Use of DTMF Controller in Distribution Line Protection

Gagari Deb,
Electrical engineering Department,
Tripura University,

Bismoy Roy,
Electrical Engineering Department,
Tripura University,

Roshan Ghosh,
Electrical Engineering Department,
Tripura University,

Abstract

In the age of electronic systems it is important to be able to control and acquire information from everywhere. Although many methods to remotely control systems have been devised, the methods have the problems such as the need for special devices and software to control the system. This paper suggests a method for control using the DTMF tone generated when the user pushes mobile phone keypad buttons. The aim of the proposed system is to design a protection scheme for distribution line. This scheme uses the logic of over voltage relay and over current relay to detect the fault. If there is any fault, then the relay will detect the fault which will be shown as cyan colour in the indicator, where else if there is no fault, the indicator gives green colour indicating no fault. The proposed work has been done in Labview 7.1 software. LabView software was used as a real-talk simulation environment to design and analyze the system.

Keywords—dtmf, fault detection, labview, over current, over voltage.

1. Introduction

Dual-tone multi-frequency (DTMF) is an international signalling standard for telephone digits. These signals are used in touch-tone telephone call signalling as well as many other areas such as interactive control applications, telephone banking, and pager systems. [1]

The remote control technologies have been used in the fields like factory automation, space exploration, in places where human access is difficult. As this has been achieved in the domestic systems partially many corporations and laboratories are researching the methods which enable human to control and monitor efficiently and easily in the house or outdoor. Controlling the domestic system regardless of time and space is an important challenge. As the mobile phone enables us to connect with the outside devices via mobile communication network regardless of time and space, the mobile phone is a suitable device to control domestic systems.

Mobile communication network coverage is larger than that of LANs, thus user can take advantage of mobile phones to control the system.

Dual Tone Multi Frequency (DTMF) technology can be used to control a crane is by a mobile phone that makes a call to another mobile phone attached to the crane's control panel. During the call, if any button is pressed, tone corresponding to that button is heard at the other end of the call. This tone is received through headset which is subsequently used to relay the commands to a Programmable Logic Controller (PLC) that would perform switching action of motors, connected to the moving parts of the crane. With advantages of simplicity, audibility, cost effectiveness & unlimited range the hypothesis is that DTMF could replace Radio Frequency (RF) in simple communications. This paper proposes other application areas, such as Industrial environments, where DTMF is feasible and would be advantageous over RF. In this fashion, direction of motion of the crane can be remotely controlled by a mobile phone by DTMF technology via Global System for Mobile communication (GSM). [2]

IJERT

Switching is achieved by Relays. Security is preserved because these dedicated passwords owned and known by selected persons only. For instance, our system contains an alarm unit giving the user a remote on/off mechanism, which is capable of informing up to five different numbers over telephony network about the nature of the event. [2]

The household electrical gadgets like light, fan, air conditioner, television, pump, refrigerator, washing machine etc can also remotely switch on or off depending on our requirement. The system finds use particularly when a person forgets to switch off the lights, fans etc. before leaving the home. Sometimes, it is required to put on the air-conditioning machine some time before entry into the house, or switch on the lights before entering the locked house. A telephone based remote control system has been devised to power on or off the electrical devices individually. [3]

Concerning the programming language, Using LabVIEW, it is possible to speed up programming considerably as it is designed to take measurements, analyze data and present data to the user. LabVIEW makes it easy to maintain good architecture in the applications because encapsulation and modularity are easy to implement through the use of sub virtual instruments VIs. [4]

This paper proposes a method to control electrical system using a mobile phone, irrespective of the phone model and mobile phone carrier. The system suggested consists of the mobile phone normally registered in communication service and a computer that can receive a call from another phone. Existing methods for control and monitoring, using mobile phones have usage problems because the cost and need for continuous control. One of the disadvantages is being the lack of feedback during the process. This paper proposes to solve the problems of existing methods of control that use simple voice call and SMS. Method proposed uses the DTMF (Dual Tone Multi Frequency) generated when a keypad button of the mobile phone is pressed by the user. The mobile phone user controls the system by sending the DTMF tone to the access point.

