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Modern Voltage Stability Monitoring Based on Arduino and Alert Through Messaging Service

Chithras Thangavel[1], Vinoth Krishnamoorthy[1], Karthik Krishnasamy[2*], Shahana Parveen[1] and Shiva Sankari[1]

[1]Department of Electrical and Electronics Engineering, Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, Chennai, Tamil Nadu, India
[2]Department of Mechanical Engineering, Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, Chennai, Tamil Nadu, India

***Correspondence to:**
Karthik Krishnasamy
Department of Mechanical Engineering,
Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology,
Chennai, Tamil Nadu, India.
E-mail: karthikk@veltech.edu.in

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Abstract

Due to the growing number of electric vehicles (EVs) on the market and the demand from governments to reduce vehicle emissions to zero at the absolute latest by 2050, there is a significant need for more efficient charging solutions. Due to nanotechnology development, all integrated circuit size has been reduced and the space requirement and cost of the integrated circuit also reduced. The consumer's use of the road determines how much money is collected under the existing toll gate tariff scheme. The toll collector must enter it and physically validate it before entering the vehicle number into the toll gate system. But some cases, due to negligence of the person may get wrong tariff. Also, they are not taking enough steps to monitor the under voltage or over voltage issues happened in grid which is supplies the current to the dynamic vehicle charging system. Because of these two different faults consumer appliances like battery and controlling circuits may damage. This paper proposed to monitoring the under voltage or over voltage faults and inform the same to the consumer as well as service provider based on giving an alert through a message using nanotechnology component global system for mobile communication (GSM). Additionally, it is guarding against surges brought on by sudden loss of the main power supply and online load identification utilizing a measurement-based strategy based on phasor measurement units. To prevent voltage collapse, it was suggested that the proximity to voltage instability be assessed. Various control and protection strategies were applied based on the load characteristics in various scenarios. Also, this system will give exact tariff details to the customer and it can pay through any nanoscience application.

Keywords

Voltage surge monitoring, Alert system, Short message service, Energy monitoring, Transient analysis, Nanotechnology, Nanosciencev

Introduction

Nowadays available alert system can provide physical monitoring services and consumed energy by the customer. It will monitor by the person who is working in toll gate. And we don't have any proper alert system when we are over usage of electricity which leads more charges we need to pay for the consumed energy. Also, we don't have any non-intrusive load monitoring techniques to explain trends from customer data, which is then used to make energy saving recommendations. Also, we don't have any alert system about the voltage instability. Figure 1 from the reference [1] illustrates the fundamental procedure; a digital AC monitor is fixed with the single-phase power entering a power grid. Admittance measurements are used to gauge voltage and current variations, which are then scaled, normalized, and recorded (using a net change detector). To determine the

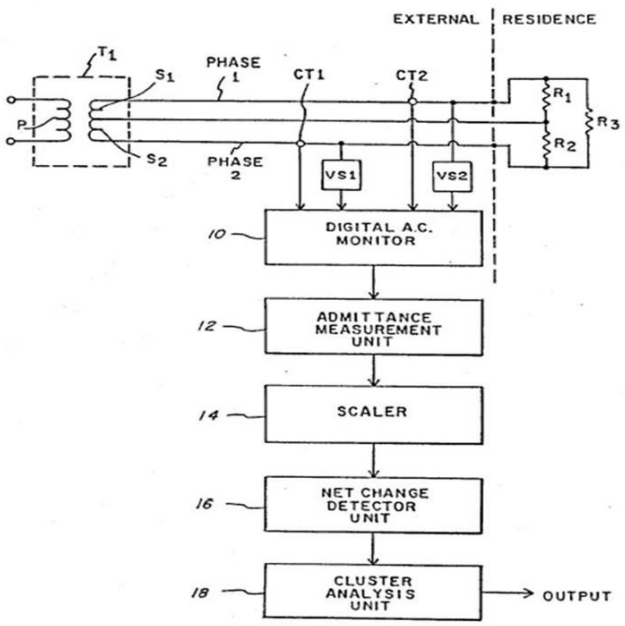

Figure 1: Multilayered armor.

timing of the on/off switch for each appliance, a cluster analysis is run. The advantages of installing a micro-grid include: (1) It is an "Eco-friendly entity", (2) Distribution grid operation policies need to be changed. (3) If there are any problems, it can still function, and (4) It is an integrated system with power grid and nanotechnology.

