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Detection of Synchronization Failure by Using Frequency and Voltage and Using IOT

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Abstract-— **This paper gives the concept of IOT based automatic synchronization of alternators to grid. In 'modern power system' power from the generating station is delivered to the consumers through a large network of transmission and distribution. There are several power generation units which supply power to the load.**

For satisfactory operation of load, consumers need constant voltage and frequency. To watch voltage and frequency a unit is developed. The essential idea is to implement the employment of up- to-date technology in sensing the very low variations in frequency or voltage magnitude of generators in grid. Consisting of terms "Frequency, Voltage, Phase Sequence and Phase Difference."

In today's practical world the ability Grid works to take care of stability and proper 'Synchronism', the detection and isolation of sources breach of synchronism, is of crucial significance as otherwise it'd have caused the whole system to fail.

Keywords - synchronization failure, IoT, voltage.

I. INTRODUCTION

Synchronization means the minimization of difference in voltage, frequency and phase angle between the corresponding phases of the generator output and grid supply. An alternating current generator must be synchronized with the grid prior to connection. It can't deliver the power unless it is running at same frequency as the network. Synchronization must occur before connecting the generator to a grid. Synchronization can be achieved manually or automatically. The purpose of synchronization is to monitor, access, enable, and automatically take the control action to prevent the abnormalities of voltage and frequency.

The detecting power grid synchronization failure system on sensing frequency or voltage beyond the acceptable range is very important in that power generation systems, where different supply sources are connecting parallel together for supplying the uninterruptible power supply to a single loaded bus bar. But for connecting the different supply sources on a single bus bar there are some limitations, such the voltage and frequency both should be same of the connecting power sources. If the both limitations are not fulfilled by the connecting power supply sources then the more current could be passing through any source or output load, resulted damaged or destroy the supply source or connecting load. For this purposes, the supply voltage and supply frequency both are detected continuously, when both are same then synchronized or connected parallel all the supply sources.

The necessity for synchronizing and parallel generator operation is often based on the following:

- The rated generating capacity of an existing system has been exceeded by new load demands.
- Enhanced reliability (multiple generating vs. single unit generating) is to be considered.
- Operating efficiency of generator sets is a valid concern.

The limits allowing for synchronization are

- Phase angle- +/-20 degrees
- Maximum voltage difference – 7%
- Maximum slip frequency – 0.44%

Synchronizing a generator to the power system must be done carefully. The speed (frequency) and voltage of the isolated generator must be closely matched, and the rotor angle must be close to the instantaneous power system phase angle prior to closing the generator breaker to connect the isolated generator to the power system.

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II. LITERATURE REVIEW

In [1], the use of up-to-date technology in sensing the very low variations in frequency or voltage magnitude of a generator in a Power grid is implemented in which there may be many generators working in synchronism with the grid in terms of phase sequence, voltage magnitude and frequency. In today's practical Power grid as we all know many generators or power source are working together and to maintain stability between all, the detection and isolation of the sources falling out of synchronism, is of crucial significance as otherwise it would have caused the entire system to fail. Hence various techniques have been developed in industries and power plants (especially solar power plants) to keep all the generators and sources in synchronism with the Power Grid and in case of and failure detect and
isolate the failed generator out of the grid and hence maintain a stable operation of the Power System.

In [2], a system to detect the synchronization failure of any external supply source to the power grid on sensing the abnormalities in frequency and voltage is developed. There are several power generation units connected to the grid such as hydel, thermal, solar etc. to supply power to the load. These generating units need to supply power according to the rules of the grid. As per CENTRAL ELECTRICTY AUTHORITY OF INDIA Regulations 2010, variation of the system voltage should be of +- 5 % and make all efforts to operate at a frequency close to 50 Hz and shall not allow it to go beyond the range
49.2 to 50.3 Hz. These rules involve maintaining a voltage variation within limits and also the frequency. If any deviation from the acceptable limit of the grid it is mandatory that the same feeder should automatically get disconnected from the grid which by effect is termed as islanding. This prevents in large scale brown out or black out of the grid power. So it is preferable to have a system which can warn the grid in advance so that alternate arrangements are kept on standby to avoid complete grid failure.

In [3], the design of a system to detect the synchronization failure of any external supply source to the power grid on sensing the abnormalities in frequency and voltage and thereby protecting the load is presented. This system is based on Arduino Uno microcontroller. The microcontroller monitors the under/over voltage being derived from a set of comparators and a standard Arduino is used to vary the input voltage to test the functioning of the paper. A lamp load (indicating a predictable blackout, brownout) being driven from the microcontroller in case of voltage/frequency going out of acceptable range. GPS and GSM technologies are used to indicate the fault location.

