A Payment System for Electric Vehicles with Vehicle -To - Grid Power Transfer System

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***Abstract*--Electrical vehicles are widely used automobile propelled by electric motors using electric energy which is stored in the battery to be recharged. The electric vehicle required to be visit charging infrastructure. In charging infrastructure vehicle need to get charged and the corresponding amount for energy get debited from account. GSM module that sends a message to the user about the charging details of the vehicles to the vehicle owner. Here, it is grid-to-vehicle power transfer system. In this proposed system implementing vehicle-to-grid power transfer system. For this system the vehicle is equipped with solar panel for generating solar energy which is stored in battery and utilized by user. In case of excess energy in vehicles battery, it can be transfer from vehicle to grid. Generally, the system is used in energy saving applications.**

Index terms-Vehicle-Grid, Grid-to-Vehicle, GSM, Solar panel

1 INTRODUCTION

An electric vehicle is a vehicle which does not depend on gasoline or liquefied petroleum gas as fuel. Electric vehicle uses electricity stored in the battery which is placed within the vehicle. This is the source for EVs, this source offers emission-free urban transport. It uses the motors which are run by electricity instead of gasoline engines. Hence harmful pollutants are not emitted from EVs. Grid-to-Vehicle power transfer system (G2V) is for recharge a vehicle's battery in a charging infrastructure.

EVs support vehicle-to-grid (V2G) system. In this concept vehicles are allowed to provide power or sell electricity to the grid. This can be possible in solar panel equipped vehicles which is parked in sunshine. In V2G system EV communicates with the power grid. It provides grid support either delivering power to the grid or by throttling their charging rate [4]. Through this, utility grid operators can communicate with vehicle. Grid operators can buy energy from the car owners when it is needed and sell it back when demand is high.

Vehicle-to-grid concept is attracted attention from grid operators and vehicle users. Convenient charging and available electricity supplies are necessary and available benefits of V2G capabilities.

Now we discuss briefly:

Section [2] Related works
Section [3] proposed System
Section [4] System Requirements
Section [5] LabVIEW Implementation
Section [6] Conclusion.

2 RELATED WORKS

Existing payment system consists of module which is for recharging the electric vehicles in EV charging station. One way anonymous payment EVs remains anonymous when it recharges at any charging station. The corresponding amount for the recharged electricity is debited in the account. In this system, there is no method for power generation itself. Some of related works are prototype of electric vehicle charging method for smart Home/Building with a photovoltaic system – Young-min wi, Jong-UK lee, Sung-kwan joo describes the methodology of charging the electrical vehicle for the home applications and schedules charging EVs according to user preferences. Rapid charge electric vehicle stations—Mehdi etezadi, kent choma, Jason Stefani describes investigation effect of fast charging electric vehicles in an existing distribution system. A new payment system for enhancing location privacy of electric vehicle by Man HoAu, Member, IEEE. Joseph K. Liu, Junbin Fang, Zoe L. Jiang. Willy Susilo, Senior Member, IEEE, and Jianying Zhou which proposes the suitable payment system for the electric vehicles. it supports privacy protection and also provides traceability of vehicle in case of the vehicle get stolen. Review of the impact of Vehicle-to-Grid technologies on Distribution systems and utility interfaces-- Murat Yilmaz, Member, IEEE, and Philip T.Krein, Fellow, IEEE which describes the reviews of the V2G concept, which depends on standardization of requirements and infrastructure decisions, battery technology, efficient and smart scheduling of limited fast-charge infrastructure.

3 PROPOSED SYSTEM

In this proposed system there is necessity to overcome the limitations in the existing implementation and need to implement more convenient payment system for electrical vehicles charging infrastructure. Proposed system differs from existing system by concept of vehicle–to–grid power transfer. The vehicle is recharge in the charging station, the corresponding amount debited in the user's account. The vehicle transmits the excess power (sell electricity) to the grid. This can be done if an EV is equipped with a solar panel and is parked outside in sunshine. It sends power back to the grid when the demand is high. The power generation module is implemented within the vehicle for charging operation. We can send the power to grid when we have excess amount of power.

