Development of Electric Source Machine for Public Used

Mohd Tarmizi Ibrahim^{*}, Damhuji Rifai, Nik Muhamad Hasif, Noraznafulsim Khamsah, Ruzlaini Ghoni and Kharudin Ali

Faculty of Electrical and Automation Engineering Technology, TATI University College, Kijal, Kemaman, Terengganu, Malaysia; tarmizi@tatiuc.edu.my, damhuji@tatiuc.edu.my, damiza87@gmail.com, sima@tatiuc.edu.my, ruzlaini@tatiuc.edu.my, kharudin@tatiuc.edu.my

Abstract

Background/Objectives: Running out of battery on phones, laptops and iPads while in public places is a problem that we are trying to avoid. Power consumption of smartphone and other mobile electronics applications is one of the major concerns due to the limited battery capacity. In public places, the grid power supply socket is difficult to find. This paper describes the development of the electric source vending machine for public used. **Methods/Statistical Analysis:** Development of this machine involves the structural mechanical design and electronic system. The photo sensor is used to detect the Light-Emitting Diode (LED) blinking from the digital electric meter to count the total power use by the different loads. Standard coin acceptor used to determine whether coins are genuine or counterfeit. Adruino microcontroller serves as the main system that controls and process the entire machine system. **Findings:** The systems are able produce stable 240 V AC and 5 V DC output voltage. Mobile electronic devices can use the electric source from the machine by connecting the adapter or Universal Serial Bus (USB) wire into the ports in the vending machine. **Applications/Improvements:** An electric source vending machine was developed. It can it can provide an electric source system in public places. This system provides a stable source of electrical 240 V AC and 5 V DC for charging various mobile electronic devices.

Keywords: Adruino Microcontroller, Electric Source, Meter, Photo Sensor, Public Used, Vending Machine

1. Introduction

The growth of electrical users is phenomenal in recent years and the need access to electricity sources is required anytime and anywhere. Mobile electronic devices derive the energy required for their operation from batteries. In the case of many consumer electronics devices, power consumption of smartphone applications such as Android application is one of the major concerns where smartphones have batteries with limited power capacity¹ especially phones, are powered from batteries which are limited in size and therefore capacity. This implies that managing energy well is paramount in such devices. Good energy management requires a good understand-

ing of where and how the energy is used. To this end we present a detailed analysis of the power consumption of a recent mobile phone, the Openmoko Neo Freerunner. We measure not only overall system power, but the exact breakdown of power consumption by the device\u2019s main hardware components. We present this power breakdown for micro-benchmarks as well as for a number of realis- tic usage scenarios. These results are validated by over- all power measurements of two other devices: the HTC Dream and Google Nexus One. We develop a power model of the Freerunner device and analyse the energy usage and battery lifetime under a number of usage patterns. We discuss the significance of the power drawn by various components, and identify themost

^{*} Author for correspondence

promising areas to focus on for further improve- ments of power management. We also analyse the energy impact of dynamic voltage and frequency scaling of the device\ u2019s application processor.", "author" : [{ "droppingparticle" : "", "family" : "Carroll", "given" : "Aaron", "nondropping-particle" : "", "parse-names" : false, "suffix" : "" }, { "dropping-particle" : "", "family" : "Heiser", "given" : "Gernot", "non-dropping-particle" : "", "parse-names" : false, "suffix" : "" }], "container-title" : "Proceedings of the 2010 USENIX conference on USENIX annual technical conference", "id" : "ITEM-1", "issued" : { "dateparts" : [["2010"]] }, "page" : "21\u201321", "title" : "An analysis of power consumption in a smartphone", "type" : "article-journal" }, "uris" : ["http://www.mendeley. com/documents/?uuid=e13d31c1-df25-460a-9eb7-34fb2fc1c441"] }], "mendeley" : { "formattedCitation" : "(1,2.

A smartphone is a powerful communication tool that combines the functionality standard computer and pocket sized communication device3. This device allows us to surf and plays a wide range of applications that can be downloaded for free. With the rapidly growing technological advances, the capabilities of smartphones role matching the computer functions when a multi application such as a voice communication function, audio and video play back, web browsing, messaging and communications integrated into a single system in smartphone application. However, incipient application and functionality in smartphone increase the power consumption due to high processing speeds needed and causing the pressure on battery lifetime4a large portion of smartphone applications (Apps, 5. The problem becomes critical when the battery runs out in public that does not provide a power grid for mobile electronic devices charging.

With millions of smartphones in the hands of millions of people all over the world, the need for electric charging machine in public area is the essential requirements. Therefore, to solve this problem, this paper describes the development electric vending machine for public usage.

The electric vending machine was developed for mobile electronic device's user charging their gadget while in public areas. It consists of three main parts namely detect and calculate the electric rate consume by charging device, detect the coins value and hardware construction. All the parts for the electric vending machine are enclosed in a metal box. The device became compact and convenient for the installation in the public area.

