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Design and Implementation of a Microcontroller-Based Automatic Waste Management Sorting Unit for a Recycling Plant

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ABSTRACT
The objectives of this study were to use microcontroller and sensors to automatically sort out organic and inorganic waste materials to be recycled. This is to reduce the time taken to sort out organic and inorganic waste materials manually and to save cost involved in processing waste. This study further described a sophisticated technique in sorting the waste based on the microcontroller unit that used gas sensors to separate the organic and raw wastes. The gas detection system was incorporated within the conveyer that passed in front of the gas sensor and sent data to controller through analog to digital convertor. The Microcontroller- based automatic waste management sorting unit for a recycling plant was successfully designed, built and this provided an efficient system for sorting out wastes into various components.
Keywords: *Recycling Plant, Microcontroller, Waste Management, Sorting Unit, Sensor*

I. INTRODUCTION

Problem Statement

Solid waste disposal is a worldwide problem that has significant environmental issues associated with it. Solid waste production in Ghana is growing in volume and in toxicity. It is estimated that the average Ghanaian generates 0.5kg of solid waste per day. From the trend of development in this country, it envisaged that the generation rate of waste would increase every year in parallel with the annual human population growth rate of 3% [1].Currently, disposal of municipal solid waste in open dumps and landfills are the conventional method that is practiced in most part of Ghana. Minimising the amount of waste generated and ending up at these disposal sites by converting waste to other useful products is a welcoming prepositions. However, the challenge is before any proper waste management can be achieved in municipalities and communities, the waste composition studies is required. In fact, the waste composition is the single factor that any waste handling and disposal technique depend upon. For instance, unsorted municipal solid waste is not suitable for gasification technologies [2]. Some of the reasons for the importance of the waste compositional studies according to Sfeir *et al.,* [3] include the need to:

- estimate material recovery potential for recycling;
- identifying sources of component generation;
- aid in the design of processing equipment and
- estimate physical, chemical , biological and thermal properties of wastes.

It is therefore essential that the composition of waste are determined accurately and possibly before technical and management steps are taken for any solid waste management program. But, this has been difficult to be achieved due to the variations in waste compositions as results of variations in seasons, lifestyles, geographic, demographic and local regulations impacts. These variations make it difficult to select an accurate and representative sample for waste composition analysis using the current analytical methodology. Thus, the physical sampling, sorting and weighing of waste constituents to establish their contributions by weights. But in order to ensure statistical significant compositional results by this method, sufficiently large number of samples must be collected and sorted. Economical reasons have been one of the shortfalls that affect the design, and after impact on the quality of the study [3]. As mentioned earlier, one indivisible aspect of waste management is the accurate determination of the waste compositions. So the primary objective of this study was to design and use microcontroller and sensors to automatically sort out municipal solid waste into organic and inorganic constituents to be recycled into their various categories of products. This is aimed at reducing the time taken to sort out organic and inorganic waste materials manually for subsequent processes and to save cost involved in

processing waste. Consequentially, this will help to control the amount of waste that goes to the dump sites and create awareness on the feasibility of waste recycling in the country [4] [5].

II. REVIEW OF RELATED WORKS

(a) Stadler Sorting Plant

Fig. 1: Stadler Sorting Plant

For this plant, general waste is fed into the plant through a squeezer to break the waste down for transportation of the waste from the beginning to the end by a conveyor belt. A central monitoring system monitors the waste throughout the plant. A trommel screen machine rotates the waste to create spacing within them. The organic fractions machine separates the organic waste and non-organic waste, a ballistic separator machine shakes up waste to differentiate the heavy once from the lighter once. The rolling fractions take the waste up to the PET-PEHD machine which mixes the plastics and the waste is passed on to the quality control. Lighter waste like paper are blown up by air and then passed on for bailing. On the other hand, the residue is compressed and bailed for storage [6].

