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Simulation of IOT Based Transformer Monitoring and Control System

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Abstract:

In this project, the design aspects of an embedded device which can monitor Distribution Transformer by sending a specific IOT message from a Server are presented. The objective of the project is to control the Distribution Transformer using wireless technology. The scope of the project is to ON, OFF and monitor the parameters like load voltage, Load Current Transformer Oil viscosity and temperature of Distribution Transformer by using IOT. The controller is extremely handy at places where we have to control the ON and OFF switching of the devices but no wired connection to that place is available. IOT controlled Distribution Transformer is automatic control system which is capable of receiving a set of command instructions in the form of internet of things and performs the necessary actions like monitoring, ON and OFF. We use a dedicated modem at the receiver module and send the AT commands using IOT service as per the required actions. The technology allows a distance control of standard equipment due to an intelligent and independent system, providing supervision, alarms and system control applicable to Distribution Transformer.

Keywords: Internet of Things, Embedded, Receiver module, Distribution transformer, Independent system, Temperature, Parameters, Monitoring.

1. Introduction

A distributed transformer networks remote monitoring system(DTRMS) is developed and constructed, for monitor and record the parameters like temperature, oil level status, of a distribution transformer. The system consists of a microcontroller based circuit, with solid-state components for handling sensors, real time clock and data communication module which based on GSM protocol. The system is installed at the distribution transformer site and by measuring above parameters it will help the utilities to optimally utilize transformers and identify problems before any catastrophic failure. Transformer is the key equipment in power system, to ensure its safe and stable operation is important. Transformers either raise a voltage to decrease losses, or decreases voltage to a safe level. "Monitoring" is here defined as on-line collection of data and includes sensor development, measurement techniques for on-line applications. It is very difficult and expensive to construct the communication wires to monitor and control each distribution transformer station.

Here IOT is used for communicating the monitored parameters. The failures of transformers in service are broadly due to: temperature rise, over load, poor quality of LT cables, and improper installation and maintenance. Out of these factors temperature rise, low oil levels and over load, need continuous monitoring to save transformer life.

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The proposed increases the reliability of distribution network, by monitoring critical information such as oil temperature, and oil level of transformer. Data are collected continuously. Monitoring the transformers for problems before they occur can prevent faults that are costly to fix and result in a loss of service life.

2. THE MAIN PARTS OF THE SYSTEM

2.1 The Client-User Interface

The user interface is through web pages that are created on the client-side, using HTML. JavaScript is used for validity checks of the information entered by the users.

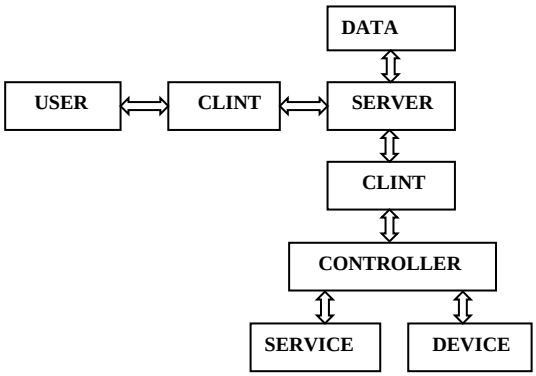
2.2 Server-Side Interface

The server is set-up using the server software of Microsoft's Internet Information Server (IIS). JSP is used for the two-way interaction between the client and the server. A database is created in MS Access for storing the status of each device being controlled and also the profiles of the valid users of the system. SQL is used for writing queries to search through the database and reply to requests sent by the client computer.

2.3 Server-Device Interface

The link between the server and the device is established by connecting the COM port of the server computer to the serial port of the microcontroller inside the device.

2.4 System Overview



2.5 The Client-Server Architecture- How The internet works

The Internet is basically a client-server system. In the retrieval of information that can be accessed using the Internet, there are two important components: client, which requests the information and server, which stores it. Each side requires a piece of software to negotiate the exchange of data. During web page retrieval, at the client side, a browser like Netscape or Internet Explorer is used. The server side software performs the task of negotiating data transfers between clients and servers via Hypertext Transfer Protocol (HTTP) - the communications protocol of the Web. Different server software are available for various operating systems such as Microsoft Internet information Server (IIS) for Windows NT and the Apache web server for Unix platform.

An exchange between the client machine and Web server proceeds in the following manner:

1. The client's browser parses the URL into a number of separate parts, including address, path name and protocol.

2. A Domain Name Server (DNS) translates the domain name the user has entered into its IP address, a numeric combination that represents the site's true address on the Internet (a domain name is merely a "front" to make site addresses easier to remember).

