. They may be in the form of swabs, human excreta, disposable syringes, body fluid, bandages, etc. This kind of waste is very infectious and harmful for human health if it cannot be managed in a proper and scientific manner.

II. RELATED WORK

Very less work is done in the field of sorting biodegradable and non-biodegradable waste. Previously, the work done is based upon NIRS, only metal detector or optical sensor and these are used to sort only plastics or metals and waste particles but in this thesis work biodegradable waste includes papers, fruit waste, vegetable waste, leaves and non- biodegradable waste includes metal, glass, plastic is sorted. The following research papers describe the earlier work done in the design and development of smart waste sorting system.

Madan Kumar et. al. In this paper, concept of Near Infrared Spectroscopy (NIRS) was used for the automatic sorting of different types of plastic. For efficient sorting of

plastic waste, low cost Raspberry Pi based control system is used. Python is the general purpose and high level programming language; it was the software that was used to process the NIRS data to attain information on the polymer category and to interface the spectrometer with the Raspberry Pi [1].

Jiu Huang et. al. In this paper, the mechanical separating system was developed and introduced with the help of operating sensor. In this system the sorting criterion was based upon particles position, size, shapes and colours of waste particle. A compressed air nozzle was there in the mechanical sorting device nozzle which blows the target particles out of the main stream which were sensed by the sensor and the whole process is controlled by computer [2].

Ohtani et. al. They proposed the work that consists of an ultrasonic sensor array and neutral networks to make the new identification method. Acoustic impedance and ultrasonic pressure distribution was used to sort the waste on the basis of its shape and material. Some of the experiments have done with a prototype sensor system. The experimental results showed the practical applicability of the identification method in a shapes and materials sorting system [3].

Suwon Shin et. al. In this project work the automatic trash basket was developed and introduced that sorts the metal and paper based trash so that there is ease of recycling them for users. A small trash bin was introduced for office workers and students to dispose their trash. The attractive thing of the project was that whole trash basket was based on the automatic motion movement [4].

Kumar, L.M. et. al. In this paper, for the on-line and instantaneous identification of the consumer plastics the technique of Near Infrared spectroscopy (NIRS) had been used. NIRS enables quick identification and monitoring of the molecular or structural properties of the plastic under exploration. For the realization of result, an automatic process which was capable of sorting plastic, an embedded system of low cost had been developed. Further, to protect the personnel from the unhealthy environments that was predominant in plastic recycling plants, wireless was interfaced which was capable of controlling the NIRS instrumentation remotely [5].

Yann Glouche et. al. For an early detection of waste type at bin level a pervasive computing technology can be used to manage the waste i.e. Radio Frequency Identification (RFID). In this paper, on the basis of self-contained in tags linked to every waste item, an application of smart bin was proposed. The smart bins track the waste using RFID-based system without any support of an external system [6].

III. PROBLEM FORMULATION

A. Need

Solid waste management is the important aspect that should be kept in mind. There is need of automatic sorting of waste at the base level so that the waste can be dumped properly at the dumping sites. As we see that the rag pickers just pick that waste only which is of their use, all other waste just litter all around, which have adverse impact on the environment. When waste is collected from different- different places then all the waste is mixed and to sort that waste manually manpower is required which consumes much time. To manage the waste, sorting is very important at the base level. This will automatically reduce the sorting time as well as manpower. So, there is need of automatic waste sorting, which helps in sorting non- biodegradable and biodegradable waste.

B. Significance

Managing waste is the major problem which we are facing now-a-days. The main significance of the thesis work is that it sorts the waste automatically into two categories, non-biodegradable and biodegradable waste. This will be helpful for the municipal corporations in sorting of waste. This thesis work will reduce the sorting time and manpower.
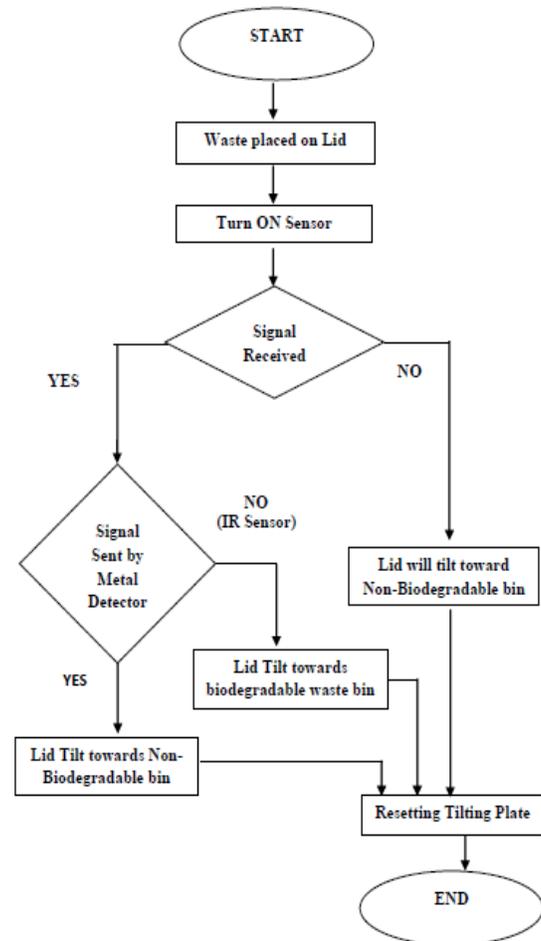
IV. METHODOLOGY