(b) Garbage Sorting Line

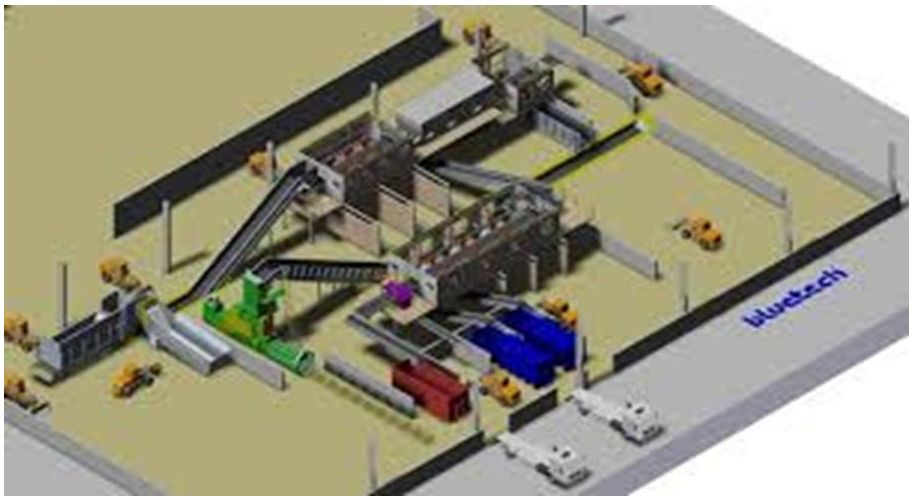

Fig. 2: Garbage Sorting Line

This plant uses pneumatic control for most of its controls. The plant uses conveyor belt for transporting waste materials from one place to the other. It receives waste through an inlet point just outside the plant. The Bay Open System opens all the bags coming into the plant, and the Ballistic Separator shakes up the waste to separate the debris in the waste and passes the waste on to the Spin Machine to transport, take out the rest of the debris and create space among the waste. The first fraction takes the waste up for Aspiration and second fraction where another Ballistic Separator, shakes up the waste thereby creating space and separating the waste. The plant then uses eddy current and NIR Machine to separate the rest of the waste. The waste then goes through manual sorting into various categories and then bailed category by category [7].

(c) Autonomous Material Waste Sorter

Fig.3: Autonomous Material Waste Sorter

This is made from cardboard and expanded PVC for minimal weight. A 9400 rmp DC motor was gear boxed to spin the AWS at 900 rmp. A sensor detects magnets on each flap to determine loaded material to be sorted. A servo controlled by a microprocessor loads each material one by one from the fully loaded hopper.

Sorting Glass: A trap door was placed under the area where each material falls. The weight of the glass opens the trap door allowing the glass to fall into sorted-glass bin.

Sorting Plastic: The height of the AWS ceiling does not allow the plastic bottle to pass through. The force opens a magnetically closed door and allows the plastic to fall into the sorted-plastic bin.

Sorting Tin: A block fitted with magnets rotates continuously by a DC motor and pulls the magnetic tin container out. The material falls off into the sorted-tin bin.

Sorting Aluminium: Since aluminium is the last material to sort, it simply falls off the end into a sorted-aluminium bin [7].

III. METHODOLOGY

3.1 Circuit Diagram

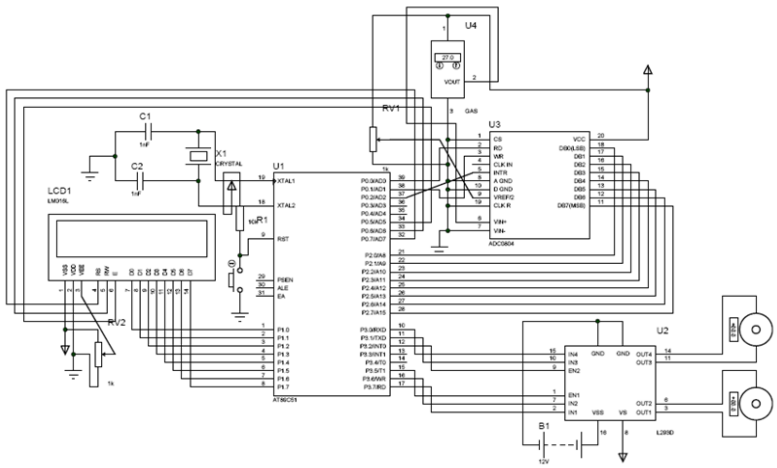

Fig.5 : Circuit Diagram of the Prototype

The Microcontroller in the circuit was provided with 5v supply along with ground and then the 11.0592 crystal was also placed on the crystal pins. The LCD control pins were connected to the port 0 and Data pins were connected to the port 2. The ADC control pins were connected to the port 0 and data pins were connected to the port 2. The motor system was connected to the port 3 of the controller [6].