The NALM unit will match the on and off signals from the 50-watt bulb and the 100-watt bulb to determine how much power was used by each bulb and when it was used most frequently, for instance [2], if a 50-watt bulb is turned on, then a 100-watt bulb is turned on, then the 50-watt bulb is turned off, then the 100-watt bulb is turned off. The device is sensitive enough to distinguish between individual 50-watt bulbs because of the typical variances in actual power use of lights with the same nominal rating. And this system can also verify that the electrical equipment is undergoing through stabilized voltage condition. If any under voltage or over voltage is detected the system alert does immediately notify the consumer as well as service provider through messaging service for preventing further damage of equipment's.

In EV, size and weight of the EV makes large problems in vehicle performance [3]. Here, battery will consume 1/3rd weight of the vehicle. This can be decreased by using nanomaterials instead of currently used battery components. For example, carbon nanotubes and nano $LiFePO_4$ can be put to the electrodes to increase capacity, specific power, and cycle life, which will improve performance and range. Additionally, lightweight nanocomposites like carbon fiber reinforced composite can be used in the structural design of an EV to further reduce body weight and boost body strength. By using this nanocomposite, the vehicle's overall weight is reduced greatly, the bodywork's stiffness is increased, and the vehicle's performance and safety are enhanced. In the future, looking for electric vehicles with greater long-term safety, better performance, and longer driving ranges.

Zhu and colleagues have implemented [4] a number of nanotechnology-inspired strategies to prevent the deterioration of silicon anodes and side reactions that can kill batteries. Because it is extremely conductive and easily transfers captured electrons to the metal wires of a circuit, graphite is the preferred anode material of today. However, the ability of graphite to collect lithium ions during charging is only fair. In graphite, it takes six carbon atoms to hold on to one lithium ion. Silicon has the capacity to perform far better. Four lithium ions can bond to each silicon atom. In theory, this means that a silicon-based anode can store ten times as much energy as a graphite-based one. For years, electrochemists have tried in vain to use that vast potential. The stress and strain that pulverize bulk silicon anodes may be reduced by constructing a silicon anode out of nano-sized silicon wires. The plan was successful. Silicon nanowires exhibited minimal damage as lithium ions migrated into and out of the nanowires. The anode maintained 75% of its theoretical energy storage capacity even after 10 times charging and discharging it. Numerous nanostructured materials have been investigated as potential positive and negative electrode materials, including nanotubes, nanowires, nano-pillars, nanoparticles, and mesopores. Researchers are trying to identify the best compositions to get the most performance out of batteries that are as inexpensive, light, and compact as feasible by altering the electrodes' shape and surface area.

Experimentation

Software usage

The alert messaging platform is an open-source platform which allow users to add multiple devices and applications to their individual dashboard or mobile phone application. Figure 2 presents overview of EV lane in highways. Figure 3 shows block diagram. Also, we used here MATLAB software (Figure 4) which is very useful software to check all electrical circuits and we can analyze the output for different load conditions. Same can be simulated and can be take here as a reference file.

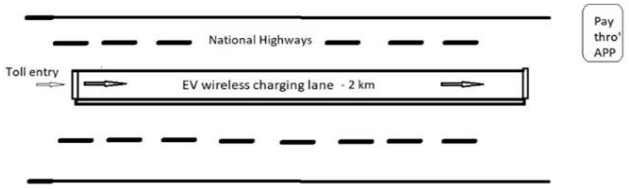

Figure 2: Overview of EV lane in highways.

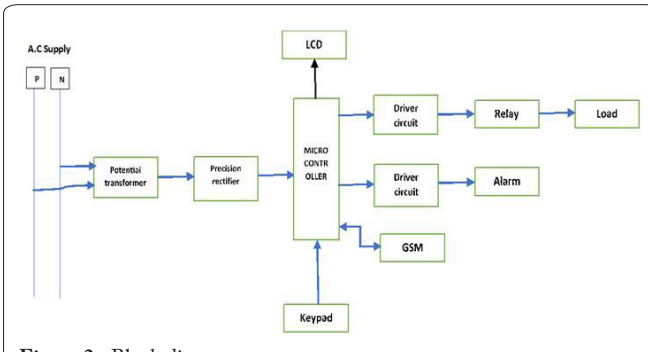

Figure 3: Block diagram.

