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Time based electricity and load shedding monitoring using embedded systems

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ABSTRACT

Electricity is one of the most important requirements of modern civilization, without which various indispensable applications will bind to bring to a standstill. As we know that demand for electricity is increasing nowadays. So electric utilities prefer load shedding when the demand exceeds the supply. Thus in a distribution system, it needs to be precisely measured for the specific period of time. The Time Based Electricity and Load Shedding Monitoring Using Embedded Systems is a reliable & effective load shedding technique that takes over the manual task of switch ON/OFF the electrical supply with respect to time. It uses a software-based real-time clock (RTC) interfaced to the ARM processor. The paper on "Time Based Electricity and Load Shedding Monitoring Using Embedded Systems" will provide real & competent load shedding techniques such that distribution substation can be monitored & load shedding from one particular place for more than one cities.

Keywords— *Load shedding, Real-time clock (RTC), ARM processor*

1. INTRODUCTION

Load-shedding is a process by which the electrical authority handles the lack of the electrical power being consumed by the society. Shedding is done to minimize the load being consumed by the society through several substations which are connected to the main power station**.** When the frequency of the power generator falls down, it fails to generate the required power. As a result, the authority lacks the scheduled amount of power & this leads the authority to perform a shedding. And the main station orders the sub-stations to cut some of the feeders for a certain period of time & thus the shedding procedure continues. To ensure that the system is stable and available during disturbances, manufacturing facilities equipped with on-site generation, generally utilize some type of load shedding scheme. In recent years, conventional under frequency and PLC based load shedding schemes have been integrated with computerized power management systems to provide an "Automated" load shedding system. It can provide faster and optimal load relief by utilizing actual operating conditions and knowledge of past system disturbances. The main theme behind the proposed method is to develop a computerized procedure for controlling the load-shedding time period in a systematic way so that in the shedding management process, manual work may be minimized. This computerized shedding scheme will be easy to operate and having fewer complexities with a proper user-friendly interface provided with the system.

2. METHODOLOGY

The main purpose of the electric power system is to recognize the power structure to consumer's loads. An electric power system consists of three parts:

1. Power generation
2. Transmission system
3. Distribution system

Electric power is generated at 11kV, 50Hz in a power generating station. For transmitting over long distances, it is stepped-up to 400kV, 220 kV as it is necessary to reduce power losses while transmitting power. Power is carried through a high voltage line of the transmission network. Usually, these voltage lines run into hundreds of kilometers and it delivers to the grid. These load centers (cities) are connected to grid through a sub-transmission network of ordinarily 33kV (or sometimes 66kV) lines. These lines dismiss into a 33kV (or 66kV) at the substation, where the voltage is to be stepped-down to 11kV for power distribution to load points over a distribution network of lines at 11kV and lower.

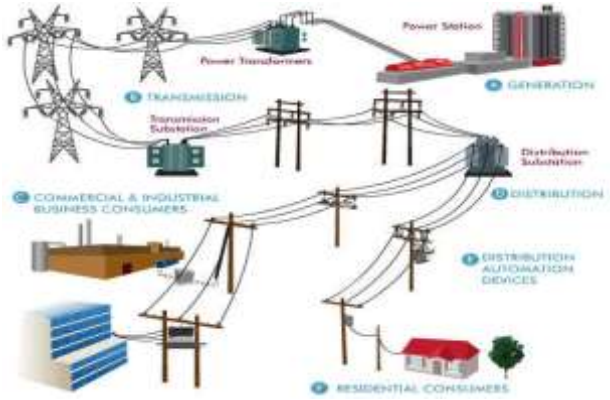

Fig. 1: Power system network

This section depicts a review of a number of effective load shedding techniques which are:

2.1. Manual load shedding technique

In the manual load shedding technique, the power supply is cut by electrician engaged at the substation for a certain period of time to control shortage of electrical energy used by locality. In this way, the load shedding did by manually at the substation to cut off the power supply in a particular locality.

2.2. Programmable load shedding

According to the data from the different chronological demand curves (Figure 2 and Figure 3), the demand for electricity regularly varies throughout a day. It is very difficult to match generating the capacity for such a huge demand. So when demand exceeds the supply we need an effective load shedding technique for the power system.

