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Implementing Automated Power Outlet Distribution Control System using Electronic Wastes

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Abstract: Electronic dumping is a global challenge and fortunately majority of these wastes could be recycled can provide an economically viable and healthy environment as well as offer new insights on how potential sources of environmental hazards could be transformed into useful products. In this paper, we present data used during the creation of an automated power outlet system from electronic wastes. Automated power control and distribution systems are important in reducing the cost of energy utilization in homes, offices, and in industrial environment. Usually, as energy utilization increases, the costs increases. The need to prioritize and conserve scarce energy becomes imminent especially in low income earning environments. Often times, the cost of acquisition of such devices may be high. This paper reflects on how components extracted from electronic wastes could be harnessed to produce computer-controlled power outlet system.

Keywords: Automated Power Distribution Control, Microcontroller, Electronic wastes, Environment, Power management

I. INTRODUCTION

Electronic waste also called E-waste is often used in different ways. In simple terms, it is a generalized name for electrical and electronic products approaching the end or at the end of its useful life [1-3].

E-waste has also been defined to imply all electric and electronic devices or components that have lost their primordial values especially to their original owners [4]. Lundgren [5] refers to e-waste as discarded electrical and electronic equipment and components.

According to Puckett et al[6] E-waste includes a growing range of electronic devices such as refrigerators, air conditioners, cell phones, consumer electronics, computers, etc. that have been discarded by their users. Technopedia[7] describes electronic waste as “the disposal of broken and/or obsolete electronic components and materials”. Electronic waste may be valuable and recyclable, for example, RAM chips, circuit boards, etc. [8]. The actual composition of electronic wastes is diverse and differs across products. These wastes have been found to contain a thousand different substances often classified into hazardous and non-hazardous groups. Commonly recognized e-waste components are plastic casings, ferrous and non-ferrous metals, activated glass, printed circuit boards (PCB), concrete, wood, batteries, cathode-ray tubes, lead capacitors, etc. A larger chunk of these wastes are shipped to less-developed and developing countries [9] where such contributes to increasing environmental pollution and hazards owing to challenges poor waste disposal systems.

Due to the advancement in technology and increased manufacturing of electronic devices in developed countries, the trend in the generation of e-wastes has become a global concern. In the last few years, there has been various international calls for action in respect of the need to develop strategic interventions for dealing with the challenge posed by e-waste. These calls include but not limited to: The Libreville Declaration on Health and Environment in Africa which was the first Inter-Ministerial Conference held in 2008 to consolidate on the commitments and declarations that bear on health and environmental health and safety [10]; the Busan Pledge for Action on Children’s Environmental Health[11-12] which emanated from the third World Health Organization(WHO) conference on Children’s health and the Environment held in Busan, Korea in June 2009 , and additions made to the Global Plan of Action of the Strategic Approach to Integrated Chemical Management(SAICM)[13] issued at the International Conference on Chemical Management(ICCM3) in Nairobi Kenya in September 2012.

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Though, there are a number of national and international initiatives and programmes that are geared towards addressing the e-waste management as it affects environmental pollution, Health, and Safety, the major bottlenecks to the success of the myriad programmes has been the implementation process. As stated earlier, e-waste may contain valuable as well as recyclable material. Accordingly, this paper on production of automated power outlet distribution system explores the re-use option as a way of reducing the volume of electronic wastes dumping.

Potential energy savings and reduced running costs can be achieved through automation [14-16]. As desirable as automated control systems are, there is often the attendant cost of procurement and deployment especially in developing countries. Alternative solutions to costly sophisticated systems is likely to attract more attention especially where there exist relatively good sources of production materials. The data presented in this article is a description of materials for the production of majority of which are synthesized from electronic computer dumps. Emphasis is on the production of cheap and cost-effective automated power outlet control and distribution system through the use of computer hardware dumps as basic materials in addition to fewer refined and cheap discrete components. Component by component specifications are represented by way of diagrams in the form of figures, tables, etc. as well as description of system design tools and program model. Access to Electronic dumps; careful extraction of useful components such as motherboards, ROM, RAM, Metal Casing, Extracted component functionality testing, Acquisition of Micro-controller (where necessary), Assembly of components, High level programming and automated microprogramming are summarily discussed. Table 1 shows the basic statistics of the components used.

