

# Smart Substation Integration Technology and Its Application in Distribution

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**Abstract-** In this paper, a new smart voltage and current monitoring system (SVCMS) technique is proposed. It monitors a single phase electrical system using an Arduino platform as a microcontroller to read the voltage and current from sensors and then wirelessly send the measured data to monitor the results using a new Android application. The integrated SVCMS design uses an Arduino Uno as the microcontroller to measure the results from voltage and current sensors and then send this data, after calculation, to the Android smartphone device of an end user using Wi-Fi module. The Arduino Uno controller and ESP8266 W-Fi module are a cheap microcontroller and wireless device, respectively. The new Android smartphone application that monitors the voltage and current measurements uses the open source MIT App Inventor 2 software. It allows for monitoring some elementary fundamental voltage power quality properties. The system also calculates frequency and power factor of line using zero crossing detectors and from calculation of voltage and current respectively.

**Keywords-** voltage sensor; current sensor; Android; Arduino; smart

## I. INTRODUCTION

Because of the increasing advances in technology, smart systems are increasingly being used. These systems allow technicians, administrators, and managers to monitor and control the performance of devices from a safe distance. The monitoring system is very important when working in the field of three phase systems; some users and companies use smart monitoring software programs. These programs are installed on the user's smartphone or company computers to allow employers to make decisions if there is an error. The main objective of this paper is to create a smart monitoring system based on an intelligent control system. The proposed system is called a smart voltage and current monitoring system or SVCMS. The SVCMS is designed to monitor the performance of a three phase grid by measuring voltage and current. The SVCMS design consists of two parts; the first is the control system shown in Figure 1a. This system has been designed using the Arduino Nano V3.0 as a microcontroller to read and calculate the RMS voltage and current from sensor units. The Arduino Nano V3.0 is an open source platform that is very cheap, flexible, and has special-purpose data processing capabilities. Similar applications have been proposed for previous versions of this microcontroller.

Any motor that operates on alternating current requires apparent power, but apparent power is addition of active power and reactive power. Active power is the power which is actually consumed by the load. Reactive power is the power demanded by the load and returned to the power source. The simplest way to specify power factor is —POWER FACTOR is the ratio between the useful (true) powers whose unit is KW to the total (apparent) power whose unit is KVA consumed by an A.C electrical equipment or motor. Power factor is a measure of how effectively electrical power is used to perform an useful work. The ideal power factor is unity or one. If power factor is less than one it means that excess power is required to perform or achieve the actual work.

Improving the PF can maximize current-carrying capacity, improve voltage to equipment, reduce power losses, and lower electric bills. A power factor of -0.7 for example, indicates that only 70% of power supplied to your business is being used effectively and 30% is being wasted. The wasted power is the reactive power (the foam in the previous example). Most loads are inductive in nature, which means the power factor will typically be less than unity. The further the power factor is from unity, the greater the apparent power drawn and therefore, the greater the current draw for the system. The increased current may require an increase in the size of your transformers and installation power wiring. Increased current also results in increased heat which affects the longevity and lifespan of an electrical system. This can add a great deal of cost to the installation and may also limit the expansion of a plant.

## II. LITERATURE SURVEY

The versatile application created in [1] screens the information (three stage voltage and current) got from the microcontroller. This paper utilizes another application planned utilizing MIT App Inventor 2, an open source stage from Google, that can be utilized to structure distinctive kinds of utilizations that can be executed of Android cell phones or tablets. The point of this work was to plan and execute a minimal effort and safe three stage estimating framework and to structure a cell phone application to screen the information got from the three stage estimating framework. The SVCMS has been intended to gauge three stage voltages and flows for each of the three stage frameworks that have a line to ground voltage of under 250 VAC with a current estimation of under 30 A.

Data about the recurrence deviation is basic to solid and stable task of the power network. Current widearea control framework observing frameworks comprise of Phasor Measurement Units (PMUs) at both high-voltage transmission level and low-voltage dissemination level, however are by and large inadmissible for substantial scale organization over exceedingly dispersed microgrids in individual families and neighborhood networks because of their staggering expense and low openness. In this paper, we present a reasonable framework structure which fundamentally enhances the openness and diminishes the expense of recurrence checking by releasing the capacities of current versatile stages in calculation, correspondence, and capacity. In our framework, the Network Time Protocol (NTP) is misused for time synchronization, supplanting unbendable GPS recipients that are generally utilized in current PMUs. A little amount of fringe equipment segments are utilized to develop an implanted detecting part for proficient and exact recurrence estimation. The analysis results contrasted with the conventional Frequency Disturbance Recorders (FDRs) demonstrate the viability of the proposed recurrence observing framework. [2]

