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Solar Powered Electronic Trash Can

[1]ENGR. JOAN P. LAZARO, [2]ENGR. ALEXIS JOHN M. RUBIO
[1]Chairman, CpE Department, College of Engineering, University of the East – Caloocan, [2]Faculty,CpE Department, College of Engineering, University of the East Caloocan, PHILIPPINES
lazaro.joan@yahoo.com, rubio_alexisjohn@yahoo.com

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Abstract *– The purpose of this study is to create an improvement of a normal trash can using an embedded systemintegrated with a solar panel that aims to improve the disposal practices of school-children and improve the awareness of the students about the emerging capability of solar power. To use the system, the user needs to scan the material of the garbage then the chamber opens depending on what type of material was scanned. As the chamber opens, the user throws the trash inside the chamber, it has 10 seconds to dispose of the trash then the chamber will automatically close. A message appears in the matrix board whether the user had successfully disposed of the trash. The framework of the system discusses the procedure in constructing the propose project. It consists of the input, the processes, and the output. Inputs consist of the software and the hardware requirements. A vital part of the software development is the coding of the embedded system and on hardware development is the construction of the mechanism, after this phase the user tests it for possible enhancement and revision to be incorporated in the mechanism. The output of the system must be a fully functional mechanism that can be executed completely by the user.Upon thorough research, the proponents developed a Solar Powered Electronic Trash Can that helps school-children in proper disposing of their trash. This can also affects the pollution rating by means of proper trash segregation.*

Keywords *– Automated-Segregation, Electronic Trash Can, Green Engineering, Microcontroller-Based, Solar-Powered.*

I. INTRODUCTION

Every school generates waste arising from routine activities such as class work, projects, and etc. The common types of solid wastes found in various schools includes paper, folders, candy wrappers, empty bottles, snack wrappers, and the like. Nowadays inappropriate solid waste management practices in schools constitutes one of the major factors leading to declining environmental health conditions. Major problems perceived with the current situation are the improper disposal of garbage, their attitude to dispose their trash properly, and their willingness in keeping themselves and the environment clean. The problems associated with the disposal of wastes in schools are numerous which includes littering.

Common methods of solid waste disposal is the use of trash can for collection and open burning, but open burning causes community environmental health nuisance and can compromise school environmental quality. Then after their homes, schools constitute the next most important place of learning and where children spend most of their time, in particular indoors for study and outdoors while at play. Therefore, we come up to create the Solar Powered Electronic Trash Can that emphasizes the use of renewable energy as its source of power. The purpose of our study is develop a system that will help people especially students to learn proper waste disposal in a unique manner and the use of renewable energy.

The Solar Powered Electronic Trash Can is a microcontroller based project that proposes a great improvement of a simple trash can, which emphasizes the use of solar energy. The concept of the project is all about Green Engineering in which the design, commercialization and use of processes and products are feasible and economical while minimizing the risk to human health and the environment. In order to achieve the proposed project, sensors will be used in order to scan what type of material is going to be disposed in the chamber and with the help of a microcontroller program, each material is categorized as plastic, can, and paper each category has its own

chamber and requirements in the sensor to correctly categorized the material being scan.

The proposed project aims to develop an embedded system based trash can that encourages people to dispose their garbage properly and responsibly. Through this, there is a chance to lessen environmental problems; such as clogging of sewage that causes flooding.

According to Philibert in his article entitled "Concentrating solar power technologies", while other solar technologies can use diffuse sunlight, concentrating solar power technologies (CSP) only use direct sunlight, concentrating it several times to reach higher energy densities – and thus higher temperatures when the light is absorbed by some material surface. CSP constitute the bulk of solar thermal power technologies – the only other technology in this family being the intriguing, but yet largely unproven, solar chimney concept. **(**Schlaich, 1995; Bonnelle, 2003)Although solar electric generating systems (SEGS) have proven to be a mature electricity generating technology, they do not represent the end of the learning curve of parabolic trough technology. For example, today's parabolic trough developers state that their new collectors are 20% more efficient than those of the most recent SEGS – and some have demonstrated such improvements in fields.