The low voltage signal we fixed here as 200 volts and high voltage signal, we fixed here as 250 volts signal. The simulation output (Figure 5) shows the different level of waveform based in different load conditions. So, it is very much essential to identify the level of voltage to increase the load performance and lifetime.

Smart metering system

A smart meter is a measuring tool [2] that is used to track and record the amount of electric energy consumed every hour or less. Also, it will communicate that information on trip basis or monthly basis to the utility grid for monitoring and billing. It also alerts the user when the certain limit of usage going to be high. So, user can avoid power theft and maximum usage of power.

Smart meters enable two-way communication with the central system and the meter. Advanced metering infrastructure differs from traditional automatic meter reading because it enables two-way communications. Smart meters can collect and send the data for remote reporting and future reference. It is possible to communicate wirelessly or over fixed wired connections, such as power line communications, from the consumer side to the network side. Customers can utilize the following nanotechnology products, such as wireless for cellular communications, which can be pricey, Wi-Fi, which is widely accessible, wireless ad-hoc networks over Wi-Fi, wireless mesh networks, low power long range wireless (LORA), ZigBee, low power low data rate wireless, Wi-SUN (Smart utility networks), etc. We can transfer data over a great distance with less power usage by employing LORA technology.

Our nationwide program intends to switch over to prepaid smart meters from the current conventional electricity meters in an effort to modernize India's power infrastructure and increase energy efficiency. Prepaid smart meters connect to a web-based monitoring system, allowing users to improve their electricity use almost immediately. The proposed energy meters, known as prepaid smart meters, are used to track electricity consumption in real time. Users and utilities may easily track and monitor electricity usage and obtain correct invoices thanks to their internet connectivity. Also, this meter is very practical and effective since they have remote meter reading capabilities that entirely replace the requirement for manual inspection. The same technology can be implemented in EV charging system and consumer can pay the power consumption amount in monthly basis which will reduce the burden for a middle-class people.

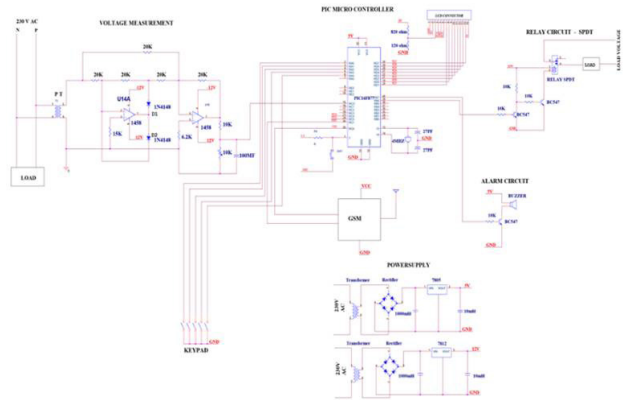

Figure 4: MATLAB circuit diagram.

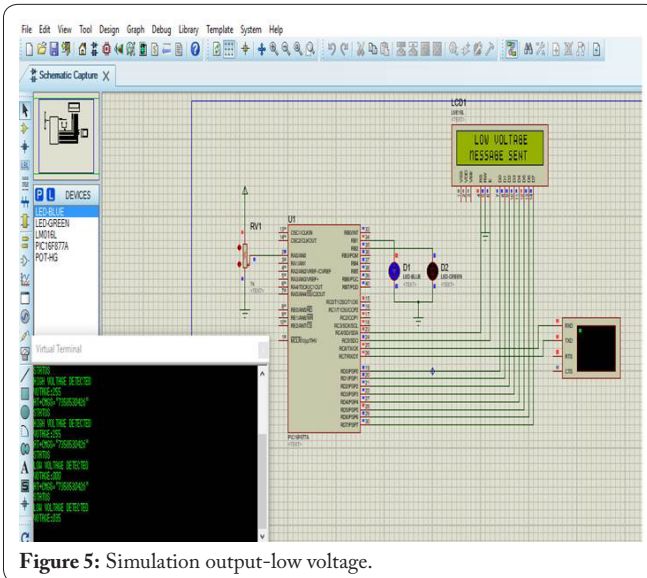

Figure 5: Simulation output-low voltage.