The versatile worked vehicle is where a person can control a vehicle by an android application by remote or remote task, without physically being situated inside it. The undertaking contains a vehicle fueled by a battery and a controller which has a Bluetooth availability. The framework comprises of a controller prepared by Bluetooth correspondence IC, it will be associated with the engines and different parts of vehicle. At the point when an android application which will be associated with this framework by Bluetooth is exchanged on one can work the vehicle by remote directions given from application. The activity scope of Bluetooth is around 10 meters or 33 feet roughly. [3]

The primary component of vitality effectiveness is to get more work with less vitality. Numerous parameters that have a place with the nonconcurrent engines can be checked with the created framework in this examination. The premise of this observing framework comprises of cell phones. By utilizing the application on the cell phone, the parameters that influence the vitality expenses of the assembling framework, for example, current, voltage, recurrence, loop temperature and obstruction can be checked. Therefore, the client can without much of a stretch screen any parameter having a place with any engine continuously. This element is conceivable with just downloading the essential application to the cell phone from IOS/Android application stores. This examination adds to the effectiveness of assembling frameworks with its constant checking highlight. [4]

The strategy for power factor rectification [5] is the utilization of a variable capacitor bank. This bank would be associated simply like the settled bank. The benefit of the variable capacitor bank is that the bank screens the framework control factor and naturally directs the measure of capacitive load

associated with the framework to balance the inductive load. Since the capacitive load is managed, there would be no contention with the utility. The variable capacitor banks regularly accompany interior insurance, give space to extra banks, and give a midway found effortlessly looked after unit. The disadvantages to the variable capacitor bank are an expanded shot of consonant issues because of the varieties in capacitance, beginning expense, and support expenses of inward parts utilized for capacitor exchanging.

The present power framework requests enhanced power factor with the end goal to bridle different focal points related with enhanced power factor. Till date, different techniques have been conveyed to enhance the power factor of the power framework. The paper [6] for the most part centers around a novel strategy for receptive power pay and in this manner control factor enhancement at the heap end. This paper displays a novel methodology of capacitance reviewing for accomplishing adjusting of intensity factor. The idea for programmed control factor revision by calibrating of evaluated capacitors with the assistance of microcontroller and paired rationale is proposed, mimicked, and actualized. The technique introduced is of iterative nature and is cost aggressive over other sent strategies. A calculation is created and a model is made to convey the idea of cycle with paired rationale. The equivalent is tried on an enlistment engine and results got are broke down.

The Purpose of paper, "Programmed Power Factor Correction by Continuous Monitoring", [7] is actualizing another innovation for power factor enhancement of 3 stage acceptance engine and additionally for single stage enlistment engine, as enhancement of intensity factor is essential for modern and also residential territories and to make control factor as close as solidarity without confronting punishment from electrical distributors. As we probably am aware in businesses a large portion of engine which is generally utilized is enlistment engine and acceptance engine having low power factor too. Home apparatuses which are for the most part utilized are by and large having low power factor. Consequently there is need of intensity consider enhancement instance of family apparatuses and additionally in modern reason. Enlistment engine is most broadly utilized engines in enterprises .As name of this engine determine this engine having low power factor. Subsequently there is need of intensity factor enhancement

The paper "Power Factor Correction of Three Phase Induction Motor Using Switched Capacitor Banks with PLC", [8] depends on novel power factor enhancement of a 3-stage enlistment engine utilizing exchanged capacitor keeps money with Programmable Logic controller which joins advancement of the equipment and programming in this work. The equipment comprises of intensity circuit and control-circuit of the working framework and programming PLC programs was produced. An on-line process is done for exchanging on or/and off a gathering of capacitors with the assistance of

strong state transfers from PLC. The fundamental control procedure is to choose the consistent example to switch the fitting capacitors relying upon power factor amendment necessity through strong state transfers. The exchanging of capacitor-banks through computerized yield of the PLC in a legitimate rationale was done. The outcomes got for power factor enhancement from power analyzer associated crosswise over acceptance engine gives a fine control of capacitive VAR for development of the power factor.

Paper [9] examines the power factor redress of electrical burdens is an issue regular to every single modern organization. Prior the power factor remedy altering by capacitor physically. The power factor adjustment hardware is diverse compose, Such as, Synchronous Alternator, Synchronous Compensator, Static var Compensator, Banks of Static Capacitors. The Static capacitors are surrendered the responsive power in the framework. While the variety in load to the diverse Static capacitor are utilized. The power factor is a proportion of the real capacity to the application isn't control. What's more, the Reactive Power is extremely helpful in the power framework. Since the inductive load is utilized in power framework and the framework is assimilated the receptive power. The structuring auto-flexible power factor amendment is to guarantee the power factor solidarity.

Power factor is the proportion of the genuine current or voltage gotten by a heap to the root mean square (rms) estimation of the current or voltage that should be obtained by a similar load. The way that the two wind up various is because of the nearness of receptive power in the circuit which gets dispersed. Enhancing the power factor implies diminishing the stage contrast among voltage and current. Since lion's share of the heaps are of inductive nature, they require some measure of receptive power for them to work. In this manner, for the better utilization of electrical machines with least measure of electrical utilization, the power factor ought to essentially be expanded and ought to be conveyed close to 1. This can be effectively done by the assistance of Automatic Power Factor Correction Capacitors and Active channels [10].