4 SYSTEM REQUIREMENTS

The components which are used in the project are listed below,

4.1 HARDWARE REQUIREMENTS:

1. PIC16F877A
2. CURRENT SENSING CIRCUIT
3. RS232 CONVERTER
4. RELAY DRIVER(ULN2003)
5. SOLAR PANEL
6. BATTERY(12V , 1.2A)
7. GSM Module

4.2 SOFTWARE REQUIREMENTS

1. MPLAB IDE v8.80
2. HI-TECH C COMPILER- 16F CTS COMPILER
3. EMBEDDED C LANGUAGE
4. LABVIEW v13.0

4.3 SYSTEM ARCHITECHTURE

In our system we are considering three nodes, those are charging station, power management server and billing server. A vehicle gets charge from charging station and sends power information's to the power management server. The power management server sends request to billing server which is sends users status to power management server. Both are interchange the data's and sends confirmation to the charging station. If charging stations gets confirmations' from power management server and billing server it allows vehicles to gets charge. A server maintains vehicles' data's itself.

A charging station is a place that is assume to be near a distribution node, where the large pool of EVs from the particular area will participate in grid support. Vehicle-to-Grid system is capability of controllable, bi-directional electrical energy flow between a vehicle and the electrical grid. The electrical energy flows from the grid to the vehicle in order to charge the battery. Guille and Gross [7] present a conceptual framework for implementation of V2G based on bi-directional energy transfer between vehicle and grid and aggregated use of EVs as generation and storage devices. Aggregated EVs can provide grid services such as up and down regulation, load leveling, and peak shaving more economically and with less environmental impact than current systems. EVs must be aggregated because individually their battery capacity is small and would not make an appreciable difference at the grid level. This implementation composed of charging station which consists of power supply circuit, current monitoring circuit, controller, relay and a PC which is acts as the billing server and power monitoring server.

It also includes solar panel equipped vehicle having battery to be recharged. The vehicle can be recharged in the charging station. Owner of the vehicle having secret code for initialize the charging process. Power grid is used to recharge the battery. Power supply circuit consists of transformer to steps up or step down the input line voltage and isolates the power supply. Rectifier which converts AC input signal to pulsating DC. Regulator maintains the output of the power supply at a constant level in spite of large changes in the load current or input line voltages. The amount of power need to be recharged to the battery should be in the charging station's billing server and power monitoring server

PIC16F877A

PIC 16F877A is one of the microcontroller which is used in this implementation. This controller is widely used for several experiments because it is inexpensive, wide range of applications, high quality, and ease of availability. It is suitable for applications such as machine control applications, measurement devices, research purpose and so on. The PIC 16F877A used here to control the processes.