Results and Discussion

Figure 6 presents simulation output-high voltage. An EV can be monitor (Figure 7) offers information on electrical energy consumption. Devices could also show how much

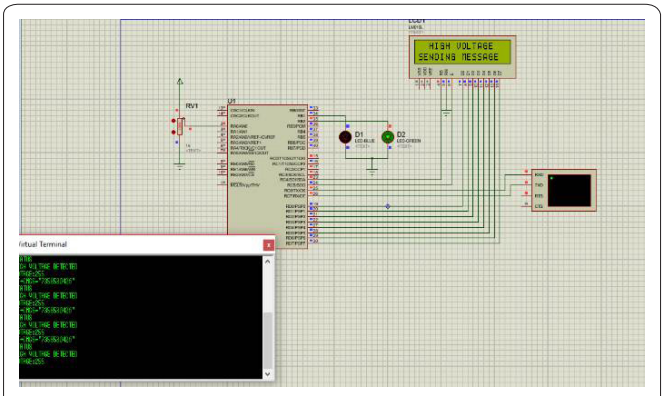

Figure 6: Simulation output-high voltage.

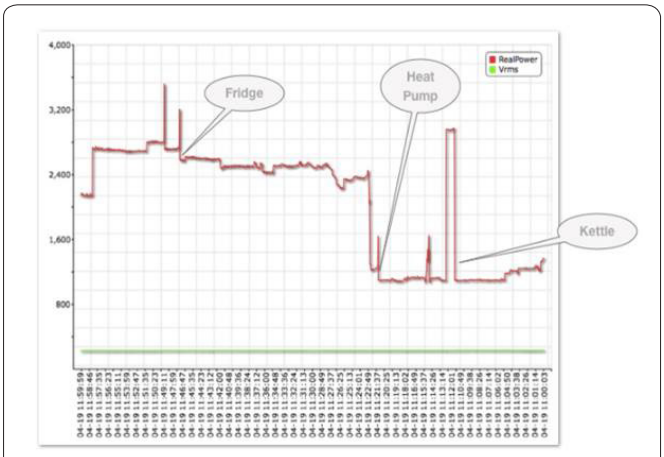

Figure 7: Chart represents different load measurement.

energy is being consumed. The use of displays has been found in numerous studies to reduce vehicle power consumption by 4 - 15%. The total amount of electricity used can therefore be determined by using an inductive clamp around the electric main, by using the electric meter's optical port, by sensing the various meter functions, or by connecting directly to the electrical grid system.

Additionally, the display component may be used independently of the measurement by connecting to the sensor via a cable, network, or power line. Additionally, the display component may be used independently of the measurement by connecting to the sensor via a cable, network, or power line. Voltage stability issues are often of a dynamic nature, although static analysis techniques offer a promising means of anticipating the issues.

It is not necessary that lowest voltage bus must be weakest one. It can be noted that (Table 1) 200 volts is the lowest one. The actual voltage 230 volts is expecting voltage. The voltage 250 volts is a higher voltage (Figure 6). Applications such as remote heating control (Smart heating), electricity monitoring (Smart energy), and home monitoring (Smart monitoring) are the various core applications, but in future because of development of many third-party devices' platform can adopt further applications like automatic lighting control in garden or streets, locks and keypads as well as smart appliances.

The Vienna rectifier can be used as a converter circuit that efficiently and with low total harmonic distortion converts AC power to DC power. Experimental results from a scaled-down prototype show that the total harmonic distortion remains below 5% over a wide range of input voltage, output voltage, and loading conditions (up to 2 kW). The outcomes demonstrate that the suggested rectifier system can be used for high power applications like welding power sources and DC fast charging stations.

Benefits of smart meter

Energy-efficient

Consumer will be motivated to modify their electricity usage and save resources and money if you regularly monitor how much energy you're using.

Operational efficiency

The current manual technique for collecting fees for energy use is not just ineffective; it also costs power distribution corporations a lot of money. Prepaid smart meters' high accuracy would greatly cut down on these losses and aid utilities in enhancing the supply of electricity.

User-friendly

In order to allow consumers to recharge well in advance and avoid any last-minute headaches, prepaid smart meters deliver alerts when the account balance is becoming low.

Green energy

Prepaid smart meters decrease our reliance on fossil fuels, lowering our nation's carbon impact as we move closer to a smart energy system.

Experimental verification

To prove the correctness and the accuracy of the proposed idea, an experimental prototype shown in figure 8 was made and verified the output for the lower voltage as well as higher voltage. In the prototype, the Arduino mega 2560 used as a main controller which is very much user friendly also any one can understand or modify the code easily. Also, two channel relay board, voltage sensor, current sensor, GSM 900, DC gear motor, 230/12 volts transformer, 12 volts battery was used to make control and GSM 900 which is used to send the message communication.

