Design and Implementation of an Industrial Power Monitoring System using RTOS Programming and Wireless Network

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Abstract - In present day's generator on/off, monitoring fuel levels, to check readings, temperature controls are can be done by manually. To go and control generator is time taking process, it is difficult to take readings due to high temperature of the generator. To avoid all these problems proposed system is developed. Manual control of all the tasks can be avoided by wireless control with mobile phones by using Wi-Fi; cool fan can be used to control temperature. To develop and implementation of this design LPC2148 is used to assemble all the tasks with different sensors and to monitor all the tasks RTX kernel programming is used, by using round robin scheduling in RTX kernel we can execute all tasks according to priorities allocated.

Keywords - Wireless network, Real time operating system (RTOS), Android mobile phone, Central monitoring system, ARM microcontroller, Diesel motor pump, cooling fan.

I. INTRODUCTION

In nowadays, we must make use of various high-tech tools and equipments to get our jobs done and make our life comfortable. And the mobile phone is the inseparable part of human lives today. Some products are commercially available in market which allows industrial appliances controlling through internet, Global system for mobile communication, Bluetooth and Zigbee. The advantage of controlling mechanism is the devices controlling and monitoring is available in two modes that is automatic mode and user mode. The proposed system has been designed for mobile phones having Android platform to enable Wi-Fi network which is interfaced with ARM Microcontroller which controls a number of modules like Generator on-off and level sensor like diesel fuel level, Temperature and voltage level, power level and transfers fuel from the main storage tank to the day tank using diesel pump motor is typically electrically operated along with controlling the backup mechanisms. The cooling fan mainly used in generator for purpose of using cooling of generator. When temperature of generator goes high, cooling fan in generator decreases due to heating effect. No security compromise can implement encryption schemes. New appliances can be added anytime to the system, which provides for the reliability of the system. The industrial appliances monitoring and controlling is done wirelessly through Android smart phone using the Wi-Fi feature present in it. The major disadvantage is in conventional generators we cannot monitor the temperature level, diesel level and there is no source to display this level.

II. WI-FI TECHNOLOGY

Wireless Local area network is a technology that allows an electronic device to ex-change data or connects using microwaves in the 2.4 GHz and 5GHz bands. Wi-Fi has established itself as the dominant Wireless Local area network technology and there are no serious challengers on the horizon. The module is based on the Institute of Electrical and Electronics Engineers 802.11 standards. Wi-Fi is more suitable for sensitive applications. It has power saving mechanisms and extended battery life. Support transparent transmission mode as well as multiple network protocols. The Wi-Fi module use is embedded based on the universal serial interface network standard, built-in Transmission control protocol / Internet protocol stack, enabling the user serial port, Ethernet, wireless network (Wi-Fi) interface between the conversions. The modules integrate all of the Radio frequency components required, removing the need to perform expensive Radio frequency design and test. It simply connecting sensors and switches to the module Input/output pins or Universal asynchronous receiver transmitter interface.

III. HARDWARE DESIGN

LPC2148 is used as Micro controller unit in this design. Because of the advanced 32 bit architecture, it can detect changes as low as 3 milli volts and more faster when compared to other 80series micro controllers. Wi-Fi as any wireless local area network product based on the Institute of Electrical and Electronics Engineers 802.11 standards. Wi-Fi is used to monitor and operate the generator through the network. The temperature sensor which is used to monitoring the generator temperature and when the generator temperature exceeds predefined limits it is known through temperature sensor. The fuel level sensor is