Molten salts use in trough field, an option under investigation by the Italian ENEA (2003) would allow raising temperature and efficiency, thus reducing costs. The challenge seems to protect molten salts from freezing in the solar field at cold night. [1]

According to Remo R. in her article entitled "Solar Power pushed in the Philippines", German and Philippine solar technology developers are pushing for a massive installation of solar panels on rooftops of households, commercial establishments and buildings as these could help ensure the country' energy security over the long term.

"As we enter 2013, we would like to focus on the solar rooftops because we believe this is going to be a major initiative by the [solar] industry in providing solutions to our problems in the energy sector," said Theresa Cruz-Capellan, one of the founders of the Philippine Solar Power Alliance (PSPA). "There are about half a million new residential projects that are going on stream every year. If only 10 percent of these can be convinced to put solar panels on their rooftops, that will be a big help to both the distribution utilities and power generation companies," Capellan said. She added that it would also help reduce the country's dependence on imported fossil fuels. The potential market for solar industry players was estimated at about $450 million, or P19 billion, yearly. This was based on the 50,000 households (representing 10 percent of the half a million constructions yearly) that can install solar panels with a capacity of 2 kilowatts. To produce a kilowatt of solar power from these rooftop panels, one would need to invest about $4,500 for the actual components and installation works. This investment can be recovered in about seven years but the solar panels usually last for at least 25 years, said Capellan. She said investors in solar energy were also in talks with real estate developers and the Climate Change Commission for the possible inclusion of rooftop solar panels in housing projects within "ecotowns." Thomas Chrometzka, head of international affairs of Germany's Bundesverband Solarwirtschaft e.V., said that the potential of photovoltaic systems globally continued to be underestimated in some parts of the world.

In Germany, however, rooftop installations account for about 80 percent of the installed solar capacity of 30 gigawatts. Chrometzka said rooftop solar panels could be a viable solution for the Philippines given its high solar irradiation level. The Philippines is said to have solar irradiation of 1,900 kilowatts a square meter. Electricity produced from solar energy, however, remained marginal compared to other renewable energy sources, such as hydro and geothermal, due to the perceived high costs of solar panels and installation. [5]

II. MATERIALS AND METHODS

Most trash cans nowadays are stationary and so that is the main reason why we proposed our trash can which is unique and requires more interaction with the user. The proposed mechanism for the development of an ordinary trash can, provides the concept of a basketball hoop for amusement.

The framework of the system discusses the procedure in constructing the solar powered electronic trash can. It consists basically of the input, the processes, and the output. Inputs consist of the software and the hardware requirements. A vital part of the software development is the coding and on the hardware development side is the construction of mechanism after this phase the user tests it for possible enhancement and revision to be incorporated in the mechanism. The output of the system must be a fully functional mechanism that can be executed completely by the user.

The figure 1 shows the setup of the entire system. It is composed of two microcontrollers the Basic Stamp II and Gizduino v3, Solar Panel, Charge Controller, Lead Acid Battery, Voltage Regulator, Light Dependent

Resistor & Laser Pointer, Magnetic Sensor, Servo Motors, Sonar Sensor, and lastly the LED matrix.