### III. SYSTEM ARCHITECTURES

This application monitors the data (voltage and current) received from the microcontroller. This paper uses a new application designed using MIT App Inventor 2, an open source platform from Google, that can be used to design different types of applications that can be implemented of Android smartphones or tablets. The aim of this work was to design and implement a low cost and safe electrical quantity measuring system and to design a smartphone application to monitor the data received from the three phase measuring system.

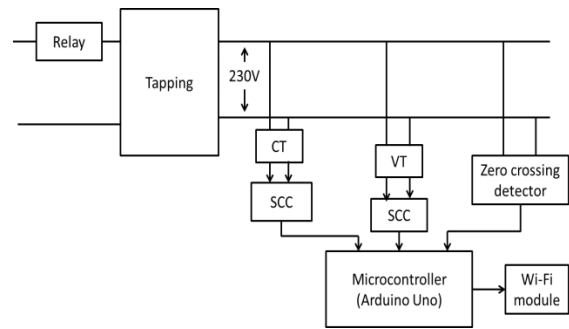


Fig.1: System architecture

Current, voltage and frequency is calculated using current transformer, voltage transformer and zero crossing detectors respectively. Android app displays current, voltage, frequency and power factor. Measurement of power factor and frequency are described below:

**Power factor calculation:** Power factor is the significant factor for evaluating the effectiveness of usage of electric power in a power system network. If the power factor is good or high (unity), then we can say that more effectively the electric power is being used in a power system. As the power factor is poor or reduces, the effectiveness of usage of electric power reduces in power system. Power factor can be described in various terms such, it can be called as the ratio between active power and apparent power, it can be defined as the cosine of angle between voltage and current.

$$PF = |\cos \phi| = \frac{1000 \times P_{(kW)}}{V_{(V)} \times I_{(A)}}$$

**Frequency calculation:** frequency calculation is carried out using zero crossover detection. We find period of waveform of signal and from that we will calculate frequency. Zero crossover detector converts AC signal to DC.

$$Frequency = \frac{1}{periodic\ time} = \frac{1}{T} Hz$$

In digital form, signal is either ON i.e. some constant amplitude or OFF i.e. null amplitude. Therefore signal width or periodic time is given as

$$T = \frac{1}{ON\ time + OFF\ time}$$

### IV. APPLICATION

1. Improved power factor Reduces electricity charges thus can be applicable in home/industry to monitor power factor.
2. Utility companies levy utility reactive power penalties to consumers with poor power factor. Such surcharges can result in electricity bills increasing by up to 20%,

depending on which company is supplying your electricity.

V. RESULT

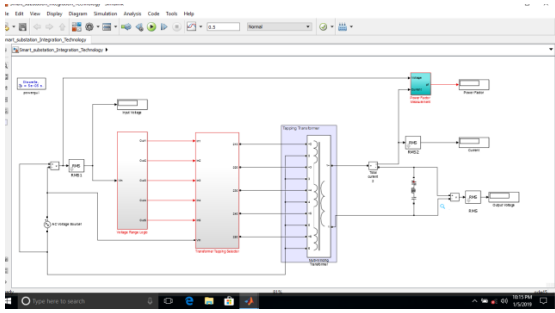


Fig.2: Simulation model

Table 1: Result when changing input voltage

V <sub>Input</sub>	R <sub>Load</sub>	C <sub>Load</sub>	L <sub>Load</sub>	PF	I <sub>Output</sub>	V <sub>Output</sub>
230	1000	100e-6F	10e-3H	0.9506	0.2297	229.8
250	1000	100e-6F	10e-3H	0.9506	0.2297	229.8
255	1000	100e-6F	10e-3H	0.9506	0.2343	234.4

Table 2: Result when changing input voltage

V <sub>In put</sub>	R <sub>Loa d</sub>	C <sub>Load</sub>	L <sub>Loa d</sub>	PF	I <sub>Output</sub>	V <sub>Output</sub>
252	1000	100-6	10e-3	0.9511	0.2316	231.7
252	1200	150-6	15e-3	0.9511	0.1544	231.7
252	1500	180-6	18e-3	0.9511	0.193	231.7

VI. CONCLUSION

A smart voltage and current monitoring system (SVCMS), is designed and implemented to measure and monitor single phase voltage and current. The SVCMS model is more cost effective than similar models that use heavy current transformers (CTs). It is also safer than having to measure the mains voltages very often. It is a low cost and easily applicable model for measuring and monitoring three phase system performance as compared with other models. The technician can also work with the domain like virtual reality. The monitoring system uses a new Android smartphone application designed by MIT App Inventor 2. This application receives the three phase RMS voltage and current data from the Bluetooth device (HC-05). The SVCMS has been tested

VII. REFERENCES

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