Zongjie Liu, Lifeng Zhu, Li Deng, Lijun Qin, Feng Jiao[4], proposed a methodology of Islanding Detection about the Photovoltaic Grid-Connected Generation System as a the photovoltaic grid- connected generation system is rapidly developed and applied due to the cleaning, renewable and wide distribution of solar. This paper is to solve the problem about islanding detection brought by the photovoltaic grid-connected generation system. First of all, it analyses the reason happened and potential hazards of the Islanding and introduces the existing detection method and islanding detection. Then, in view of the insufficiency of the existing method, it put forward a new solution that combined the negative sequence voltage positive feedback voltage with active power positive feedback to the islanding detection. The amount of change of the frequency and the voltage is introduced to the voltage - active power positive feedback, which can effectively and fast detect the island.

Karan Gupta, Shreyas Gupta, KummadVerma, Anil Singh, Abhimanou Sharma [5], gave an idea of
Detecting Power Grid Synchronization Failure on Sensing Bad Voltage or Frequency Documentation in which they described in modern power system, electrical energy from the generating station is delivered to the ultimate consumers through a huge network of transmission and distribution. There are several power generation units connected to the grid such as hydro, thermal, solar, wind etc. to supply power to the load. Thus, for satisfactory operation of loads, it is desirable that consumers are supplied with substantially constant voltage and frequency.

Laukik S. Raut, Shahrukh B. Pathan, Gaurav N. Pawar, Mandar V. Pathak [6], gave an idea of Detecting Power Grid Synchronization Failure on Sensing Frequency or Voltage beyond Acceptable Range. The system to detect the synchronization failure of any external supply source to the power grid on sensing the abnormalities in frequency and voltage. There are several power generation units connected to the grid such as tidal, thermal, solar etc to supply power to the load. These generating units need to supply power according to the rules of the grid. These rules involve maintaining a voltage variation within limits and also the frequency. If any deviation will occurs then automatically disconnect the grid line. This prevents in large scale brown out or black out of the grid power. So it is preferable to have a system which can warn the grid in advance so that alternate arrangements are kept on standby to avoid complete grid failure. This system is based on a microcontroller of 8051 family. The microcontroller monitors the under/over voltage being derived from a set of comparators. As the frequency of the mains supply cannot be changed, so by using variable frequency generator (555-timer) frequency can changed. A lamp load (indicating a predictable blackout, brownout) being driven from the microcontroller in case of voltage/frequency going out of acceptable range.

Rohan Solanki, Divyesh Patel, Yuvraj Gharia, Daivik Sailor, Bhumit Patel, AshishChaudhari [7], generated Detection And Protection of power grid synchronization failure system in which they gave the idea if any deviation from the acceptable range limit of the grid it is mandatory that the some feeder should automatically get disconnected from the grid which in termed as islanding, these prevent in large scale brownout or blackout of the grid power so it is preferable to have a system which can warn the grid in advance so that alternate arrangements are kept on standby to avoid complete grid failure.

A simple and cost-effective system is developed in [8] to detect the power grid synchronization failure on the basis of voltage and frequency variation. To provide power to the load the rules of grid involve maintaining a voltage in the limits and the frequency as well. If any deviation from the range of the grid occurs then it is compulsory that the grid should automatically get disconnected. This prevents in large scale brown out or black out of the grid power by sensing abnormalities of voltage and frequency.

Pankaj Singh et al [9] concludes that it is possible to have a power grid system that is smarter, more effective as well as efficient in its operation, thus proving to be more economical as compared to be the present installations. The challenge is a continuous and uninterrupted transmission which can be very well achieved with the implementation described by this paper and in addition to the continuous transmission several other parameters i.e. the passive parameters are being monitored regularly and any discrepancies occurring in these, are taken into account and accordingly worked upon thus making the process of management and recovery convenient and effective.