GENERAL BLOCK DIAGRAM

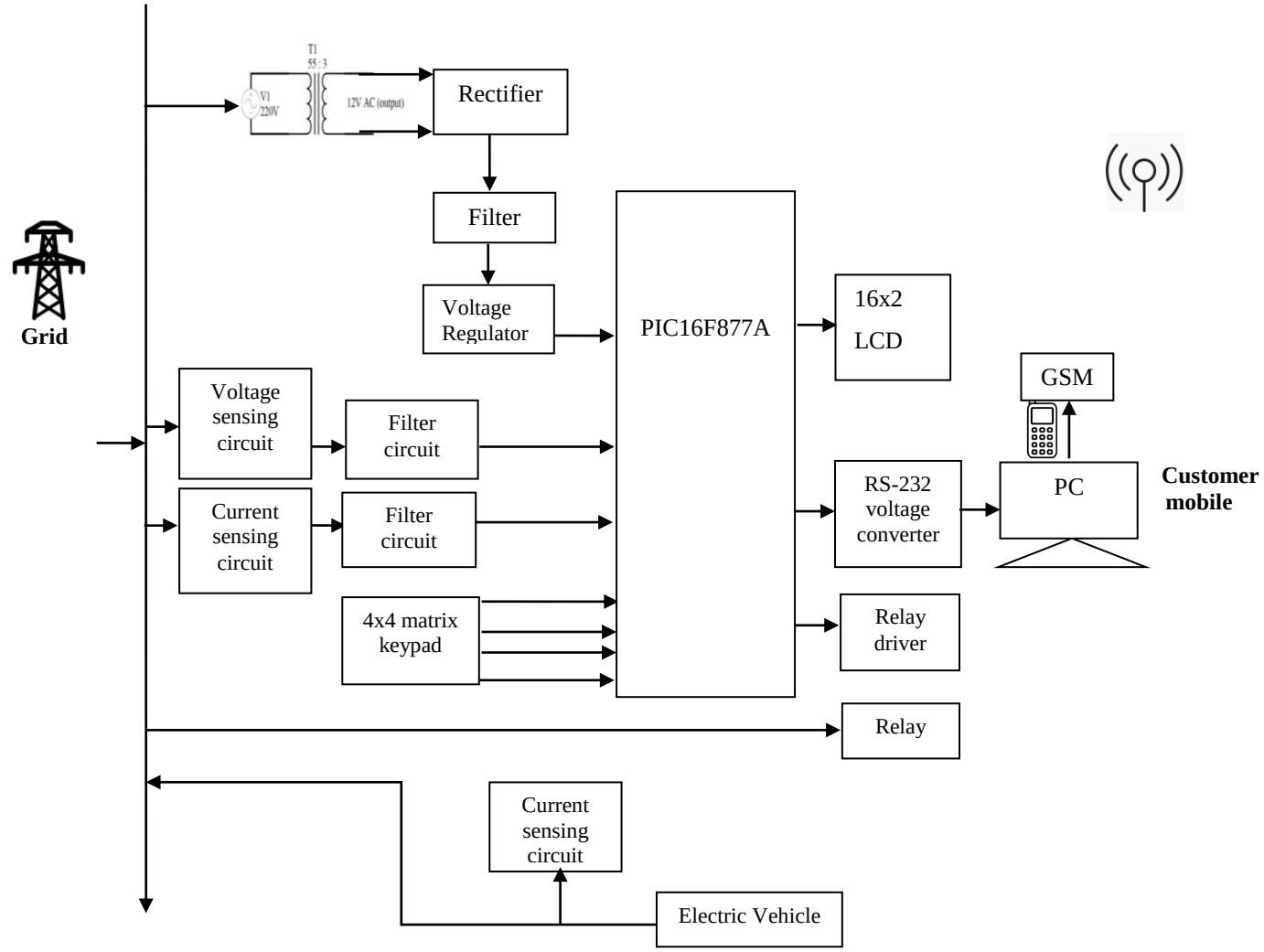

FIG 2: GENERAL BLOCK DIAGRAM

RELAY

A relay consists of a set of contacts; two in the relay pictured. Iron yoke provides a low reluctance path for magnetic flux. The armature is attached to the yoke and mechanically linked to the moving contacts. By using relay switch we easily turn on or off any high voltage device by microcontroller. Other relays may have more or fewer sets of contacts depending on their function. This ensures continuity of the circuit between the moving contacts on the armature. The circuit track on the via the yoke. The yoke is soldered to the PCB

RS 232 TO USB CONVERTER

RS232 ports which are physically mounted in a computer are often powered by three power sources: +5 Volts for the UART logic, and -12 Volts and +12 Volts for the output drivers. USB however only provides a +5 Volt power source. Some type of USB to RS232 converters use integrated DC/DC converters to create the suitable voltage levels for the RS232 signals, but in very cheap implementations, the +5 Volt voltages is directly used to drive the output. This may strange, but many RS232 ports recognize a voltage above 2 Volt as a space signal, where a voltage of 0 Volt or less than 0 Volt is recognized as a mark signal. The well known Maxim MAX232 series of RS232 driver chips have this non-standard behavior for example. Although the outputs of these drivers swings between -10 Volt and +10 Volt, the inputs recognize all signals swinging below 0 Volt and above 2 Volt as valid signals. If RS232 connected to USB converter over a serial line with another device, it might work with some devices only not with others. This can particularly become issue with industrial applications. When you test the cheap RS232 to USB converter with a computer, it might work. But the same converter may fail if you try it in an industrial environment.