Project Design

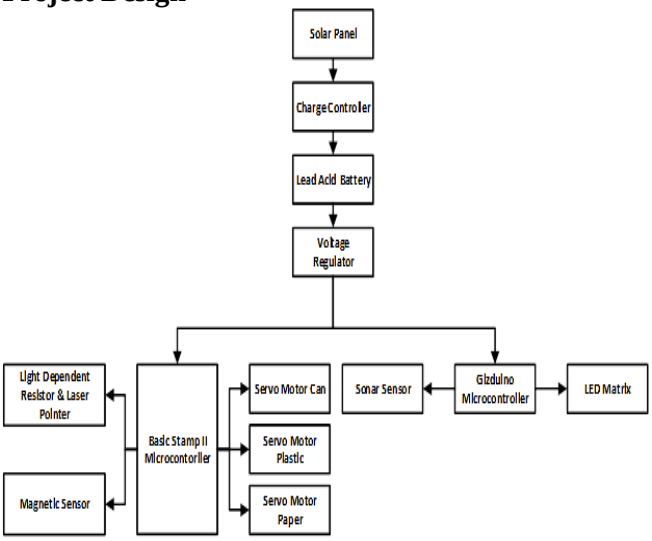

Fig. 1 Block Diagram of Solar Powered Electronic Trash Can

First is that the solar panel charges the battery then the voltage regulator will attenuate the voltage to be fed in the Basic Stamp II and Gizduino v3, the Basic Stamp II is connected along with light dependent resistor and magnetic sensor to identify trash then the accompanying servo motor will move depending on what type of trash has been identified, it will wait for 10 seconds for the user to throw the trash then flipper in the chamber will close. Then the Gizduino v3 accompanied by sonar sensor will detect if the user has thrown the trash if the user has successfully throw the trash corresponding message will display to the LED Matrix, if no trash has been thrown the default message that is programmed in the Gizduino v3 will be displayed.

Operation

Solar Powered Electronic Trash Can consists of Basic Stamp II microcontroller module together with Light Dependent Resistor (LDR), Magnetic Sensor Kit, and three Servo Motors, Gizduino v3 microcontroller with Sonar sensor, 8x32 LED Matrix Display Board and LED Matrix Common Cathode Driver Shield, 12V lead acid battery, 10W Solar panel, Switch Mode Supply, eDC-2420 DC/DC Boost Converter, 12v Charge Controller, 5v voltage regulator, and laser pointer. Basic Stamp Editor V.2.5.3 and Arduino v.1.0.5 is used for IDE of the microcontroller, codes are written in Java and PBASIC programming language. This project has been created to lessen littering issues, to promote a more responsible trash disposal, and to improve disposal practices of school-children with a vision to indirectly influencing their families, non-school-going children and other members of their communities.

The capabilitiesof the Solar Powered Electronic Trash Can, are the following:

- Identify solid waste whether paper, plastic, and can, depending on the output resistance of LDR and analog voltage reading on the magnetic sensor that is to be fed in the Basic Stamp II.
- Display a text message on the LED Matrix if the trash has been thrown.
- Power comes from battery that is charged through the solar panel.

The limitationsof the Solar Powered Electronic Trash Can are the following:

- It can't identify several trash at the same time.
- It can't identify plastic waste if it has a covering or other factors that make it not translucent or clear. Hence it will be categorized as paper.
- Sonar sensor can't accurately detect small solid waste.
- Battery can't be discharged below 50% of its rated capacity, discharging a 12 volt battery below this point can damage it.
- The battery must be disconnected immediately when it is fully charged, continuing to charge a fully charged battery will severely damage the internal plates and shorten battery life.
- Do not undercharge the battery because it reduces the capacity of the battery.

Testing

The proponents conducted the testing that is stated in testing procedures and these are the results:

Accuracy of the LDR and Magnetic Sensor

The following steps were performed to test if the light dependent resistor and magnetic sensor detects the solid waste disposed correctly:

1. Prepare three types of solid waste; crumpled paper, plastic bottle and can.
2. Scan the solid waste.
3. Observe what servo motor flipper will move according to what type of solid waste has been scanned.
4. Repeat the second and third procedures with the other type of solid waste.

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Accuracy of the Sonar Sensor

The following steps were performed to test if the Sonar Sensor works correctly:

1. Prepare three types of solid waste; crumpled paper, plastic bottle and can.
2. Scan the solid waste.
3. Throw the solid waste depending on what flipper will move.
4. See the text message displayed in the LED Matrix.
5. Repeat the second to fourth procedures using various sizes of solid waste.

Solar panel as a direct power supply to the whole circuit

The following steps were performed to test if the solar panel can directly act as a power supply to the whole circuit without the battery:

1. Place the solar panel directly under the sun.
2. Connect the solar panel into the charge controller's slot designated for the solar panel.
3. When connected check if the indicator in the charge controller light's up
4. Connect the circuit into the charge controller's slot designated for the battery.
5. Check if the circuit is working.

Charging the battery through the solar panel

The following steps were performed to test if the solar panel charges the battery.

1. Place the solar panel directly under the sun.
2. Connect the solar panel into the charge controller's slot designated for the solar panel.
3. When connected check if the indicator in the charge controller light's up
4. Connect the battery into the charge controller's slot designated for the battery.
5. Check the battery if it's charging by measuring its voltage using multimeters.

Usage of the battery

The following steps were performed to test the voltage drop of the battery that is connected to the solar panel.