Table 1: Component Specification

S/N	Description	Source
1	PC with 512MB RAM, 50GB Hard running Windows 2000 or XP	Discarded PC Dumps
2	USB-to-Serial cable	Discarded PC Dumps
3	12V Step down transformer	Purchase
4	Diode Bridge rectifier	Purchase
5	16x2 LCD	Purchase
6	Microcontroller with Solid state isolation(Intel 8051/8052)	Discarded PC Dumps
7	Capacitor filter	Discarded PC Dumps
8	DC step-down converter(voltage regulatorIC7805)	Purchase
9	RS232 Voltage converter	Purchase
10	Motherboard(circuit board)	Discarded PC Dumps
11	Soldering iron and Lead	Purchase

Figure 1 is a block diagram that reflects the assemblage of the various components of the system.

II. PROBLEM IDENTIFICATION

Electronic dumping poses serious global environmental challenge especially in the Eastern, Central, and Sub-Saharan Africa where much dumping of second-hand electronic goods from Europe and the Americas is predominant. Electronic waste disposal is a difficult venture hence recycling is a welcome development as it is a way of generating

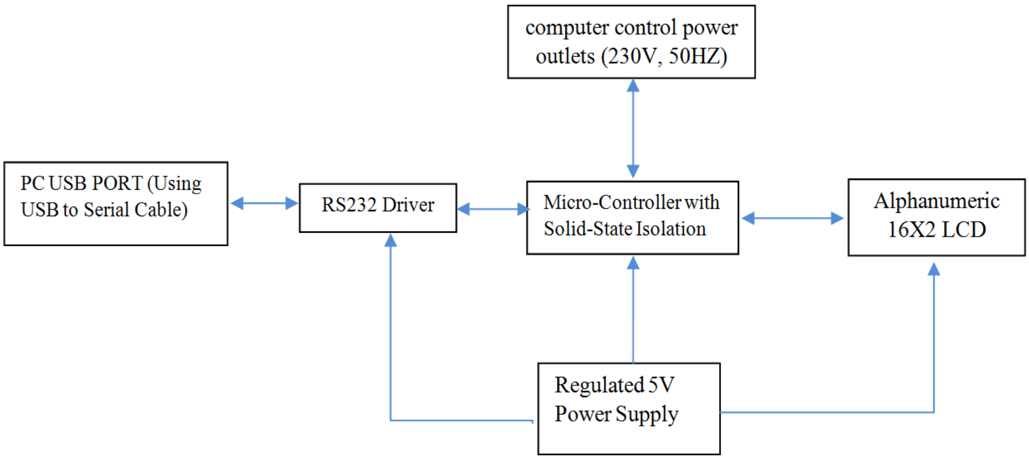

Figure 1: Block Diagram for Automated Power Distribution Outlet System

economically viable products, reducing environmental pollution thereby boosting healthy environment as well as offer new insights on how potential sources of environmental hazards could be transformed into useful products. New automated power control systems for home and office uses may not be cost-effective especially to low income earners; exploring other options may lead to the development of cheaper and effective solutions. Extraction, fabrication, assembly, integration and deployment of a cost-effective power utilization solution can ignite new line of small to medium scale production industries thereby creating jobs and improving gross domestic product of the country in question.

Homes, offices, and industries can conserve energy and reduce energy costs by deploying such automated power outlet distribution system like the one described in this article

III. EXPERIMENTAL DESIGN, MATERIALS AND METHODS

Materials: The materials used are: PC, USB-serial cable, Step-down transformer, Diode bridge rectifier, capacitors, Microcontroller, Microsoft Visual studio IDE, 16x2 LCD, transistors, DC Step-down converter.

Material selection/ acquisition: The materials are classified into two namely: hardware and software. Some hardware components are sourced from electronic dumps which attracts little or no costs. However, other components as shown in Table 1 above are purchased. The components sourced from dumps are carefully extracted and tested to ensure workability. The design of the system is divided into three sections:

a. Power supply circuitry
b. Microcontroller and LCD integration
c. High-level programming of Application frontend

Power Circuitry: Every electrical or electronic device in use or intended for use require a power supply. The AC supply in use at this geographical area is 220V 60Hz, but this power cannot be used directly on electronic devices. In other words, the AC power has to be converted to the required form usually a DC and in this case 5V DC which is what the Microcontroller in this design requires. Power electronic converters are of various types e.g. step-down converter, step-up converter, voltage stabilizer, AC to DC converter, DC to DC converter, DC to AC converter, etc. but we used a 12V step-down converter to convert the 220V AC mains supply to 12V AC.