In [10], a new methodology to select preventive controls for voltage stability problems considering the coexistence of multiple critical contingencies was proposed. This methodology is based on the sensitivity analysis of the MLP with respect to control variables. It selects a group of preventive controls taking into consideration the cost, availability, and effectiveness of the control in simultaneously eliminating the criticality all selected contingencies. Tests were conducted in a reduced version of the south–southeast Brazilian system with 107 buses and 171 lines. The control actions were correctly selected in terms of bringing the system to a secure operation region with a low cost. Although the simulations were performed considering only shunt capacitors and load shedding, the implementation of other control elements, such as static VAr compensators or other types of FACTS devices is straightforward and depends only on the sensitivity calculation for these other control variables. The group of controls determined in this paper can be used as a decision support tool for the operator to keep the power system operating in a secure state or it can be used as an input for tools of preventive control design based on optimal power flow. The results of the proposed method are promising. Further work is required to: 1) integrate this method with an optimal power flow tool; 2) take into account the hierarchy of the controls in the selection procedure; and 3) considering the interaction of voltage controlling devices, such as transformers equipped with on-load tap changers (since transformer taps were considered as fixed in this paper), with preventive control actions. These possibilities are among the future directions of this research.

III. AIM AND OBJECTIVES

- **Aim**

To develop a system, capable of identifying abnormalities in voltage or frequency in order to detect a synchronization failure of a power source

- **Objectives**
  - To detect the failure of synchronization in power line using IoT.
  - To introduce fault in system by external means, to check functionality of system (synchronization failure detection)
  - To calculate phase difference and phase sequence

IV. PROBLEM STATEMENT

To monitor, access, enable, and automatically take the control action to prevent the abnormalities of voltage and frequency

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V. MOTIVATION

In today's practical Power grid as we all know many generators or power source are working together and to maintain stability between all, the detection and isolation of the sources falling out of synchronism, is of crucial significance as otherwise it would have caused the entire system to fail.

VI. PROPOSED SYSTEM

The proposed system consists of Arduino Mega, voltage detector, frequency detector, touchpad, fault button and Node MCU. Mobile App is developed which, along with touchpad, displays values of voltages and frequency and failure message if synchronization failure occurs.

Voltage and frequency detector are placed at two different ends of power line, voltage1 and frequency1 detects voltage and frequency of first end whereas voltage2 and frequency2 detects voltage and frequency of other end respectively. We calculate Φ sequence and Φ difference for detecting synchronization failure Synchronization failure occurs if Φ sequence is not same or/and Φ difference between two phases is not 120° or/and Voltage difference is not equal. A load is connected to system. Relay is used to ON/OFF contactor. By using contactor we attaching or detaching load. Contactors are used for high power applications. They allow a lower voltage and current to switch a much higher power circuit, so they are generally larger and more heavy-duty than control relays, enabling them to switch higher power loads on and off for many thousands of cycles.

In detecting power grid synchronization failure system on sensing frequency or voltage beyond the acceptable range, the touch pad display is used for displaying the supply frequency and voltages of different sources. It is interfaced with microcontroller and powered up with 5V dc.

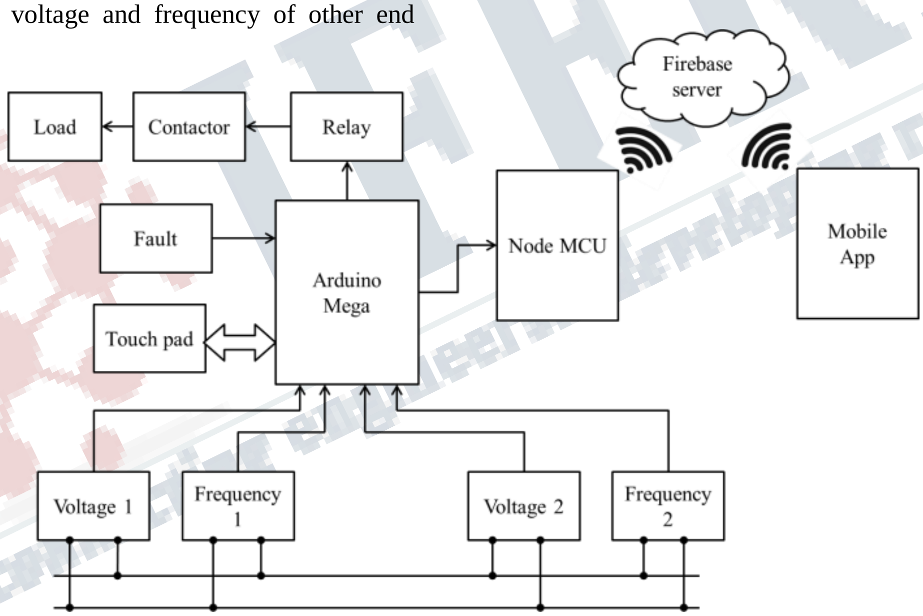

Fig 1. Proposed system

Node MCU is an open source firmware for IoT platform which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware, which is based on the ESP-12 module.