3. The browser now determines which protocol (the language client machines use to communicate with servers) should be used. Examples of protocols include FTP (File Transfer Protocol), and HTTP (Hyper Text Transfer Protocol).

4. The browser sends a GET request to the Web server to retrieve the address it has been given. For example, when a user types http://www.example.com/1.jpg, the browser sends a GET 1.jpg command to example.com and waits for a response. The server now responds to the browser's requests. It finds the necessary files, runs the appropriate scripts, exchanges cookies if necessary, and returns the results back to the browser. If it cannot locate the file, the server sends an error message to the client.
5. The browser, after receiving the HTML file, displays the web page to the user.

2.6 Client-User Interface

The user interface on the client side has been implemented as a series of web pages, where all the requests are made. Using the URL, the user brings up the page, goes through an authentication procedure (to ensure privacy and security), and makes his/her requests. The authentication process makes use of javascripts, which detect wrong inputs at the client side itself. Upon reception of the requests, the server parses and analyzes the request, contacts a database, and carries out the desired operations. As a confirmation process, the server provides the client with a list of all the requested updates for approval before submitting them to the database. Additionally, the server displays a screen indicating the current status of all functioning devices.

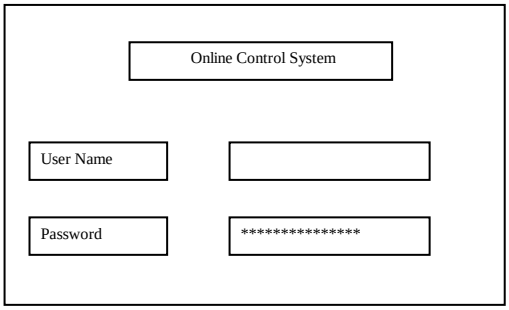
2.7 Creating A User Interface-Using Html

As mentioned above, the user interface is a collection of web pages written in HTML, most of which were created using Microsoft FrontPage. Specific pages have been created for each of the options provided by our system. That is, we have created pages to allow the user to access the device, check the device status, configure the device, get help, and quit.

3. THE VARIOUS WEB PAGES ARE:

3.1 Welcome Page

The welcome page has a short form that will enable the user to log in to the system. The form has text fields for username and password entry. The user has to specify his/her username and password obeying the following rules.



4. CREATING THE DATABASE AT THE SERVER

All the user information and states of the devices are maintained in the database. Tables are created for each user as well as for each device. The table containing user information will be filled using the data from the "New User Registration" form. It will have attributes such as name, address, phone number and birth-date. In these tables, the serial number will be the primary key. In order to reference the device(s) corresponding to each user, we will have an id for each device that will serve as the foreign key. The device states include power and other details.

4.1 Linking Server To The Database

SQL queries are written, which instruct the server to gather the necessary information to reply to requests from clients. In particular, queries are needed for usernames and passwords for authentication purposes. We will also need to write queries to check for the status of the device and to view user information. With SQL commands such as select, delete, insert, and update, we will be able to easily access and manipulate the contents of the database. We will not only be able to look at data in many different ways, but will also be able to specify queries so that only the essential information is visible.

5. CONNECTING CLIENT TO THE SERVER

The **Common Gateway Interface, or JSP,** permits interactivity between a client and a host operating system through the World Wide Web via the Hyper Text Transfer Protocol (HTTP). The name **JSP** is very aptly chosen.

5.1 Common

The idea is that each server and client program, regardless of the operating system platform, adheres to the same standard mechanisms for the flow of data between client, server, and gateway program. This enables a high level of portability between a wide variety of machines and operating systems.

5.2 Gateway

Although a JSP program can be a stand-alone program, it also can act as a mediator between the HTTP server and any other program that can accept at runtime, some form of command-line input (for example, standard input, STDIN, or environmental variables). This means that, a SQL database program that has no built-in means for talking to an HTTP server can be accessed by a gateway program. For example, the gateway program usually can be developed in any number of languages, regardless of the external program.

5.3 Interface

The standard mechanisms provide a complete environment for developers. There is no need for a developer to learn the nuts and bolts of the HTTP server source code. After we understand the interface, we can develop gateway programs; all we need to know in terms of the HTTP protocol is how the data flows in and out. JSP programs go beyond the static model of a client issuing one HTTP request after another. Instead of passively reading server data content one prewritten screen at a time, the JSP specification allows the information provider to serve up different documents depending on the client's request. The JSP specification also allows the gateway program to create new documents on the fly i.e. at the time the client makes the request. Basically JSP is distinguished from plain HTML document in that plain HTML document is static while JSP executes in real time to output dynamic information. JSP scripts are used to supplement basic HTML pages by making our web site more interactive and functional.