continuously monitoring the fuel level of the generator. The generator to maintain the level of fuel and an abnormal decrease in content could indicate fuel is being stolen. Cooling fan is mounted on the generator and it is a primary cooling system. Continuous usage of the generator causes its various components to get heated up. It is essential to have a cooling and ventilation system to withdraw heat produced in the process. Diesel pump motor transfers fuel from the main storage tank to the day tank. The fuel pump is typically electrically operated. So we are implementing a power monitoring system for fuel levels, temperature level, power, voltage level, activation Starting & stopping generator, and transfers fuel from the main storage tank to the day tank using diesel pump motor is typically electrically operated along with controlling the backup mechanisms.
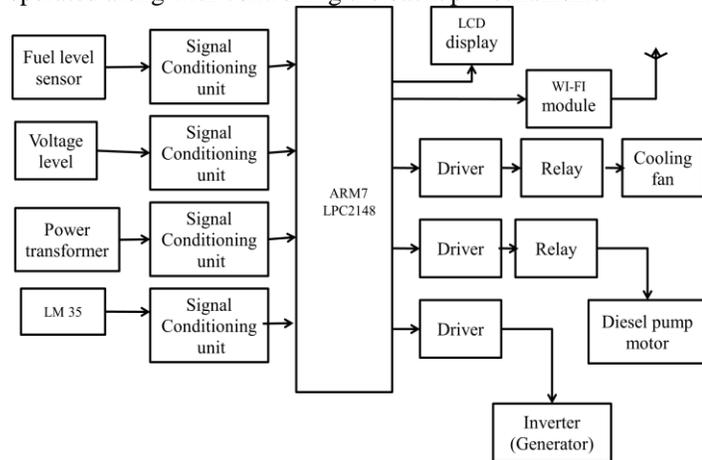

Fig1. Functional block diagram

A. ARM Micro controller

Micro controller is used to control all the peripherals. LPC2148 is used as micro controller unit in this design. Because of the advanced 32 bit architecture, it can detect changes as low as 3 milli volts and more faster when compared to PIC's and other 80series micro controllers. Inbuilt ADC was an added benefit of LPC2148. Hence we used this as our micro controller unit .A Microchip microcontroller LPC2148 is used to collect and process data and then stores it in a serial buffers. The LPC2148 is a 32k instructions program buffers, 512 kb bytes of Read Write Memory, three timers, and a 32 -bit Analog to Digital converter microcontroller. It has reduced instruction set computer architecture and can use oscillators, thus it is ideal to be used as an embedded system.

B. Sensors Used

In this project we are using inverter in the place of generator for demo purpose. LM 35 is the temperature sensor used to measure the temperature of the area which is being monitored. This temperature sensor can operate at a temperature range of -400C to 1250C. A potentiometer is a

three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider. Transformers are used to increase or decrease the voltages of alternating current in electric power applications. The fuel level sensor is continuously monitoring the fuel level of the generator. The generator to maintain the level of fuel and an abnormal decrease in content could indicate fuel is being stolen.

C. Relay

Relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a Low-power signal with complete electrical isolation between control and controlled circuits, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers; they repeated the signal coming in from one circuit.

D. Diesel Pump Motor & Cooling fan

Cooling fan is mounted on the generator and it is a primary cooling system. Continuous usage of the generator causes its various components to get heated up. It is essential to have a cooling and ventilation system to withdraw heat produced in the process. Diesel pump motor transfers fuel from the main storage tank to the day tank. The fuel pump is typically electrically operated. The supply line directs fuel from the tank to the engine and the return line directs fuel from the engine to the tank. For all other common applications, both residential and industrial, a standard radiator and fan is mounted on the generator and works as the primary cooling system.

E. Generator & Inverter

In this project we are using inverter in the place of generator for demo purpose. An electric generator is a device that converts mechanical energy obtained from an external source into electrical energy as the output. Generators have been consist of an energy source, usually a fossil fuel such as diesel, propane or gasoline, which powers a motor attached to an alternator that produces electricity. The motor must run at a constant speed (usually 3600 rpm) to produce the standard current that most household uses require typically 120 Volts AC @ 60 Hertz. If the engine's rpm fluctuates, so will the frequency Hertz of electrical output. Generator is a machine which it converts mechanical energy into electrical energy. Diesel Generator sets are used in synchronization with other power supply sources to act as back up sources.

IV. SOFTEARE DESIGN

The software tools used in designing this monitoring system are Keil UV5, RL-flash magic file, Real time library.

A. RTOS Software description

The powerful Keil RTX Real-Time Operating System designed for microcontrollers based on ARM7™TDMI, ARM9™, and Cortex™-M Central processing unit cores. RTX programs are written using standard C constructs and are compiled with the ARM Compiler. RTX can be configured to use Round-Robin Multitasking or task switching. Round-Robin allows quasi-parallel execution of several tasks.

In a round robin RTOS tasks will run for a fixed period, or time slice, or until they reach a blocking OS call. In this scheme, each task will be allotted a fixed amount of run time before execution is passed to the next ready task. If a task blocks before its time slice has expired, execution will be passed to the next ready task. RTX allows one to create programs that simultaneously perform multiple functions (or tasks, statically management and peripheral management.