2. Dual Tone Multi Frequency (DTMF) and Relay

2.1 Description of the equipment

DTMF means Dual-Tone-Multi-Frequency. DTMF signaling is used for telecommunication signaling over analog telephone lines in the voice-frequency band between telephone handsets and other communication devices and the switching center.

Dual-tone multi-frequency (DTMF) signaling is used in telephone dialing, voice mail, and electronic banking systems. A DTMF signal corresponds to one of twelve touchtone digits and consists of a low-frequency tone and a high-frequency tone. Four low-frequency tones and three high-frequency tones are possible. [5]

The DTMF system generally uses eight different frequency signals transmitted in pairs to represent sixteen different numbers, symbols and letters. When someone presses any key in the key pad of the handset, a DTMF signal is generated. As shown, in Table I (for 12 different numbers or symbols), when someone presses '1', the mixture of 1209 Hz & 697 Hz is generated. Similarly, a mixture of 941 Hz and 1477 Hz shows that the key '#' has been pressed. [3]

2.2 DTMF generation and decoding

A DTMF signal is the algebraic sum of two different audio frequencies, and can be expressed as follows:

$f(t) = A0\sin(2*\Pi*fa*t) + B0\sin(2*\Pi*fb*t) + \ldots\ldots$ (1)

Where fa and fb are two different audio frequencies with A and B as their peak amplitudes and f as the resultant DTMF signal. fa belongs to the low frequency group and fb belongs to the high frequency group.

Each of the low and high frequency groups comprise four frequencies from the various keys present on the telephone keypad; two different frequencies, one from the high frequency group and another from the low frequency group are used to produce a DTMF signal to represent the pressed key.

The amplitudes of the two sine waves should be such that

$(0.7<(A/B)<0.9)V$ (2)

The frequencies are chosen such that they are not the harmonics of each other. The frequencies associated with various keys on the keypad are shown in figure [1]:

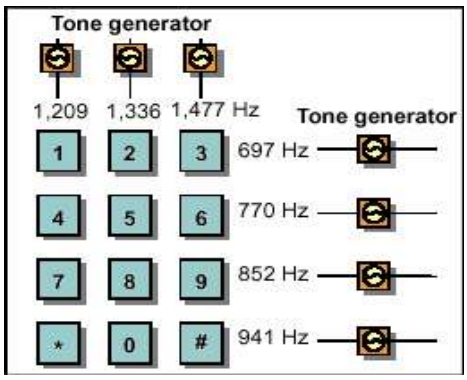

Fig 1:- Phone Keypad

Now by this 12 different Amplitude values there are 12 different range of amplitude using the comparison tool in Labview 7.1. For every individual amplitude

IJERT

range 12 different relays can be operated. The whole scenario will be more clear from the Table shown below :-

Table 1: - For 6 different range of amplitude 6 different relays are operated

Pressed Key	Amplitude Comparison Range	Fault Indicator used
1	2.75 - 2.77	Fault Indicator 1
2	3.11 - 3.13	Fault Indicator 2
3	3.41 - 3.43	Fault Indicator 3
4	2.83 - 2.85	Fault Indicator 4
5	3.19 - 3.21	Fault Indicator 5
6	3.48 - 3.50	Fault Indicator 6

2.3 Over Current Relay

This Relay employs the first and the last terms in the general relay equation i.e. the relay operates when current through it satisfies the condition

$$\mathbf{Q= K_1 |I^2| – K_4 > 0}$$

$$\text{or } |\mathbf{I}| > \sqrt{(\mathbf{K_4/K_1})} = |\mathbf{I_p}| \text{..... (3)}$$

where $|I_p|$ is said to be the pickup value of the relay. Such a relay is an over current relay and would operate in the shortest possible time. The equation (3) can be written as

$|\mathbf{I}|>|\mathbf{I_p}|$..... trip (relay trips the circuit breaker)
$|\mathbf{I}|<|\mathbf{I_p}|$ .....block (relay does not trip the circuit breaker)

The pickup current is expressed as percentage of relays current rating (5A or 1A). In the circuit I is the given current value and I_p is the default value (5A).