Other applications infrequently use hardware flow control. Only with large data bursts, or in situations where the CPU is busy performing other tasks, hardware flow control might kick to prevent data loss. Using the RS232 to USB converter expose the charge values to the PC through serial port. The voltage values can be displayed in the labview software. The current and voltage flow in the battery is monitored using the monitoring circuits, and values obtained are transfer to PC through the RS232 to USB converter.

GSM MODULE

A **GSM modem** is a specialized type of modem which accepts a SIM card and operates over a subscription to a mobile operator, just acts like a mobile phone. From the mobile operator perspective view, a GSM modem acts just like a mobile phone. When a GSM modem is connected to a computer allows the computer to use the GSM modem to communicate over the mobile network.

A GSM modem is an interface that allows applications such as SMS to send and receive messages over the modem interface. The mobile operator will charge for this message sending and receiving as if it was performed directly on a mobile phone. To perform these sending and receiving tasks, a GSM modem must support an "extended AT command set" for sending/receiving SMS messages, as defined in the billing server which holding the vehicle's specifications. Global System for Mobile Communication module (SIM900) is a complete Quad-band GSM/GPRS solution in a SMT module which can be embedded in the customer applications. Implementing an industry standard interface to transfer signals, the SIM900 delivers GSM/GPRS 850/900/1800/1900MHz performance for voice, SMS, Data. GSM module sends a message to the vehicle user about the recharged power. The text message consists of user account number, recharged power in units, bill amount of the recharged power.

5 LABVIEW IMPLEMENTATION

Lab-VIEW is a highly useful development environment for creating custom applications that interact with real-world data or signals in fields such as science and engineering. LabVIEW is a graphical programming language that uses icons instead of lines of text to create application.

Instructions in Text-based Programming languages determine program execution. LabVIEW uses dataflow programming. The flow of data determines the execution. The LabVIEW build a user interface with a set of tools and objects. The user interface is coded using graphical representations of functions to control the front panel objects. All the toolsets for developing specialized applications integrate in LabVIEW. Refer to the National Instruments Web site at ni.com for more information about these toolsets.

LabVIEW makes the process of integrating hardware much easier by using a consistent programming approach no matter about type of hardware. The same initialize-configure-read/write-close pattern is repeated for a wide range of hardware devices, data is always returned in a format which is compatible with the analysis and reporting functions.

Here is the screenshot of EV charging system login in the LabVIEW. In this project, the

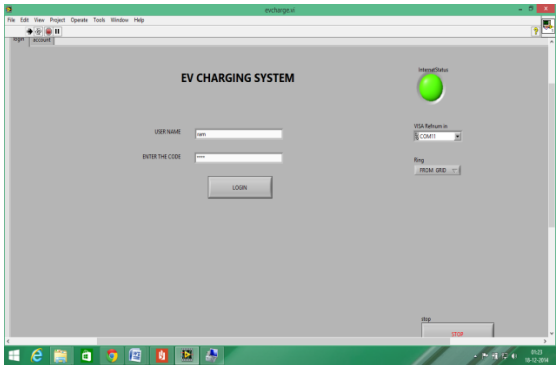

Fig 3: EV Charging System Login

LabVIEW front end collects the values of current sensing circuit, voltage sensing circuit, power which is stored in the battery through USB to RS232 converter. The values are updated continuously for the user reference. Vehicle user need to enter their username password to get their charging updates from the billing server. If user want to recharge the battery of their vehicle, they need to choose the *grid-to-vehicle* option in the LabVIEW front end panel. Choose *vehicle-to-grid* option for selling the excess power in the battery to the grid.

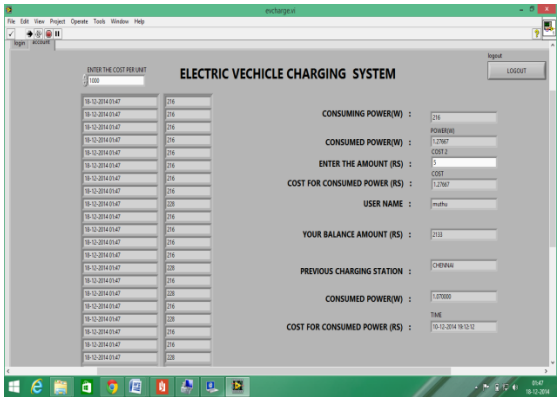

Fig 4: EV Charging System Update For Individual User.

