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AUTOMATIC VOLTAGE REGULATOR FOR GENERATOR

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ABSTRACT :

This paper presents the development of an Automatic Voltage Regulator (AVR) for synchronous generator in industries applications. The AVR operates as a voltage stabilizer and controller because the output voltage is controlled and regulated through a power electronic system. It is observed that the automatic voltage regulator managed to achieve up to 2% voltage regulation at full load operation of SOOW. A thyristor controller is used to control the excitation voltage. The design also includes protection such as noise suppressor, radio frequency interference 0, surge protection, current limiter and electronic control system.Supplying regulated voltage is one of the most important topic for all equipments. This paper aims to design and implementation of single phase ac voltage regulator using arduino uno. A regulator is designed to automatically maintain a constant voltage level. This paper deals with the control techniques for load voltage regulation. The technique of tap-changing transformer switched by relay module. Arduino uno is used to control the switches to regulate the load voltage against supply voltage. This paper presents a single phase electronic voltage regulator based on unregulated primary side voltage is controlled by full-bridge rectifier. The controller,arduino uno is used to sense the output of full-bridge rectifier.

INTRODUCTION :

In every renewable energy application, an alternator is considered a major component to convert the kinetic energy to electricity for end-users. A synchronous generator is used in ocean wave application because it manages, to regulate a stable output voltage during over speeds compared with an induction generator or a permanent magnet generator (PMG). Induction generator and PMG have disadvantages in extreme high speeds resulting in an increased output voltage with the speed of prime mover. In this case, the output voltage is regulated through a power electronic controller such as an inverter or AC controller at a higher cost in high power application. Therefore, a synchronous generator is a good choice to be used in ocean wave application because it could reduce the cost of development of a power electronic controller at output terminals. At the same time, the generator will be reliable because it used the stator winding rather than the power electronic controller. A synchronous generator has advantages to control the output voltage through a field exciter. As such, power electronics and control system design will be the focus in this paper for output voltage regulation in under and over speed situations. AVR is a suitable choice to control the output voltage through field excitation in variable speed application.

In existing market, a traditional generator voltage regulator normally designed is only suitable at synchronous speed of the primer mover and it may cause easy bum out of the power electronic components if hunting and speed change occurs. A speed change of prime mover may affect high dvldt and di/dt generated from output voltage and it may cause the control system to suddenly push up fast triggering. In this situation, power generation affects power electronic component namely, a thyristor responds to fault triggering for high dv/dt and di/dt generated from output voltage and internal control system. In this case, thyristors and the control system is to be considered for protection fkom over voltages. Also, over speed and under speed of the prime mover affects the control circuit design. The control system and EM1 filter design also will categorize as main issues for reliability of the power electronic design and stable output voltage.

LITERATURE SURVEY :

- Yoshida et al. proposed PSO for reactive power andvoltage control considering voltage stability. The resultsreveal that the proposed method generates a solution very nearto the global optimum solution.
- Ying-Tung Hsiao presents anoptimum approach for designing of PID controllers using ACO to minimize the integral absolute control error. Theexperiment results demonstrate that better control performancecan be achieved in comparison with conventional PIDmethod.[6]
- Ing-Tung Hsiao proposed a solution algorithm based on the ant colony optimization to determine the PIDcontroller for getting a well performance. Simulation resultsdemonstrate that better control performance can be achievedin controller in AVR system shows that minimize themaximum percentage overshoot, the rise time, the settlingtime and oscillation and step response of AVR system can bechanged.
- Richa Singh (IEEE 2016)-ACO is popular techniquewhich shows behavior of real ant colonies to find solutions to discrete optimization

problems.[13]

- Duan Hai-bin presented a parameter optimization strategy for PID controller using ACOAlgorithm. The algorithm has been applied to thecombinatorial optimization problem, and the results indicatehigh precision of control and quick response.
- Mohd. RozelyKalil, Ismail Musirin proposed Ant Colony Optimization(ACO) technique for searching the optimal point of maximumloadability point at a load bus.
- Hamid Boubertakh, MohamedTadjine, Pierre-Yves Glorennec and Salim Labiod has proposed theory that although conventional PID controllersare the most used in the industrial process, their performancecomparison with known methods.[4]
- Hany M. Hasanien (2013) propose optimization of PID isoften limited when it is poorly tuned and/or used forcontrolling highly complex processes with nonlinearities,complex dynamic behaviors.[3]
- Kiarash, Mehrdad Abedi,(2011) Shuffled frog leaping and particle swarm optimizationthis two algoritm are used to determine optimal PID controllerin AVR system and also shows that for tuning PID controller