Node MCU updates data (voltage and frequency) on cloud and fetches data from cloud (failure introduced via app).

Since the system is designed to detect synchronization failure, hence we are externally introducing failure in system by two ways 1) Fault button and 2) Mobile App. When fault button is clicked or the button (designated for synchronization failure) on Mobile App is pressed, system acts as if failure is occur and disconnect load by switching relay.

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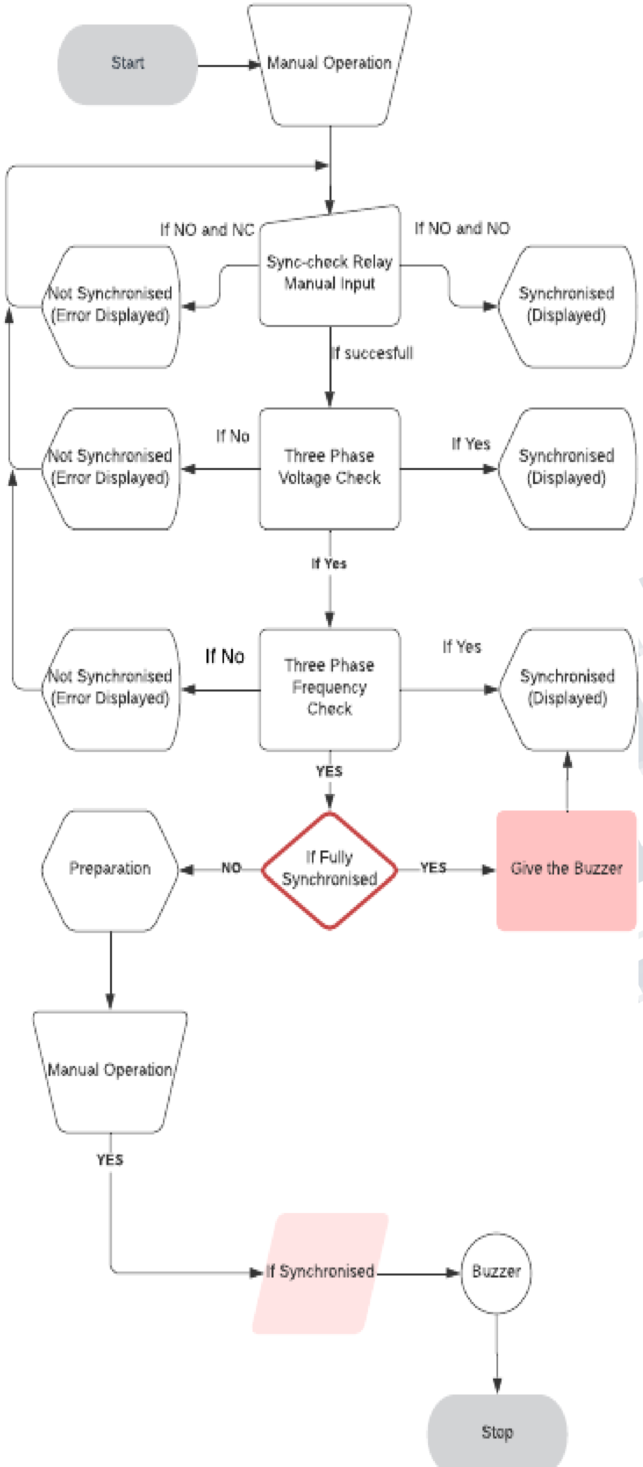
VII. FLOWCHART



OUTCOMES

- Detected fault is shown on app.
- Voltage and frequency values updated on cloud and App .

VIII. CONCLUSION

This implementation concludes that it is possible to have a power grid system that is smarter, more effective as well as efficient in its operation, thus proving to be more economical as compared to be the present installations. This paper gives brief idea about indicator which senses the abnormalities in voltage as well as in frequency so as to detect the synchronization failure of any external supply source to the power grid. This type of indicators are much needed in most crowded EHV substations where number of voltage levels, number of sources, number of power transformers and number of load lines are existing. By using this system, the consumer load could be automatically shifted to another source of energy. This system is more compact and reliable as compared to the manual system. It secured the power of the grid coming from different power stations by detecting the abnormal conditions of frequency and voltage beyond its acceptable. It prevents the synchronization failure between power grid and feeder.

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