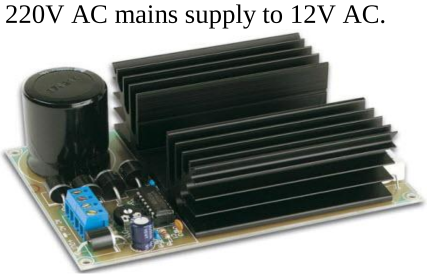

Figure 2: Step-down converter

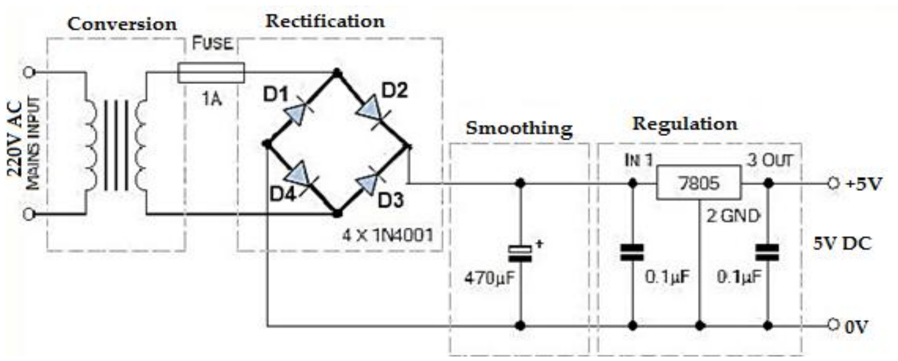

Figure 3: Conversion, Rectification, Smoothing, and Regulation of 220V AC to 5V DC for Use by the Microcontroller

Figure 2 shows a 12V step-down converter circuit component. The 12V AC output of stepdown transformer is still not in a useful form and have to be converted into an equivalent DC form. This is achieved through rectification, smoothing, and regulation. That is the 12V AC from the step-down transformer(converter) is sent through a bridge rectifier, smoothened through the use of capacitor filters as the DC obtained during rectification is not pure DC but pulses. Smoothing filters the pulsating DC into a pure DC. The smoothened voltage is subsequently regulated using the 5V DC regulator. Figure 3 shows a schematic for the rectification, smoothing, and regulation process.

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Microcontroller and LCD integration: This phase involved the connection of the relevant Microcontroller connectors to the LCD, regulated voltage(5V) and the input power from the power distribution outlets(sockets). Four sockets were used in this experiment. Connection is achieved through soldering the connectors with the Soldering iron and lead metal. Figure 4 shows the HD44780U 16x2 LCD module. The LCD module is to provide display for user interaction with the Microcontroller via the High level program that runs on the PC. The LCD is a 16x2 display allowing the display of sixteen characters (16 columns) in any of the two rows(lines).

Table II presents the specifications of the Intel 8052 8-bit Microcontroller.

Table II: Intel 8052 8-Bit Microcontroller Specifications

Clocks per instruction cycle (fewer is better)	12
Timers	3
Watchdog Timer	No
UARTs/serial ports	1
Internal DATA RAM bytes	256
Internal XDATA RAM bytes	0
Maximum program size without external logic	64K
Wait-state support	No
DMA channels	0
Maximum PIO port pins	32
Debug without emulator	No
Number of interrupts	Fixed

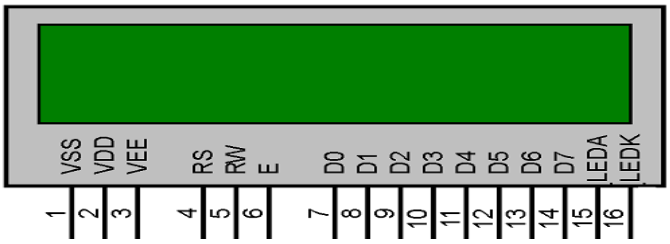

Figure 4: HD44780U Dot Matrix Liquid Crystal Display (LCD) Controller/Driver [Source: Hitachi]

Table III shows the pinout descriptions of the HD44780U dot-matrix LCD module.