The use of a real time operating system represents a more sophisticated design approach, inherently fostering structured code development, which is enforced by the Real time operating system Application Programming Interface. The Real time operating system structure allows you to take an object-orientated design approach while still programming in C.

B. RTOS programming tool

The Keil Microcontroller Development Kit helps us to create embedded applications for ARM Cortex-M processor-based devices. Microcontroller Development Kit Version 5 consists of the Micro controller Development kit Core plus device-specific Software Packs, which can be downloaded and installed based on the requirements of our application. Microcontroller Development Kit Core includes all the components that are needed to create, build, and debug an embedded application. The Pack Installer manages Software Packs that can be added any time to Microcontroller Development Kit Core.

To get access to devices and example projects we should install the Software Pack related to our target device or evaluation board. Other than general embedded C programming in Keil, Real time operating system programming contains events and tasks that helps our application to perform in a more efficient way. Programming part for the application that has done in the Keil is verified and ported to the ARM board using a tool called flash magic. Flash Magic is Windows software from the Embedded Systems Academy that allows easy access to all the features provided by the devices. It provides simple and clear user interface and only obtains access to the selected COM Port when ISP operations are being performed. Top win is another tool to port the program onto the controller board from the Keil. Flash magic allows porting only onto the ARM boards. To dump the program on the microcontroller of 80xx series we have to use top win. In this the Integrated circuits is detached from the Printed circuit board and placed onto the dumping board to dump the program.

C. Flash Magic

NXP Semiconductors produce a range of Microcontrollers that feature both on-chip Flash memory and the ability to be reprogrammed using In-System Programming technology. Flash Magic is Windows software from the Embedded Systems Academy that allows easy access to all the ISP features provided by the devices.
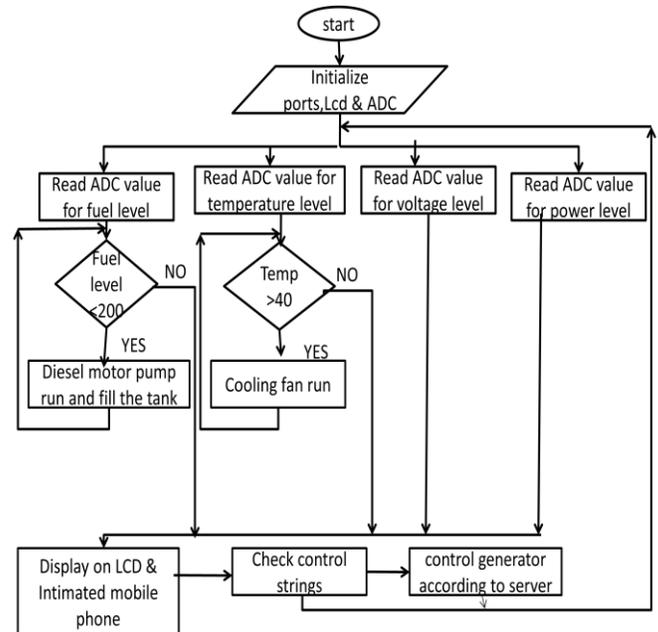
V. FLOWCHART

Fig.2: Following is the working flowchart that describes the overall working procedure of Industrial monitoring system in a step by step manner.