Fig.1: Flow Diagram of Overall System

The main goal of the system is to design and develop a sorting system that sorts the waste automatically. It is an eco-friendly automatic system. The smart waste sorting system sorts the biodegradable and non- biodegradable waste. The system starts when the waste material is placed on the lid, then the sensor transmits the signal and that signal is received by the microcontroller, depending on the signal received the lid of the system works. If the signal is transmitted by metal detector then the lid tilts towards the bin that collect the non- biodegradable waste. If the signal is transmitted by the IR sensor then the lid tilts towards the biodegradable bin. In case no signal is transmitted by either sensor then the waste may be plastic bottle, glass bottle or poly bag, and then the lid tilts towards the bin which collects the non-biodegradable waste. Another IR sensor is interfaced in front of bin which detects that a person is arrived to throw the waste and this alerts the system. And in this way the waste is sorted.

V.   RESULTS

The above system consists of microcontroller unit which is helpful in commanding the lid of the system according to the sensors input to the microcontroller and its output. LCD is interfaced with the microcontroller which shows the type of waste approach to the system. Two types of sensors are interfaced with the microcontroller, one metal detecting sensor and two IR sensors. The bin is partitioned in two parts one is biodegradable and another one is non- biodegradable waste. Metal detecting sensor is used to detect the metallic garbage; it

detects cans, foil papers, iron pieces, gold, etc. IR sensor detects the biodegradable waste; it detects fruit waste, vegetable waste, leaves, papers etc. another IR sensor is mounted on front side of bin. When a person approaches to the bin to throw the waste then that IR sensor alerts the other sensors. As the waste placed on the lid the sensors turns on, if the waste is metallic then the metal sensor sends the signal to the microcontroller then the lid will tilt towards the non- biodegradable waste bin. And when the biodegradable waste is placed on the lid then the IR sensor works, sends signal to the microcontroller and the lid tilts towards the biodegradable bin. In case no signal is sent to the microcontroller by either sensor then the waste is of transparent plastic, glass or poly bag. Then the lid tilts towards the non-biodegradable bin. The LCD shows the type of waste i.e. "Metallic Waste" for metallic waste, "Biodegrade Waste" for biodegradable waste and "Plastic Waste" for transparent plastic, glass and ploy bag. In this way the system works. Below is the result table for different types of waste tested.

Table 1: Types of waste tested

Waste	Type of Waste	Sensor Works	Movement of Lid
Foil paper	Metallic Waste	Metal Detecting Sensor	Non- biodegradable Bin
Gold	Metallic Waste	Metal Detecting Sensor	Non- biodegradable Bin
Steel Bangle	Metallic Waste	Metal detecting Sensor	Non- biodegradable Bin
Wrapper	Metallic Waste	Metal Detecting Sensor	Non- biodegradable Waste
Lemon	Vegetable Waste/ Decomposable	IR Sensor	Biodegradable Bin
Potato	Vegetable Waste/ Decomposable	IR Sensor	Biodegradable Bin
Mango	Fruit Waste/ Decomposable	IR Sensor	Biodegradable Bin
Poly Bag	Recyclable	No Sensor	Non- biodegradable Bin
Plastic Bottle	Recyclable	No Sensor	Non- biodegradable Bin
Glass	Recyclable	No Sensor	Non- biodegradable Bin
Colored Plastic Bottle	Recyclable	No Sensor	Non- biodegradable Bin
Cans	Metallic Waste	Metal Detecting Sensor	Non- biodegradable Bin
Paper	Decomposable	No sensor	Biodegradable Bin

VI.   CONCLUSION AND FUTURE SCOPE

Due to rise in urbanization the waste is increasing very fast. Therefore waste management is the vital need to protect the environment. The technological growth and innovation can

contribute to this vital aspect to achieve environmental sustainability. There are many compelling reasons for choosing these approaches. To manage the waste, automatic sorting systems are needed to be developed on the lower level as well as higher levels. Waste should be sorted at the basic level first so that it is helpful for Municipal Corporation to dump it properly and recyclables can be recycled. This system is helpful in sorting non- biodegradable and biodegradable waste. Two types of sensors are used, one is metal sensor and other one is IR sensor. This system can be made more efficient by using different sensors for different types of waste. More bins can be added to this project as per demand of user. Some more efficient sensors can be used which can detect the waste in some packing, opaque plastic or poly bags. The system can be made waterproof. The system should be cheap and approachable, so that everyone can buy it and use it. Since many factors come in play and have to be considered.

VII. REFERENCES

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