Table III: Pinout Description Of The Hd44780u Dot-Matrix Liquid Crystal Display Module

S/No	Pin	Label	Status	Function	Pin Connection
1	Pin 1	Ground	Source	Ground pin of LCD	Connected to the ground of MCU/ Power source
2	Pin 2	VCC	Source	Supply voltage pin of LCD	Connected to supply pin of Power source
3	Pin 3	V0/VEE	Control	Used to adjust the contrast of the LCD.	Connected to a variable POT that can source 0-5V
4	Pin 4	Register Select	Control	Toggles between Command/Data Register	Connected to a MCU pin and is either 0 or 1. 0 => Command Mode 1=> Data Mode
5	Pin 5	Read/Write	Control	Toggles the LCD between Read/Write Operation	Connected to a MCU pin and is either 0 or 1. 0 => Write Operation 1=> Read Operation
6	Pin 6	Enable	Control	To be held high to perform Read/Write Operation	Connected to MCU and always held high.
7	Pin 7-14	Data Bits (0-7)	Data / Command	Send Command or data to the LCD.	In 4-Wire Mode The 4 pins (0-3) are connected to MCU but in 8-Wire Mode, the 8 pins(0-7) are connected to the MCU

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8	Pin 15	LED Positive	LED	For normal LED-like operation to illuminate the LCD	Connected to +5V
9	Pin 16	LED Negative	LED	Normal LED-like operation to illuminate the LCD connected with GND.	Connected to ground

Microcontroller Programming: Assembly language was used to program the micro-controller. Assembly language provide mnemonics that reflect the machine code instructions. The steps taken to write the Assembly language instructions are outlined as follows:

1. The MIDE editor was used to write the instructions which were saved in an ASCII source file. The "asm" source file above is fed to an 8052 assembler (MIDE) which converts the instructions into machine code. Prior to the machine code conversion, note that the assembler produced two files in the process: an object file and a list file with extensions ".obj" and ".lst" respectively. These files must be linked using a linker.
2. The linker program takes one or more object code files and produce an absolute object file with the extension ".abs"
3. The ".abs" file is then fed into the object to hex converter(OH) which creates a file with extension "hex". The '.hex' file is then downloaded or burnt into the ROM.

Frontend/User Interface Programming: The User interface programming is done using Microsoft Visual Basic. The frontend has three components:

a. Splash Screen – which displays welcome messages to the users.
b. Power Outlet distribution Interface – This enables the user switch ON or OFF any of the power outlet.
c. Timer – This enables user set time to turn any socket ON or OFF.