3.3 Procedures of Implementation

The following describes the implementation stages:

First Stage: Data Acquisition for Gas Detection from wastes

Second Stage: Implementation of Embedded Microcontroller Hardware and firmware Design

Third Stage: LCD Interfacing & Testing
Fourth Stage: Motor Control for separating Raw & Composting Wastes
Fifth Stage: System integration and Testing

3.3.1 Explanation of the above stages

First Stage:

The gas sensor was studied on physical and electrical properties based on the sensors information, the necessary power supply was given to the sensor and the analogue output was given to the ADC0804, the basic circuit for ADC0804 was implemented and then it was interfaced with the controller.

Second Stage:

The MCS51 Microcontroller was studied and then the basic power circuit, frequency circuit, and reset circuit was designed and verified on the hardware. The basic circuit was connected to controller according to pin configuration.

Third Stage:

LCD display had the capacity to display whatever it was promoted in the programming for the microcontroller. The microcontroller sends appropriate commands to the LCD. In the project it displayed the conditions of the library. LCD has two ports to be connected with the microcontroller, one is for control lines, another one is for data lines, this data lines carries the data to be displayed in LCD display and control lines gets the control commands for LCD in which placed data has to display.

Fourth Stage:

The motors here dump organic and inorganic wastes in each place. The DC motor was connected to the microcontroller via motor driver H-Bridge, this bridge provided the required power to the motor. Whenever H-bridge get enabled signal the motor rotates according to the input to the bridge, the piezoelectric buzzer is added to the controller for warning purpose.

Fifth Stage:

Each and every part of the project was integrated as given below, the gas sensor was connected to the controller through the A/D converter which convert analog to digital value that is accepted by controller, the ignition motor was connected to the controller via motor driver to control the car based on driver status. The LCD was directly interfaced with controller to know the gas level of the garbage. The above system was connected to a power supply.

IV. RESULTS AND DISCUSSIONS

4.1 Results

The goal for this project is to build a microcontroller – based automatic waste management sorting unit for a recycling plant. This project provides an ideology to reduce the amount of bulky waste that is sent to the dump site and improves waste sorting method automatically.

Thus by completing that goal, it is believed to have built a full operation concept or prototype of an ideal microcontroller – based automatic waste management sorting unit for a recycling plant. One among those issues which requires our personal presence is the guidance of the waste component onto the conveyer belt for sorting out into various components.

4.2 Discussions

In existing systems, the wastes are manually sorted out into their various components. These systems consume time which when lost could never be recovered. Also, constant monitoring and lots of manpower are needed to enable the plant to meet its scheduled target. Furthermore, there are health implications on the workers of the plant due to the stench coming from the refuse, the contaminated socked up water in the refuse which drips onto the plants conveyer belt whiles work is going on. There can be an outbreak of diseases from these refuse. The automatic waste sorting method deals with curving away these procedures at the plant to minimize cost and also do away with outbreak of any diseases and other health implications.

V. CONCLUSION

This research concludes the gas level detection of each waste materials, discusses dumping and separating each type of wastages by using motor. Also, it describes a sophisticated technique for sorting the waste based on low-power controller of microcontroller which uses gas sensors to separate the compost and raw wastes to garbage management system. The method reduces the consumption of natural resources and lowers the ultimate waste disposal needs. The result of this work explains that a Microcontroller-Based Automatic Waste Management Sorting Unit provided an efficient system for sorting wastes into various components.

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REFERENCES

[1]. Adu, R. O. & Lohmueller, R. (2012), The use of organic waste as an Eco-Efficient Energy source in Ghana, J. OF Environmental Protection 3,pp 553-562.
[2]. Paolucci, M., Filippis, P. De & Borgianni, C (2010), Pyrolysis and Gasification of Municipal and Industrial Wastes Blends. Thermal Science, vol.14 (3), pp739-746.
[3]. Sfeir, H. Reinhart, D. R. & McCauley-Bell, P.R (1999), An Evaluation of Municipal Solid Waste composition Bias sources; Technical Paper, J. Air & Waste Management Assoc.49:1096-
[4]. R. Cossu. Waste management, International Journal of Integrated Waste management, Science and Technology,
[5]. Freduah George Municipal Solid waste Management in Accra, by, University of Ghana, legon.
[6]. http://sustainability.psu.edu/recycling-and-waste-management-overview
[7]. www.waste-management-world.com/.../waste-sorting-a-look-at-the-separ...

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