Whenever the system identifies the lag of voltage or over voltage, voltage sensor will intimate to the controller and controller will insist the GSM to send a message for the consumer as well as service provider. So, the preliminary action can be taken by the respective people to clear the fault.

In this prototype, the over voltage or under voltage can be measured by the use of voltage sensor and it will be communicated to the Arduino controller. Sensors and other input devices are connected to Arduino, which has digital and analogue I/O pins, and it controls all other output devices like a motor, display, buzzer, and GSM. The controller will have programme in such a way that when the low voltage or under voltage measured by the sensor, it will be make alert the consumer through a short message by the use of global system for mobile communication. For that here we used GSM 900 which will send the message to the consumer. Also, we can measure the total power consumption for a single trip/month through this system and the same will be communicated to the consumer through a message. So that consumer can pay the exact tariff which will stop the negligence of the electricity usage.

Table 1: Analysis of input voltage.

S. No.	Sensor voltage	Reference voltage	Remarks
1	230	200 - 240	Normal
2	220	200 - 240	Normal
3	210	200 - 240	Normal
4	190	200 - 240	Low voltage
5	240	200 - 240	Normal
6	250	200 - 240	High voltage

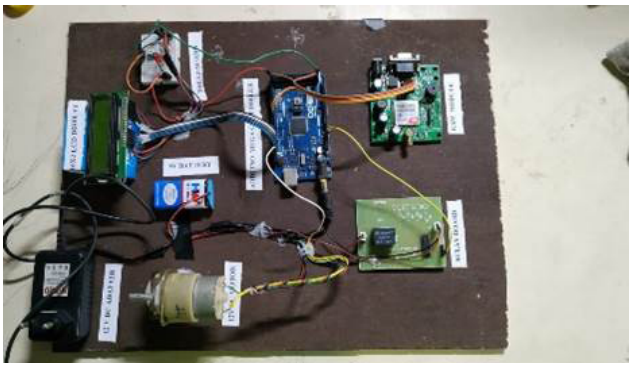

Figure 8: Experimental prototype.

These components are installed in consumer premises. The advantages are including as follows: (1) Power quality is high, (2) Able to provide continuous power supply, (3) High energy efficiency, (4) Reliability is more, (5) Less pollution and effort, (6) Low manpower, and (7) Eliminates the requirement for services like demand response and voltage support.

Conclusion

To develop a device that can keep track of energy that has been consumed or being consumed, at this rate consumers can know their usage limit as well as by saving the power being used unnecessarily. This is a study of concept that brings an interface of electricity being used well and educated manner. The usage of power is delivered to the consumers by via or short message service, and also, to intimate the consumers about over /under voltage factor by using nanotechnology device called GSM which helps them to avoid the further damage of devices being occurred. This circuit should be used as a standalone circuit between the main supply and the load. By this method we can provide good voltage stability as well as quality power supply throughout the power grid. Also, we can ensure accurate charging of different electric vehicles based on their coil design. So, by advancement of nanotechnology people will use of more electric vehicle which will lower the pollution as well as global warming issues. This will ensure the system stability and continuous power supply. Also, we can improve the life span of all electrical equipment which is connected to the power grid.

The key benefit of this method is that it can accurately and reasonably estimate the voltage stability margin of the entire system and determine the necessary corrective action in the event that the margin is insufficient. In order to alter the reduced network, it is expected that phasor measurement units and traditional measurements updated the system's states at equal intervals. The voltage obtained for this optimized margin is used as target values for determining the actual control action by meaning of Gauss-Newton optimization. In all aspects if we got these kinds of measuring and alert system from the service provider, we can call it as smart metering system which will be benefited for the people as well as global world.

The feature research can be done in the charging circuit technology as well as transmitting and receiving coils to increase the length of the airgap. Also, research can be done to provide proper sheathing technology to avoid electric accidents. Nanotubes, nanowires, nano-pillars, nanoparticles, and mesopores are just a few examples of the various nanostructured materials that have been researched as potential positive and negative electrode materials. Therefore, these nanotechnologies can be improved upon in order to achieve our aim of EVs.

Acknowledgements

None.

Conflict of Interest

None.

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