IV. RESULTS

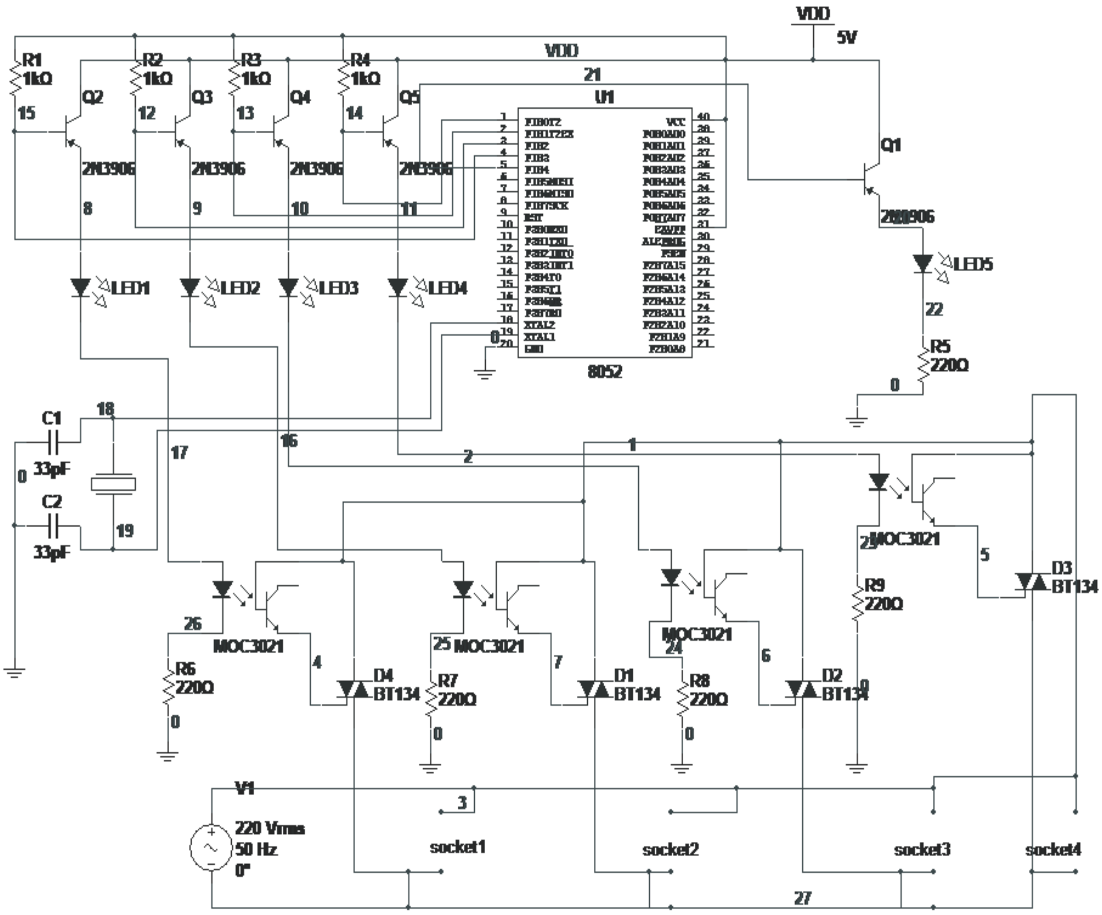

Figure 5: Schematic showing Integration of Microcontroller and LCD

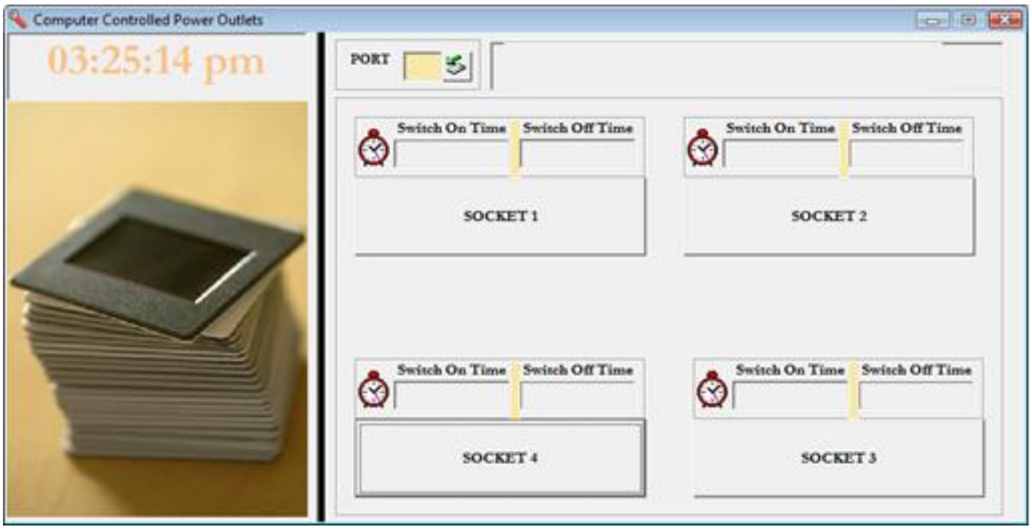

Figure 6: User interface for controlling the power distribution outlets

V. CONCLUSION

This paper discussed the creation of an automated power outlet distribution system using materials derived from electronic wastes. The prototype includes an interactive graphics user interface through which a user will be able to control the four power outlets attached to the PC via USB interface. With this solution, power distribution in homes or office for automation could be appropriately shared and controlled from a low-end computer system. The methods employed here could also be adapted or extended to produce sophisticated but easy to use apparatus for controlling distribution by way of a local or remote electronic device not necessarily a PC in a Production Line, Factory line automation and control, Security Systems, to mention a few.

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