Block Diagram

WORKING PRINCIPLE :

An automatic voltage regulator (AVR) for a generator is a crucial component that ensures the generator produces a stable output voltage, essential for powering electrical loads reliably. Its operation revolves around maintaining a constant voltage output despite fluctuations in load or other operating conditions

The AVR functions through a feedback control loop. It continuously monitors the generator's output voltage using a sensing circuit. This sensed voltage is compared to a reference voltage set by the user or predefined by the AVR itself. The difference between the sensed voltage and the reference voltage, known as the error signal, determines the corrective action needed to maintain voltage stability.

Based on the error signal, the AVR adjusts the excitation current supplied to the generator's rotor windings. The excitation current influences the strength of the magnetic field in the generator's rotor, which, in turn, affects the output voltage. By increasing or decreasing the excitation current, the AVR regulates the generator's output voltage to match the desired reference voltage.

Modern AVRs often utilize electronic circuits or microprocessor-based controllers to execute these adjustments swiftly and accurately. They offer features such as voltage droop compensation, overvoltage protection, and transient response enhancement, ensuring optimal performance under varying load conditions.

In summary, an AVR for a generator operates by continuously monitoring the output voltage, comparing it to a reference voltage, and adjusting the excitation current to maintain voltage stability. This feedback control loop ensures that the generator produces a constant and reliable voltage output, essential for powering electrical equipment and protecting sensitive devices from voltage fluctuations.

These functions are generated with the Thing and added at the end of this sketch.

```
const int Pwm_pin = 10;
const int Input_pim = A1;
#include <LiquidCrystal.h>
LiquidCrystal lcd(7, 8, 9, 10, 11, 12);
int analogInput = 0;
float vout = 0.0;
float vin = 0.0;
float R1 = 47000.0;
float R2 = 10000;
// float R1 = 100000.0;
// float R2 = 10000.0;
int value = 0;
int a;
void setup() {
  Serial.begin(9600);
  pinMode(analogInput, INPUT);
  pinMode(Pwm_pin, OUTPUT);
  lcd.begin(16, 2);
  lcd.print("DC VOLTMETER");
}
void loop() {
  value = analogRead(analogInput);
  voltage_read();
  lcd.setCursor(0, 1);
  lcd.print("INPUT V= ");
  lcd.print(vin);
  Serial.print(vin);
  Serial.println(" V");
  a = map(vin, 21, 5, 50, 255),
  analogWrite(Pwm_pin, a);
  delay(500);
}
void voltage_read() {
  value = analogRead(analogInput);
  vout = (value*5.0)/1024.0;
  vin = vout/(R2/(R1+R2));
  if (vin<0.09) {
    vin = 0.0;
  }
};
```

CONCLUSION :

This paper presents a practical design consideration for development of high efficiency and reliable Automatic Voltage Regulator, AVR for renewable energy application. The cost of the equipment will be very low for large scale production. The power electronic controiler developed and tested, can be used to control field excitation and variable speed application EMl filter and half wave controlled rectifier is used for step dawn converter with positive half cycle as power supply for field exciter. The EMI filter and noise suppressor will protect the thyristor from fault triggering when noise comes. In experimental results, the voltage regulation of the synchronous generator reached +2% regulation at 500 W load. And the powa regulator is managed to limit the excitation voltage when under speed and over speed come. The maximum output of the voltage regulator is observed to be 750W.

FUTURE SCOPE :

The Global Automatic Voltage Regulator (AVR) market is anticipated to rise at a considerable rate during the forecast period, between 2023 and 2030. In 2022, the market is growing at a steady rate and with the rising adoption of strategies by key players, the market is expected to rise over the projected horizon.

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