2. Related Work

2.1 Vending Machine

A vending machine is a machine which automatically provides the sales of items such as food, tobacco, commuter train tickets, pay parking and consumer goods after customers insert money or a credit card into a payment slot on the vending machine^{6,7}. The innovation of the vending machine system has increased substantially. Starting with the payment method only accept coins and then cash note, now the system on the vending machines also accepts payment through direct online transfer. Implementation of new technology in vending machine allows the companies owner to monitor the status of the machine from afar.

After a few decades of gradual progress in innovations, vending machines have seen a trend to integrate more recent technology and innovations such as interactive touch display, digital signage,video analytics to recognize gender and age group, remote content management, cloud manageability for sales, inventory, refill, etc. All of this features make them to be known as smart vending machines^{8,9}.

2.2 Calculation of Energy

Electrical energy used or produced is the product of the electric power input or output and the time over which this input or output occurs. Formula for energy calculation in this system given as follow. Current signal (I (t)) and voltage signal (U (t)) are calculated by¹⁰:

$$U(t) = U_{max} \sin(\omega t)$$
(1)

$$I(t) = I_{max} \sin (\omega t + \varphi)$$
(2)

As $\rm V_s$ and $\rm V_d$ are voltage signal through ADC in Adruino, we obtain:

$$V_{s} = C. \sin (\omega t + \varphi)$$
(3)

$$V_d = A. \omega. \cos (\omega t). Kdif$$
 (4)

Integration in Equations (3) and (4), we obtain:

$$V_{si} = -(C/\omega). \cos(\omega t + \varphi). \text{ Kint}$$
(5)

$$V_{di} = A. \sin (\omega t). Kdif. Kint$$
 (6)

where V_{si} and V_{di} is an integration of V_s and V_d , parameter C, A, Kdif and Kint are constant values realized from current and voltage signals through analog and digital sections. Electrical energy consumed by electronic device in this system is quantified in kilowatt-hour (kWh) even though it is not an SI unit. Kilowatt hour is defined as the kilowatt power absorbed by electronic device in one hour¹¹. This electric source vending machine converts each pulse on the digital meter to kilowatt hour. According to the standard electricity tariff, each signal is identically tantamount to 0.0025 kWh. In principle, the electricity which absorbed by electrical appliances for this electric source vending machine system is given by Equations 7 and 8.

$$P1 = V_d \cdot V_{si} \tag{7}$$

$$P2 = V_d. V_{si}$$
(8)

From Equation 7 and 8, we obtain:

$$P = (P2 - P1) / 2$$
(9)

3. Methodology

3.1 Design of Electric Source Vending Machine

The conceptual block diagram of the electric source vending machine is shown in Figure 1. Input to this system is a coin acceptor and an Arduino microcontroller as the main controller for the whole system. Arduino microcontroller was translated the output this vending machine as 5 V DC USB port charging and 240 V AC for the domestic electric source. The Arduino controls the operation of the relay, LCD and coin acceptor.

3.2 Hardware Realization

For the hardware development, the distribution board has been custom made which according to the project sketch. On the distribution board, the Liquid Crystal Display (LCD), LED, USB port supply and 240 Voltage Alternating Current (VAC) plug socket has been assembled. The board consists of Direct Current (DC) circuit, coin acceptor and also coin box to keep all coins. The wiring system on this board is wired inside the tracking to prevent from electric shock and ensure the safety of user electric device during charging process.



Figure 1. Electric vending machine conceptual block diagram.

3.3 Circuit Development

The system circuit has been designed by using Freezing software and the simulation was made by using Proteus simulation software. The system circuit has been divided into two parts that are DC circuit and Alternate Current (AC). It integrated together to make a complete circuit of the electric source vending machine. Figures 2 and 3 show the complete DC and AC circuit design for the system.



Figure 2. DC circuit.



Figure 3. AC circuit.

All the input and output signal are connected to the Arduino Mega microcontroller. When the coin is inserted into coin acceptor, it will send the signal or pulse to the microcontroller. The photo sensor detects the LED blinking from the digital electric meter to count the total power used by the different loads. After the coin is inserted, the relay will trigger the AC output on pin 3 plug socket and trigger DC supply for USB port. Red LED shows the system is ready and green LED shows that the systems are fully operational. The LCD will show the power remain, power use, balance of the coin inserted and time remaining. Figure 4 shows the complete circuit wiring connection in the system.



Figure 4. Integration of DC and AC wiring connection.

3.4 Software Development

The software is programmed into the Arduino microcontroller to control the whole system. Figure 5 shows the algorithm program of the project from start until the end of the system operation. The supply will turn ON only at electric sockets and USB port charging

adapter when the coins entered. Since the coins entered, the systems operate for a certain time and certain power use until the coins entered again. The supply will cut off if there are no coins entered anymore.

Based on the flow chart, the system does not have feedback but it has two close loops to make sure the system work according to the plan setupbefore. The controller manipulates or analyze the pulse receive from coin acceptor in digital form to ensure the coins is entered correctly.



Figure 5.	Flow chart of system algorithm for the
whole op	eration system.

When the users do not insert the coins anymore after 10 seconds, the system will send commands to the output components to cut off the supply. System return to the initial condition and no electric energy supply at the electric sockets and USB port adapter.