2.4 Over Voltage Relay

An over-voltage relay operates when the current produced by a load, or device connected to the output of a circuit, exceeds a predetermined value. The over-voltage relay connects to a transformer, or device that transfers electrical energy from one circuit to another. The relay is calibrated to operate at or over a preset voltage level. When the relay is switched on, one or multiple contacts trip, or opens a circuit breaker. Here in the circuit the preset voltage level is 230V.

The relay operates when the preset value is exceeded.

3. Circuit Diagram

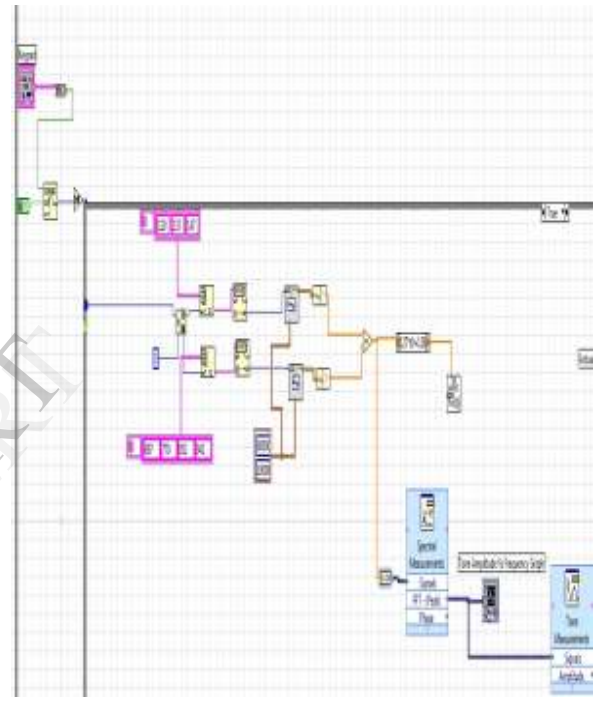

Figure 2(a) : Part 1 of the circuit daigram

IJERT

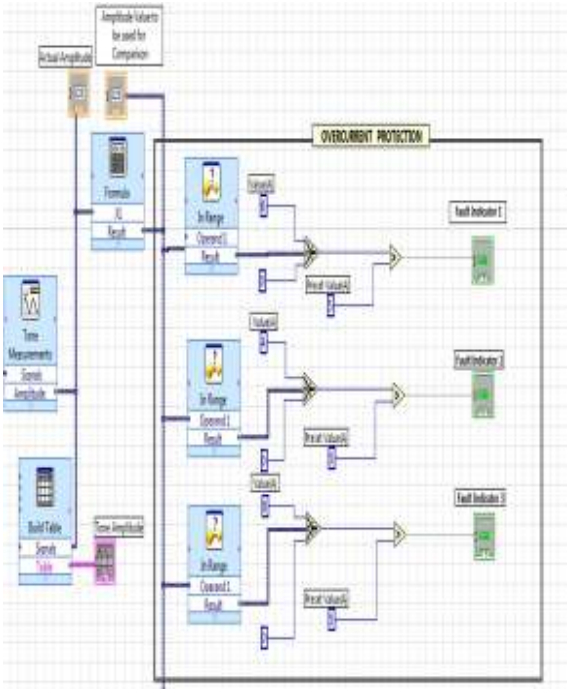

Figure 2(b) : Part 2 of the circuit daigram

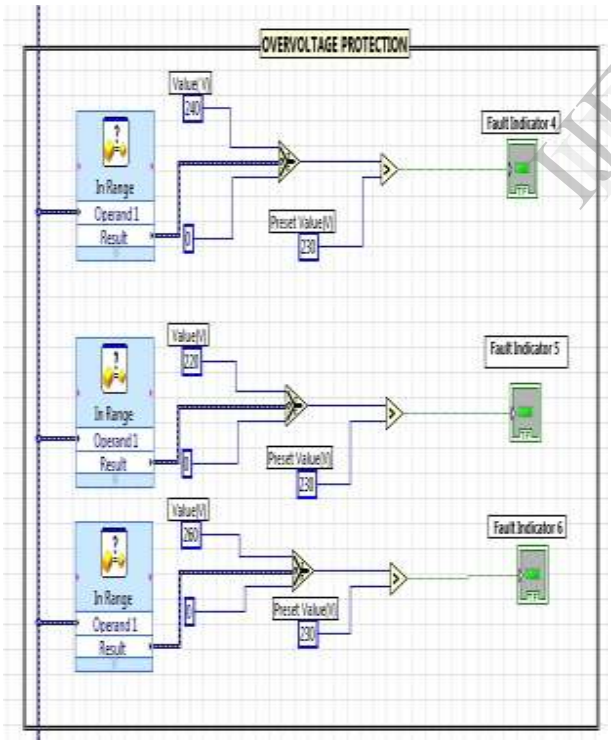

Figure 2(c) : Part 3 of the circuit daigram

When a key is pressed from the keypad then it come to Cluster to array conversion and the value entered by the keypad is converted to array and it enters to a 1-D Array. The output of the 1-D Array enters to the case structure. The result then goes to the Quotient & Remainder function with 3 as divisor. Since the numbers on the keypad are arranged in three columns and four rows, the remainder of this operation becomes the column index, and the quotient becomes the row index. Based on the column and row indices , a high and a low tone value are chosen using two 1D array constants. The low and high tone values are wired to a sine waveform vi to generate a waveform based on the chosen frequencies. Then the desired frequencies is entered to the input of the index array's. Those frequency then are connected to the sine wave generator and the sampling info is also provided. Then the Y (the data values of a waveform) is taken. To connect the Y with sound driver a expression according to the NI standards is used. The Expression is [120*t0+128]. Output of that expression is connected Snd Write Waveform to get connected to the sound driver for getting the dual tone.