GUI IN CONTROL CLIENT

GUI (Graphical User Interface) program is used to interface the central server with control Clint (i.e. Machine attached system) for the purpose of data transfer and serial port interfaces. The GUI constructed with Microsoft .net.

MICROSOFT.NET

Microsoft .NET was an umbrella term that did apply to a wide collection of products and technologies from Microsoft. Now it is only used to refer to the Microsoft .NET Framework and other products no longer has .NET as part of its name unless they are part of the Microsoft .NET Framework for example .NET Passport has changed name to Microsoft Passport Network but ASP.NET still has .NET as part of its name.

VISUAL BASIC.NET

Visual Basic .NET (VB.NET) is an object-oriented computer language that can be viewed as an evolution of Microsoft's Visual Basic (VB) implemented on the Microsoft .NET framework. Its introduction has been controversial, as significant changes were made that broke backward compatibility with VB and caused a rift within the developer community.

The original Visual Basic .NET was released alongside Visual C# and ASP.NET in 2002. C# — widely touted as Microsoft's answer to Java — received the lion's share of media attention, while VB.NET (sometimes known as VB7) was not widely covered. As a result, few outside the Visual Basic community paid much attention to it.

6. GSM (GLOBAL SYSTEM FOR MOBILE COMMUNICATIONS)

GSM is a cellular network, which means that mobile phones connect to it by searching for cells in the immediate vicinity. GSM networks operate in four different frequency ranges. Most GSM networks operate in the 900 MHz or 1800 MHz bands. Some countries in the Americas (including Canada and the United States) use the 850 MHz and 1900 MHz bands because the 900 and 1800 MHz frequency bands were already allocated.

The rarer 400 and 450 MHz frequency bands are assigned in some countries where these frequencies were previously used for first-generation systems.

GSM-900 uses 890–915 MHz to send information from the mobile station to the base station (uplink) and 935–960 MHz for the other direction (downlink), providing 124 RF channels (channel numbers 1 to 124) spaced at 200 kHz. Duplex spacing of 45 MHz is used. In some countries the GSM-900 band has been extended to cover a larger frequency range. This 'extended GSM', E-GSM, uses 880–915 MHz (uplink) and 925–960 MHz (downlink), adding 50 channels (channel numbers 975 to 1023 and 0) to the original GSM-900 band. Time division multiplexing is used to allow eight full-rate or sixteen half-rate speech channels per radio frequency channel. There are eight radio timeslots (giving eight burst periods) grouped into what is called a TDMA frame. Half rate channels use alternate frames in the same timeslot. The channel data rate for all 8 channels is 270.833 kbit/s, and the frame duration is 4.615 ms.

The transmission power in the handset is limited to a maximum of 2 watts in GSM850/900 and 1 watt in GSM1800/1900.

GSM has used a variety of voice codecs to squeeze 3.1 kHz audio into between 5.6 and 13 kbit/s. Originally, two codecs, named after the types of data channel they were allocated, were used, called Half Rate (5.6 kbit/s) and Full Rate (13 kbit/s). These used a system based upon linear predictive coding (LPC). In addition to being efficient with bitrates, these codecs also made it easier to identify more important parts of the audio, allowing the air interface layer to prioritize and better protect these parts of the signal.

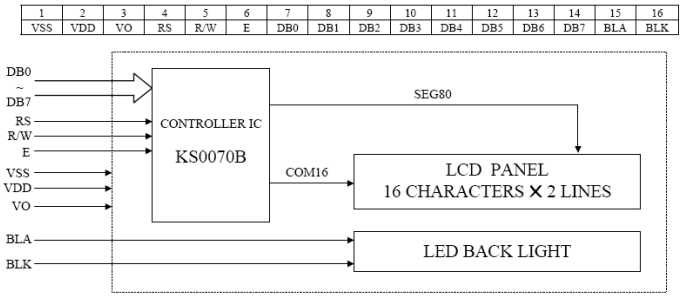
GSM was further enhanced in 1997[12] with the Enhanced Full Rate (EFR) codec, a 12.2 kbit/s codec that uses a full rate channel. Finally, with the development of UMTS, EFR was refactored into a variable-rate codec called AMR-Narrowband, which is high quality and robust against interference when used on full rate channels, and less robust but still relatively high quality when used in good radio conditions on half-rate channels.