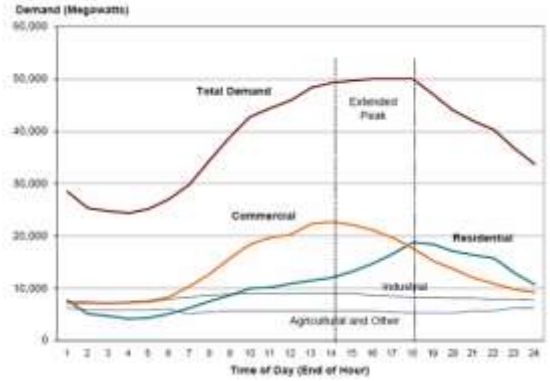

Fig. 2: Electricity Load Curve (For Demand in Megawatts)

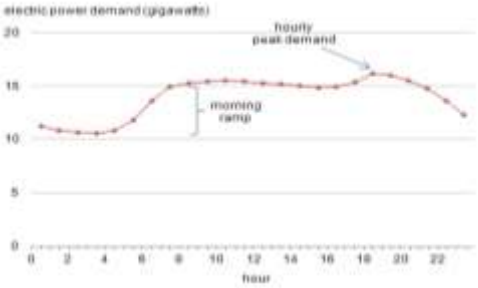

Fig. 3: Electricity Load Curve (For Demand in Gigawatts)

"Time-Based Electricity and Load Shedding Monitoring Using Embedded Systems" is a reliable technique that takes over the manual task of switch ON/OFF the electrical supply with respect to time. It practices software-based real-time clock (RTC) interfaced to an ARM processor. When the set time equals to the real-time, then the ARM processor gives the command to the corresponding relay to turn ON the electric load and then another command to switch OFF the load as per the program. Multiple ON/OFF time entries is the biggest advantage of this project. A Computer-based control System helps to monitor the entire operation. A computer-based GUI (Graphical User Interface) which is also interfaced to the ARM processor provides information about the status of the load which is considered as Cities where the load shedding is carried out.

3. IMPLEMENTATION OF IDEA

This new method is a complete shift from the manual methods being practiced for automation of load shedding systems, in line with best practices. This paper, therefore, seeks to create awareness about the automatic method of load shedding as well as develop a laboratory scale load shedding module to assist teaching and research of power system engineering relating to automatic load shedding among students and researchers.

3.1 Proposed solution

So In this project "Time Based Electricity and Load Shedding Monitoring Using Embedded Systems" we are connecting the loads operating through ARM processor using relay circuits. Here 230V AC supply is rectified to 12V DC which is then converted into input circuit supply of 5V DC with the help of voltage regulator. As we know that in power system relays are used to trip the circuit at a time of any fault or disturbance. So to shed the particular load, relay receives the command from the ARM processor. Input load shedding time is provided through computer keypad. When real-time clock (RTC) set time comes equally to the input load shedding time the ARM processor gives the command to the relay to shed the particular load from the system and finally the shed time can be monitored on the GUI on a computer display.

3.2 Proposed system block diagram

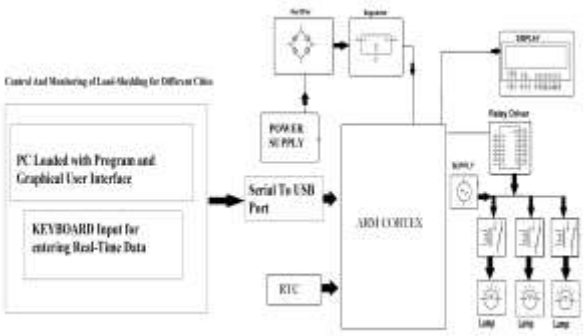

Fig. 4: Proposed block diagram of the system

3.3 Target device

3.3.1 Arduino Due Arm Cortex M3 processor

The Arduino Due is a microprocessor board based on the Atmel ARM Cortex-M3 CPU. It is the first board based on a 32-bit ARM core processor. It has 54 digital input/output pins (of which 12 can be used as PWM outputs), 12 analog inputs, 4 UARTs (hardware serial ports), a 84 MHz clock, an USB OTG capable connection, 2 DAC (digital to analog), 2 TWI, a power jack, a built-in software-based RTC, an SPI header, a JTAG header, a reset button and an erase button. Unlike most boards, the ARM Due board runs at 3.3V. The maximum voltage that the I/O pins can tolerate is 3.3V. Applying voltages higher than 3.3V to any I/O pin could damage the board. The board contains everything needed to support the microprocessor, simply connect it to a computer with a micro-USB cable or power it with an AC-to-DC adapter or battery to get started. Either of the USB ports can be used for programming the board, though it is recommended to use the Programming port due to the way the erasing of the chip is handled. The Native USB port can also act as a USB host for connected peripherals such as mice, keyboards, and smartphones.