4. Results and Discussion

The system had been tested and data are collected and analyzed in term of power consumption of the whole system in one week and one month. Figure 6 shows the graph of the power consumed by the system in one week. Cost of the rate of electric power consumption is given by:

Figure 6 shows the total energy consumption of the entire system without load in one week. The pulse LED blinking on the digital electric meters is measured by photo sensor. One pulse is equal to 0.000625 Wh. Total power consumption of the whole system without load in one week is 0.573125 KWh and for one month is 2.45625 KWh.



Figure 6. System power consumption without load for one week.

Table 1.	Charging	efficiency	⁷ for	different	mobile	phone
	() ()					

Devices	IPhone	Nokia	Samsung
	5	105	\$3
Initial % of battery	43%	33%	54%
1 hour charging	94%	83%	79%
Total power use per hour (KWh)	0.00375	0.0025	0.0025
Cost for 1 hour charging (Myr)	0.1875	0.125	0.125
Meter signal	6	4	4

Power consumption of different mobile phones for one hour charging is recorded. The data is shown in the Table 1.

Table 1 shows the charging efficiency of the system for different model mobile phone. The first device is an iPhone 5 that was charged for one hour. The percentage of the battery indicator for iPhone 5 increases 51% from the remaining battery level. Six pulse meter signal was recorded which it equal to 0.00375 KWh. For Samsung S3 and Nokia 105 increase 50% and 45% after on hour charging with 4 pulses (0.0025 KWh). For confirmation efficiency evaluation, this system has additionally been tested utilizing three variants of laptops. Lenovo Ideapad Y500, Asus A55V series and HP-Pavilion G4 have been charged for one hour. After one hour charging with 74 and 58 meter signal pulse, Asus A55V Series and HP-Pavilion G4 increase 55% from the initial remaining battery level. With 62 pulse meter signal recorded, Lenovo Ideapad Y500 laptop only increase 30% from the remaining battery level. The complete data is shown in Table 2.

Table 2. Charging efficiency for different laptor	Table 2.	Charging	efficiency	for	different	laptor	os
---	----------	----------	------------	-----	-----------	--------	----

Devices	Lenovo Ideapad Y500	Asus A55v Series	HP-Pavilion G4
Initial % of battery	15%	31%	7%
1 hour charging	45%	86%	62%
Total power use per hour (KWh)	0.03875	0.04625	0.03625
Cost for 1 hour c harging (Myr)	1.9375	2.3125	1.8125
Meter signal	62	74	58

5. Conclusion

An electricity source vending machine was successfully developed. It can provide an electric source system in public places. This system provides a stable source of electrical 240 V AC and 5 V DC for charging various mobile electronic devices.

For future work, improvement of the security of this product is needed to prevent vandalism in public places. Near-Field Communication Identification (NFC ID) based security system can apply for this electric source vending machine, which is only authorized person can open the vending machine system.

6. References

- 1. Carroll A, Heiser G. An analysis of power consumption in a smartphone. Proceedings of the USENIX Annual Technical Conference; California, USA. 2010. p. 21.
- Nakajima S. Model-based power consumption analysis of smartphone applications. Proceedings of the 6th International Workshop on Model Based Architecting and Construction of Embedded Systemsco-located with ACM/IEEE 16th International Conference on Model Driven Engineering Languages and Systems; Florida, USA. 2013 Sep. p. 1–10.
- 3. Nakajima S, Ueda Y. Power consumption analysis of smartphone applications using UPPAAL. Proceedings of the 1st

International Conference on Cyber-Physical Systems, Networks and Applications; Taipei, Taiwan. 2013. p. 33–8.

- 4. Lee M, Kim DK, Lee JW. Analysis of characteristics of power consumption for context-aware mobile applications. Information. 2014 Nov; 5(4):612–21.
- Ganurkar S, Gour P. Prepaid energy meter for billing system using microcontroller and recharge card. International Journal of Core Engineering and Management. 2014; 1(1):12–8.
- Monga A, Singh B. Finite state machine based vending machine controller with auto-billing features. International Journal on VLSI and Communication System. 2012 Apr; 3(2):19–28.
- Deru M, Torcellini P, Bottom K, Ault R. Analysis of NREL cold-drink vending machines for energy savings. US: National Renewable Energy Laboratory; 2003.
- Ellenki SK, Reddy S, Ch GS. An advanced smart energy metering system for developing countries. International Journal of Scientific Research and Education. 2014; 2(1):242–58.
- 9. Akram M, Habib S, Javed I. Intuitionistic fuzzy logic control for washing machines. Indian Journal of Science and Technology. 2014 May; 7(5):654–61.
- Shukla A, Saxena S, Singh S, Jain S. Embedded system based prepaid electricity metering and billing. International Journal of EmergingTrends in Electrical and Electronics. 2013 Apr; 2(4):40–3.
- 11. Dara SKV, Chary MV. Pre-paid remote energy meter monitoring and overvoltage protection through electricity using GSM network. IJSETR. 2013 Sep; 2(9):1738–42.