There are five different cell sizes in a GSM network—macro, micro, pico, femto and umbrella cells. The coverage area of each cell varies according to the implementation environment. Macro cells can be regarded as cells where the base station antenna is installed on a mast or a building above average roof top level. Micro cells are cells whose antenna height is under average roof top level; they are typically used in urban areas. Picocells are small cells whose coverage diameter is a few dozen meters; they are mainly used indoors. Femtocells are cells designed for use in residential or small business environments and connect to the service provider’s network via a broadband internet connection. Umbrella cells are used to cover shadowed regions of smaller cells and fill in gaps in coverage between those cells.

Cell horizontal radius varies depending on antenna height, antenna gain and propagation conditions from a couple of hundred meters to several tens of kilometers. The longest distance the GSM specification supports in practical use is 35 kilometers (22 mi). There are also several implementations of the concept of an extended cell, where the cell radius could be double or even more, depending on the antenna system, the type of terrain and the timing advance.
Indoor coverage is also supported by GSM and may be achieved by using an indoor picocell base station, or an indoor repeater with distributed indoor antennas fed through power splitters, to deliver the radio signals from an antenna outdoors to the separate indoor distributed antenna system. These are typically deployed when a lot of call capacity is needed indoors, for example in shopping centers or airports. However, this is not a prerequisite, since indoor coverage is also provided by in-building penetration of the radio signals from nearby cells.
The modulation used in GSM is Gaussian minimum-shift keying (GMSK), a kind of continuous-phase frequency shift keying. In GMSK, the signal to be modulated onto the carrier is first smoothed with a Gaussian low-pass filter prior to being fed to a frequency modulator, which greatly reduces the interference to neighboring channels (adjacent channel interference).

7. LCD DISPLAY

Liquid crystal displays (LCDs) have materials which combine the properties of both liquids and crystals. Rather than having a melting point, they have a temperature range within which the molecules are almost as mobile as they would be in a liquid, but are grouped together in an ordered form similar to a crystal.



7.1 **Liquid crystal display**

An LCD consists of two glass panels, with the liquid crystal material sand witched in between them. The inner surface of the glass plates are coated with transparent electrodes which define the character, symbols or patterns to be displayed polymeric layers are present in between the electrodes and the liquid crystal, which makes the liquid crystal molecules to maintain a defined orientation angle.

One each polarisers are pasted outside the two glass panels. These polarisers would rotate the light rays passing through them to a definite angle, in a particular direction When the LCD is in the off state, light rays are rotated by the two polarisers and the liquid crystal, such that the light rays come out of the LCD without any orientation, and hence the LCD appears transparent.

When sufficient voltage is applied to the electrodes, the liquid crystal molecules would be aligned in a specific direction. The light rays passing through the LCD would be rotated by the polarisers, which would result in activating / highlighting the desired characters.

The LCD's are lightweight with only a few millimetres thickness. Since the LCD's consume less power, they are compatible with low power electronic circuits, and can be powered for long durations. The LCD's don't generate light and so light is needed to read the display. By using backlighting, reading is possible in the dark. The LCD's have long life and a wide operating temperature range. Changing the display size or the layout size is relatively simple which makes the LCD's more customer friendly.

The LCDs used exclusively in watches, calculators and measuring in uments are the simple seven-segment displays, having a limited amount of numeric data. The recent advances in technology have resulted in better legibility, more information displaying capability and a wider temperature range. These have resulted in the LCDs being extensively used in telecommunications and entertainment electronics. The LCDs have even started replacing the cathode ray tubes (CRTs) used for the display of text and graphics, and also in small TV applications.

8. OPERATION

When a current flows through the coil, the resulting magnetic field attracts an armature that is mechanically linked to a moving contact. The movement either makes or breaks a connection with a fixed contact. When the current to the coil is switched off, the armature is returned by a force approximately half as ong as the magnetic force to its relaxed position. Usually this is a spring, but gravity is also used commonly in indu ial motor starters. Most relays are manufactured to operate quickly. In a low voltage application, this is to reduce noise. In a high voltage or high current application, this is to reduce arcing.

If the coil is energized with DC, a diode is frequently installed across the coil, to dissipate the energy from the collapsing magnetic field at deactivation, which would otherwise generate a spike of voltage and might cause damage to circuit components. If the coil is designed to be energized with AC, a small copper ring can be crimped to the end of the solenoid. This "shading ring" creates a small out-of-phase current, which increases the minimum pull on the armature during the AC cycle.