3.3.2 Relay Driver

Relay Driver is a high voltage, high current Darlington transistor array comprising seven open collectors Darlington pairs with common emitters. It comprises of NPN Darlington pairs that feature high voltage outputs with communal cathode Clamp diodes for switching inductive loads. The collector current rating of a single Darlington pair is 510 mA. For higher current competences, the pairs can be paralleled.

3.3.3 Single Pole Double Throw SPDT Relay

The Single Pole Double Throw SPDT relay is quite useful in certain applications because of its internal configuration. The Relay consists of a coil, 1 common terminal, 1 normally closed terminal, and one normally open terminal. When the

coil of the relay is at rest (not energized), the common terminal and the normally closed terminal have continuity. When the coil is energized, the common terminal and the normally open terminal have continuity. This relay's operating voltage is up to 12V and the contact is rated up to 30A (250VAC, 30VDC). It can also use it to control high current devices.

3.3.4 LCD

A 16x2 LCD means it can display 16 characters per line and there are 2 such lines present. This LCD has two registers, namely, Command and Data. The command register rations the command directives given to the LCD. A command is an instruction given to LCD to do a predefined job like initializing it, clearing its screen, setting the cursor position, regulatory display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD. Just like most of the presently available electrical devices and home appliances, the project is driven by an onboard power supply containing transformer for AC source, a bridge rectifier to convert to DC source and a voltage controller to get 5V DC source. The power supply will deliver 5V to the Atmel AT89S52.

3.3.5 CP2102 Single Chip USB-To-UART Bridge

The CP2102 is a highly-integrated USB-to-UART Bridge Controller providing a simple solution for updating RS-232 designs to USB using a minimum of components and PCB space. The CP2102 includes a USB 2.0 full-speed function controller, USB transceiver, oscillator, EEPROM, and asynchronous serial data bus (UART) with full modem control signals in a compact 5 x 5 mm MLP-28 package. No other external USB components are required. The CP2102 includes an on-chip 5 to 3 V voltage regulator. This allows the CP2102 to be configured as either a USB bus-powered device or a USB self-powered device.

3.4 Simulation environment

Visual basic 6.0

Visual Basic (VB) is a programming environment from Microsoft in which a programmer uses a graphical user interface (GUI) to choose or modify selected sections of code written in the BASIC programming language. Visual Basic is engineered for building safe and object-oriented applications. Visual Basic enables developers to target Windows, Web, and mobile devices. As with all languages targeting the Microsoft .NET Framework, programs written in Visual Basic benefit from security and language interoperability.

4. OBSERVATION AND CONCLUSION

So according to our observations, the proposed system will overcome the manual efforts to maintain the load shedding scheme. It will minimize a huge amount of manual work and enhance efficiency to the existing manual system. Load shedding is one of the main actions that can be used to prevent further spread of a wide area disturbance and restoration of the load generation balance in a separated part of the system. It can also be concluded that automated techniques in load shedding are more efficient than other methods with respect to fast response, exact load shedding amount and updated load priority list. However, further improvements are still needed.

5. ADVANCEMENT AND FUTURE SCOPE

This project can be upgraded in which the multiple locations can be monitored by one central unit. The relays are used to cut off the supply of concerned geographical region through the circuit breaker. In this system, the user can send commands to concerned DP to read the remote electrical parameters. This system can repeatedly send the real-time electrical parameter data like active power, reactive power, voltage, current, frequency etc., periodically in the form of SMS to the user. It can be designed to send SMS alerts when relay trips. In this power system, the processors are being used to effectively communicate with the sensors. The processor has internal memory to hold the assembly code. This internal memory is used to implement some set of assembly instructions into the processor. The operation of the processor is completely dependent on these assembly instructions.

The proposed system will overcome manual efforts for controlling the load shedding time break in a systematic way by sending SMS. The central unit can cut off the power supply of a specific zone by just sending an SMS to the concerned geographical region. These relay gets activated whenever the electrical parameters cross the predefined values. The proposed system is designed to Load Monitoring in such cases.

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