1. Place the solar panel directly under the sun.
2. Connect the solar panel into the charge controller's slot designated for the solar panel.
3. When connected check if the indicator in the charge controller light's up
4. Connect the battery into the charge controller's slot designated for the battery.
5. Connect the load into the charge controller's slot designated for the load.
6. Check if the circuit is working.
7. Check the battery's voltage by using multimeters.

III. RESULTS AND DISCUSSION

Solar Powered Electronic Trash Can consists of Basic Stamp II microcontroller module together with Light Dependent Resistor (LDR), Magnetic Sensor Kit, and three Servo Motors, Gizduino v3 microcontroller with Sonar sensor, 8x32 LED Matrix Display Board and LED Matrix Common Cathode Driver Shield, 12V lead acid battery, 10W Solar panel, Switch Mode Supply, eDC-2420 DC/DC Boost Converter, 12v Charge Controller, 5v voltage regulator, and laser pointer. Basic Stamp Editor v.2.5.3 and Arduino v.1.0.5 is used for IDE of the microcontroller, codes are written in Java and PBASIC programming language. This project has been created to lessen littering issues, to promote a more responsible trash disposal, and to improve disposal practices of school-children with a vision to indirectly influencing their families, non-school-going children and other members of their communities.

The accuracy of LDR (light dependent resistor) with laser beam pointer is 87.5 percent and 85.42 percent for the sonar sensor. Based on the values that acquired, we found out that paper wastes are adequately scanned/detected by the system. The sonar and metal are enough to identify paper waste materials. The accuracy of LDR (light dependent resistor) with laser beam pointer is 87.5 percent and 85.42 percent for the sonar sensor. Based on the values that acquired, we found out that paper wastes are adequately scanned/detected by the system. The sonar and metal are enough to identify paper waste materials. The accuracy of Magnetic sensor is 89.8% and 91.84% for the sonar sensor. Based on the values that acquired, we found out that canned wastes are adequately scanned/detected by the system. The sonar and metal are enough to identify canned waste materials.

The testing of the system are done to satisfy the objectives of the project specifically the accuracy of the LDR and Magnetic Sensor. The proponents find out wherein when various solid waste was tested, LDR may work imprecise due to ambient light of environment therefore causing inconsistencies in reading the resistance in the microcontroller. Also the magnetic sensor is having difficulty in identifying cans due to limited proximity of two inches. Then next based on the series of tests we conducted, we found out that most of the solid wastes that is not detected by the sonar sensor mostly does not have certain shape. Then next the voltage gain of the battery when charged by the solar panel took almost 6 hours to fully charge the battery

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from its initial voltage rating. The results in testing the voltage loss in the battery when being used and when it is on idle state is inversely proportional to the time, as the time value increases the voltage decreases. They only differ in the ratio of loss of voltage per time. Then lastly solar panel can directly supply the whole circuit but may not work properly depending on the light source.

IV. CONCLUSION AND RECOMMENDATION

Upon thorough research, the proponents developed a Solar Powered Electronic Trash Can that helps the students in proper disposing of their waste. This can also help the environment by lessening the pollution rating by means of proper trash segregation.

The Solar Powered Electronic Trash can is capable of detecting what type of material the object by means of scanning it through a Magnetic Sensor with the integration of the Light Dependent Resistor Sensor, thus the system can detect whether the material being scanned is a paper, plastic, or can. The materials being scanned are limited only with crumpled paper, transparent plastic bottle, and a metal can which are the wastes that are mostly produced by an educational institution.

The use of Sonar Sensor helps the process of the system in a way that it detects the trash being thrown by the user, if the user successfully disposes the trash before ten seconds time limit the trash will be detected by the Sonar Sensor and displays if the user has thrown the trash then the chamber will close within 10 seconds. Also it aims to promote Green engineering through the use of renewable energy in terms of solar energy.

The proponents recommend to the future researchers with the similar project to improve and enhance the following feature of the Solar Powered Electronic Trash Can.

- Additional method and/or sensor to improve the accuracy of scanning the trash.
- Additional category/type of trash.
- Enhanced mechanism of the servo motors.
- Higher wattage of the solar panel, higher voltage and ampere of lead acid battery

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