A **transformer** is an electrical device that transfers energy between two circuits through electromagnetic induction. Transformers may be used in voltage conversion to transform an AC voltage from one voltage level on the input of the device to another level at the output terminals, to provide for different requirements of current level as an alternating current source, or it may be used for impedance matching between mismatched electrical circuits to effect maximum power transfer between the circuits.
A transformer most commonly consists of two windings of wire wound around a common core to effect tight electromagnetic coupling between the windings. The core material is often a laminated iron core. The coil that receives the electrical input energy is referred to as the primary winding, while the output coil is called the secondary winding.
An alternating electric current flowing through the primary winding (coil) of a transformer generates an electromagnetic field in its surroundings and a varying magnetic flux in the core of the transformer. By electromagnetic induction this magnetic flux generates a varying electromotive force in the secondary

winding, resulting in a voltage across the output terminals. If a load impedance is connected across the secondary winding, a current flows through the secondary winding drawing power from the primary winding and its power source.
A transformer cannot operate with direct current, but produces a short output pulse as the voltage rises when connected to the DC source.

8.1 **Basic principles**

The functioning of a transformer is based on two principles of the laws of electromagnetic induction: An electric current through a conductor, such as a wire, produces a magnetic field surrounding the wire, and a changing magnetic field in the vicinity of a wire induces a voltage across the ends of that wire.
The magnetic field excited in the primary coil gives rise to self-induction as well as mutual induction between coils. This self-induction counters the excited field to such a degree that the resulting current through the primary winding is very small when no load draws power from the secondary winding.
The physical principles of the inductive behavior of the transformer are most readily understood and formalized when making some assumptions to construct a simple model which is called the *ideal transformer*. This model differs from *real transformers* by assuming that the transformer is perfectly constructed and by neglecting that electrical or magnetic losses occur in the materials used to construct the device.

8.2 Ideal transformer

The assumptions to characterize the ideal transformer are:

The windings of the transformer have no resistance. Thus, there is no copper loss in the winding, and hence no voltage drop. Flux is confined within the magnetic core. Therefore, it is the same flux that links the input and output windings.
Permeability of the core is infinitely high which implies that net mmf (amp-turns) must be zero (otherwise there would be infinite flux) hence $I_P N_P - I_S N_S = 0$.

The transformer core does not suffer magnetic hysteresis or eddy currents, which cause inductive loss. If the secondary winding of an ideal transformer has no load, no current flows in the primary winding. The circuit diagram (right) shows the conventions used for an ideal, i.e. lossless and perfectly-coupled transformer having primary and secondary windings with N_P and N_S turns, respectively.

8.3 Insulation drying

Construction of oil-filled transformers requires that the insulation covering the windings be thoroughly dried of residual moisture before the oil is introduced. Drying is carried out at the factory, and may also be required as a field service. Drying may be done by circulating hot air around the core, or by vapor-phase drying (VPD) where an evaporated solvent transfers heat by condensation on the coil and core.

For small transformers, resistance heating by injection of current into the windings is used. The heating can be controlled very well, and it is energy efficient. The method is called low-frequency heating (LFH)

since the current used is at a much lower frequency than that of the power grid, which is normally 50 or 60 Hz. A lower frequency reduces the effect of inductance, so the voltage required can be reduced. The LFH drying method is also used for service of older transformers.

8.4 IR Transmitter & Receiver
Infrared

Infrared radiation (IR) is electromagnetic radiation with a wavelength between 0.7 and 300 micrometres, which equates to a frequency range between approximately 1 and 430 THz.

Its wavelength is longer (and the frequency lower) than that of visible light, but the wavelength is shorter (and the frequency higher) than that of terahertz radiation microwaves. Bright sunlight provides an irradiance of just over 1 kilowatt per square meter at sea level. Of this energy, 527 watts is infrared light, 445 watts is visible light, and 32 watts is ultraviolet light.

RTCs often have an alternate source of power, so they can continue to keep time while the primary source of power is off or unavailable. This alternate source of power is normally a lithium battery in older systems, but some newer systems use a supercapacitor because they are rechargeable and can be soldered. The alternate power source can also supply power to battery backed RAM.

Most RTCs use a crystal oscillator, but some use the power line frequency. In many cases the oscillator's frequency is 32.768 kHz. This is the same frequency used in quartz clocks and watches, and for the same reasons, namely that the frequency is exactly 2^{15} cycles per second, which is a convenient rate to use with simple binary counter circuits.

8.5 Overview

Infrared imaging is used extensively for military and civilian purposes. Military applications include target acquisition, surveillance, night vision, homing and tracking. Non-military uses include thermal efficiency analysis, remote temperature sensing, short-ranged wireless communication, spectroscopy, and weather forecasting. Infrared astronomy uses sensor-equipped telescopes to penetrate dusty regions of space, such as molecular clouds; detect cool objects such as planets, and to view highly red-shifted objects from the early days of the universe.