6 CONCLUSION

In proposed system the vehicle which in need of charge can get recharged in the charging station. The amount can be payable using the new payment system. The solar panel equipped vehicle can also sell the excess charge stored in the battery using solar panel. The power can be sold by sending the excess energy from the vehicle's battery to the grid. The amount for the sold power will be credited in the account. The charging infrastructure is composed of charging module and billing server. This system is control by relay and this system includes GSM (SIM900) module that sends message to the vehicle owner about recharged power and the bill for consumed power. All these processes are controlled and monitored through LabVIEW.

Fig 5 describes the initial state while the secret code of the user should enter the charging station. After this the acquired amount of charge need to be entered, then the vehicle get recharged. LCD displays the recharged power and corresponding amount.

Fig 5: Initial State

Here is the charging system module, this is connect with billing server to get through the account database. The charging infrastructure is additionally equipped with GSM. If the vehicle get recharged, the charging details and user account details will be send as message to the user's mobile.

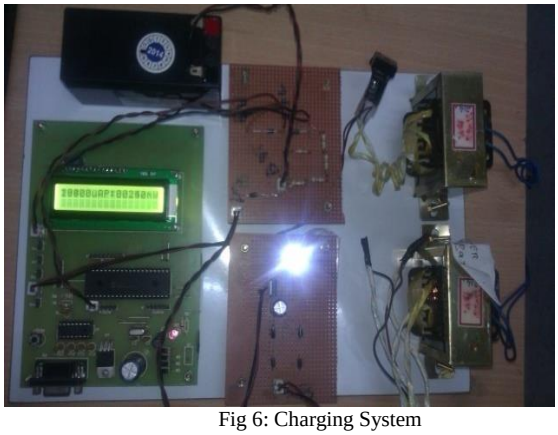
Fig 6: Charging System

REFERENCES

[1] Man Ho Au, Member, IEEE, Joseph K. Liu, Junbin Fang, Zoe L. Jiang, Willy Susilo, Senior Member, IEEE, and Jianying Zhou "A New Payment System for Enhancing Location Privacy of Electric Vehicles" IEEE Transactions On Vehicular Technology, Vol. 63, No. 1, January 2014.

[2] Murat Yilmaz, Member, IEEE, and Philip T. Krein, Fellow, IEEE "Review of the Impact of Vehicle-to-Grid Technologies on Distribution Systems and Utility Interfaces" IEEE Transactions On Power Electronics, Vol. 28, No. 12, December 2013

[3] Young-Min Wi, Jong-Uk Lee, and Sung-Kwan Joo, Member, IEEE "Electric Vehicle Charging Method for Smart Homes/Buildings with a Photovoltaic System." IEEE Transactions on Consumer Electronics, Vol. 59, No. 2, May 2013.

[4] Mukesh Singh, Praveen Kumar, and Indrani Kar "Implementation of Vehicle to Grid Infrastructure Using Fuzzy Logic Controller" IEEE Transactions On Smart Grid, Vol.3, No.1, March 2012.

[5] Sekyung Han, Student Member, IEEE, Soohee Han, Member, IEEE, and Kaoru Sezaki, Member, IEEE, "Development of an Optimal Vehicle-to-Grid Aggregator for Frequency Regulation" IEEE transactions on smart grid, vol. 1, no. 1, june 2010.

[6] Mehdi Etezadi-Amoli, Senior Member, IEEE, Kent Choma, Member, IEEE, and Jason Stefani, Student Member, IEEE "Rapid-Charge Electric-Vehicle Stations" IEEE transactions on power delivery, vol. 25, no. 3, july 2010

[7] C. Guille, G. Gross, "A conceptual framework for the vehicle-to-grid (V2G) implementation," Energy Policy, Volume 37, Issue 11, pp. 43794390, November 2009

[8] http://www.slac.stanford.edu/cgi/wrap/getdoc/slac-pub-9761.pdf, Hardware Testing.

[9] "GSMconcept" http://www.alcom.nl/binarydata.aspx?type=doc/WISMO2 xx(1).pdf.

[10] LCD http://oomlout.com/LCDD/LCDD-Guide.pdf