VI. DISCUSSION AND RESULTS

Mobile phones having Android platform to enable Wi-Fi network which is interfaced with ARM Microcontroller which controls a number of suitable on/off switching devices. All high power devices are disconnected in main supply (or) connected to generators which have to activated and monitored manually for fuel levels, starting and stopping of it .The advantage of controlling mechanism is the devices controlling and monitoring is available in two modes that is automatic mode and user mode. The power failure will be detect by relay, and it communicates to Microcontroller to alerts the authorized person. In power system monitoring in emergency and commercial areas like Hospitals, Restaurants, and Industries etc.
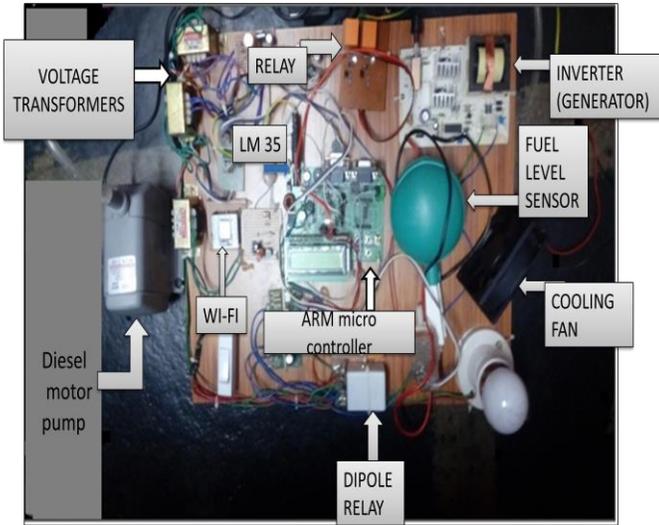
Fig.3: Hardware modules contain inbuilt ARM board, Wi-Fi and sensor values display on LCD.
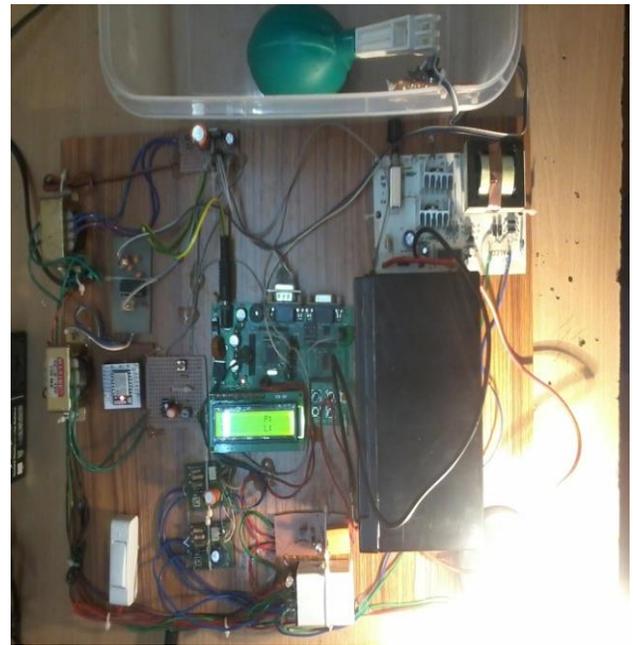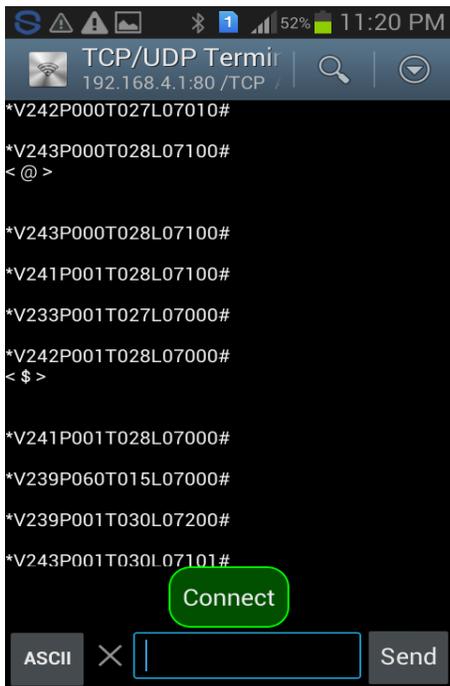

Fig.4: Android mobile to operate switching on/off device by using TCP/UDP terminal front end software it supported to Wi-Fi module.

Fig.5: Generator on/off condition using mobile

VII. CONCLUSION

The performance of any electrical system depends upon system voltage, frequency, rated current and operating temperature. Any violation of these parameters from its desired value leads to malfunctioning of the equipment or damages the system. So it is an engineer's task to maintain these parameters within the permissible limits. Compared to low power devices, the high power device generators can achieve much better performance due to the efficient, economical and highly flexible. In this project both the embedded based micro controller and ADC monitors the parameters and protects the system in abnormal condition. Additionally it continuously records the data which is very useful for the future analysis. Industrial monitoring has recently found more and more acceptance from various industries because of its huge benefits, such as, increased productivity, quality and safety at low costs.

In Future scope, Diesel generators can be rather loud when operating than other generators. Load can be shared among parallel running generators through load sharing while load released if fuel supply decreased.

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