Humans at normal body temperature radiate chiefly at wavelengths around 12μm (micrometers).[citation needed]

At the atomic level, infrared energy elicits vibrational modes in a molecule through a change in the dipole moment, making it a useful frequency range for study of these energy states for molecules of the proper symmetry. Infrared spectroscopy examines absorption and transmission of photons in the infrared energy range, based on their frequency and intensity.

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8.6 IR Transmitter

An IR light-emitting diode (LED) is a semiconductor diode that emits incoherent narrow-spectrum light when electrically biased in the forward direction of the p-n junction, as in the common LED circuit. This effect is a form of electroluminescence.

An IRLED is usually a small area source, often with extra optics added to the chip that shapes its radiation pattern. LED's are often used as small indicator lights on electronic devices and increasingly in higher power applications such as flashlights and area lighting. The color of the emitted light depends on the composition and condition of the semiconducting material used, and can be infrared (IR LED), visible, or near-ultraviolet. An LED can be used as a regular household light source.

LEDs are produced in an array of shapes and sizes. The 5 mm cylindrical package (red, fifth from the left) is the most common, estimated at 80% of world production. The color of the plastic lens is often the same as the actual color of light emitted, but not always. For instance, purple plastic is often used for infrared LEDs (or IR LED), and most blue devices have clear housings. There are also LEDs in extremely tiny packages, such as those found on blinkies.

IR Receiver

An IR Receiver is a type of photodetector capable of converting light into either current or voltage, depending upon the mode of operation.
IR Receivers are similar to regular semiconductor diodes except that they may be either exposed (to detect vacuum UV or X-rays) or packaged with a window or optical fiber connection to allow light to reach the sensitive part of the device. Many diodes designed for use specifically as a IR Receiver will also use a PIN junction rather than the typical PN junction.

A photodiode is a PN junction or PIN structure. When a photon of sufficient energy strikes the diode, it excites an electron, thereby creating a mobile electron and a positively charged electron hole. If the absorption occurs in the junction's depletion region, or one diffusion length away from it, these carriers are swept from the junction by the built-in field of the depletion region. Thus holes move toward the anode, and electrons toward the cathode, and a photocurrent is produced.

Photovoltaic mode

When used in zero bias or photovoltaic mode, the flow of photocurrent out of the device is restricted and a voltage builds up. The diode becomes forward biased and "dark current" begins to flow across the junction in the direction opposite to the photocurrent. This mode is responsible for the photovoltaic effect, which is the basis for solar cells—in fact, a solar cell is just a large area photodiode.

Photoconductive mode

In this mode the diode is often reverse biased, dramatically reducing the response time at the expense of increased noise. This increases the width of the depletion layer, which decreases the junction's capacitance resulting in faster response times. The reverse bias induces only a small amount of current (known as saturation or back current) along its direction while the photocurrent remains virtually the same. The photocurrent is linearly proportional to the illuminance.

Other modes of operation

Avalanche photodiodes have a similar structure to regular photodiodes, but they are operated with much higher reverse bias. This allows each photo-generated carrier to be multiplied by avalanche breakdown, resulting in internal gain within the photodiode, which increases the effective responsivity of the device.
Phototransistors also consist of a photodiode with internal gain. A phototransistor is in essence nothing more than a bipolar transistor that is encased in a transparent case so that light can reach the base-collector junction. The electrons that are generated by photons in the base-collector junction are injected into the base, and this photodiode current is amplified by the transistor's current gain β (or hfe). Note that while phototransistors have a higher responsivity for light they are not able to detect low levels of light any better than photodiodes.[citation needed] Phototransistors also have slower response times.

9. SIMULATION

MPLAB

MPLAB is a Windows program package that makes writing and developing a program easier. It could best be described as developing environment for some standard program language that is intended for programming a PC computer. Some operations which were done from the instruction line with a large number of parameters until the discovery of IDE "Integrated Development Environment" are now made easier by using the MPLAB. Still, our tastes differ, so even today some programmers prefer the standard editors and compilers from instruction line. In any case, the written program is legible, and well documented help is also available.

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MPLAB CONSISTS OF

- Grouping the projects files into one project (Project Manager)
- Generating and processing a program (Text Editor)
- Simulator of the written program used for simulating program
- Function on the microcontroller.

REQUIREMENTS

- PC compatible computer 486 or higher
- Microsoft Windows 3.1x or Windows 95 and new versions of the Windows

Operating system

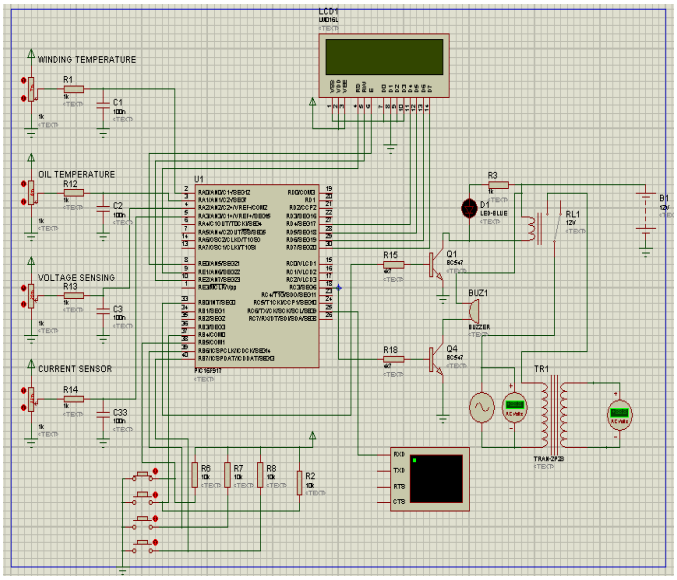
- VGA graphic card
- 8MB memory (32MB recommended).
- 20MB space on hard disc
- Mouse

CCS C

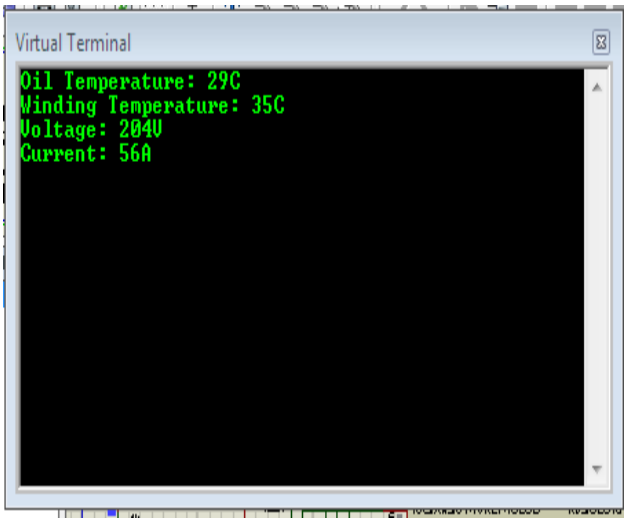
CCS developed the first C Compiler for Microchip microcontrollers to provide software solutions to developers of embedded applications using PIC® MCU and PIC24/dsPIC® DSC devices. CCS compilers are easy to use and quick to learn. For the less experienced programmer, a detailed textbook explaining the C language and how it may be applied to PIC® microcontrollers.

Our compiler products include pro-level optimization, the largest library of built-in functions, powerful PIC® MCU specific pre-processor commands, and ready-to-run programs to quickly jump-start any project. Our massive customer base provides us access to understanding our customer's requirements while developing advanced features with frequent releases and rare bugs.

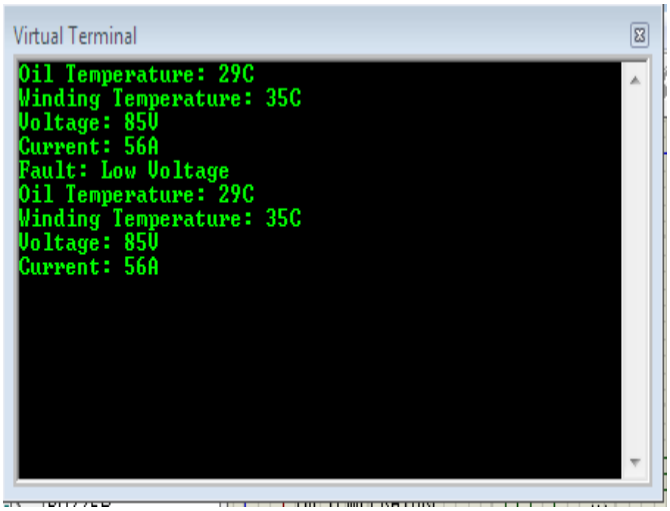
9.1 SIMULATION RESULTS



AT NORMAL



LOW VOLTAGE



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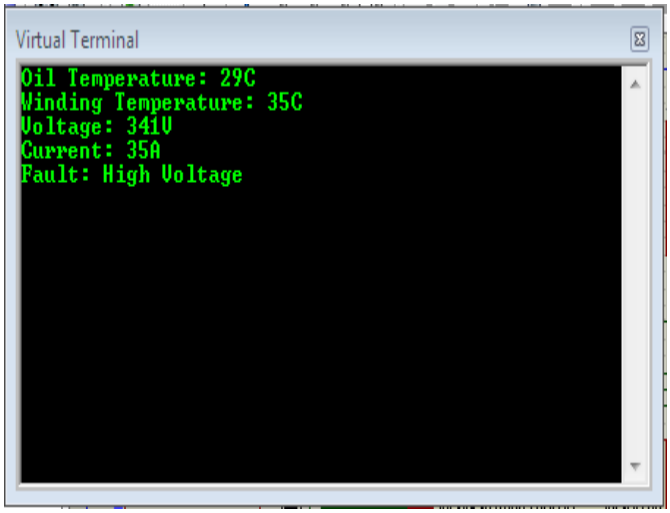
HIGH VOLTAGE



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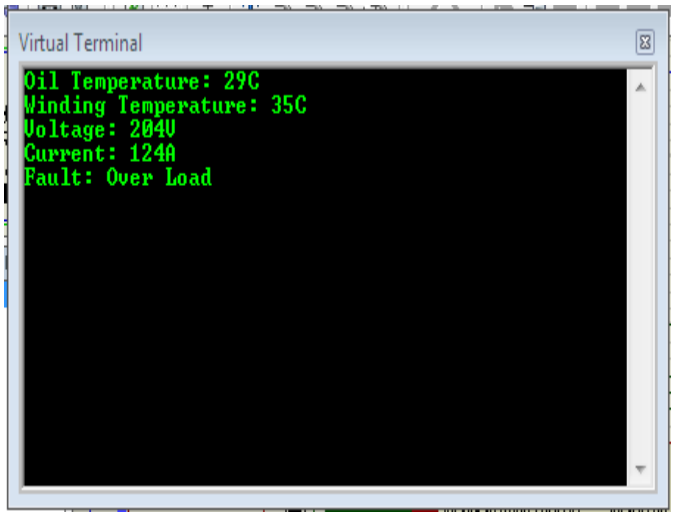

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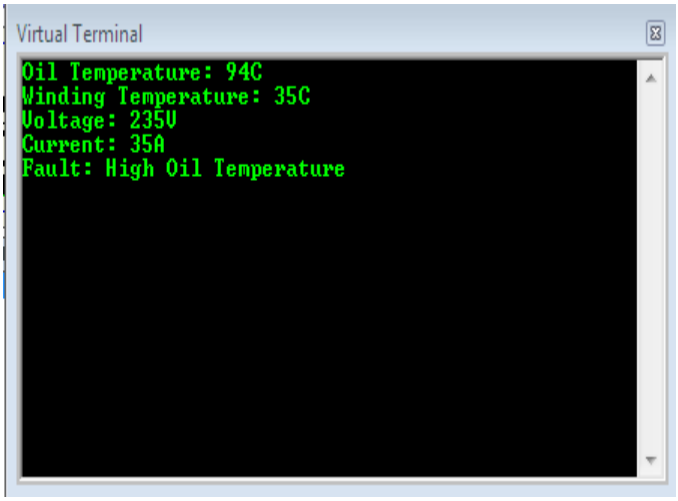
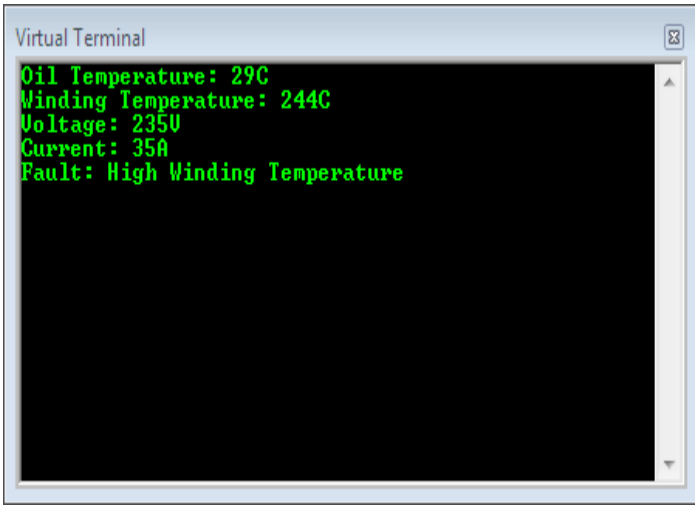


HIGH WINDING TEMPERATUR



10. CONCLUSION

The remote monitoring system that had been developed was very useful in understanding conditions of the transformer. It also enables operators to monitor the parameters away from the transformer. The result of the experimentations showed that the system could handle remote monitoring control tasks for the 10-kVA switchable transformer. The system may contain either embedded IOT or computers or a combination of them. The use of embedded GSM units as a client and a server however provides the most compact system. This system is easy to operate, to maintain, and to reproduce massively with low cost for applications in the fields.

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