The Select operator in Lab View returns the value wired to the true (t) input or false (f) input, depending on the value of s. If s is TRUE, this function returns the value wired to t. And if s is FALSE, this function returns the value wired to f. In the circuit the value for s is always true as the in range operator checks for the amplitude which is in range and gives TRUE signal as output, which in turn returns the value wired to t i.e. the given value.

Then comparison is done to find out if there is any over current in the distribution line. For checking over current in the distribution line, a given preset value of current as 5A. If there is any over current in the distribution line, the comparison box sends a signal to the fault indicator. For checking over voltage in the distribution line, the given preset value is 230V. Then distribution line voltage is taken and compared with preset value. If the voltage is more than 230V, a fault signal is send to the fault indicator and if less than 230V then there is no over voltage and no fault signal is send to the fault indicator.

IJERT

4. Result & Discussion

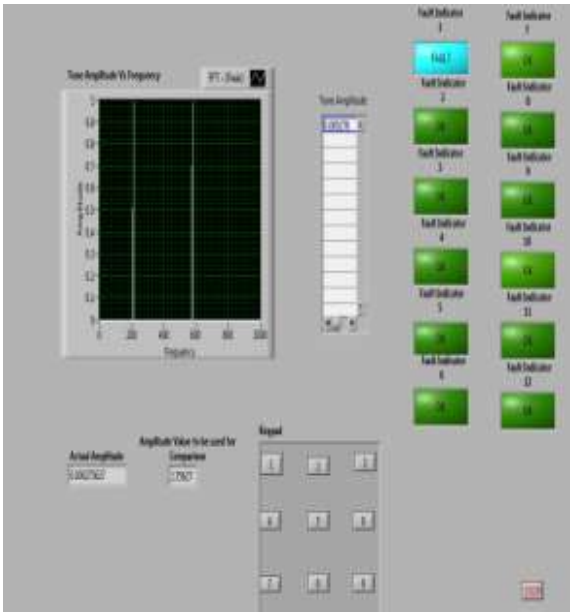

Figure 3(a): Result for pressing the key 1

When key 1 is pressed on the DTMF keypad, comparison is done between the given value and the preset value, which is 5A. As the given value is 6A, which is greater than the preset value, the fault is shown in the indicator. The indicator shows the cyan colour, which is set as default colour for fault.

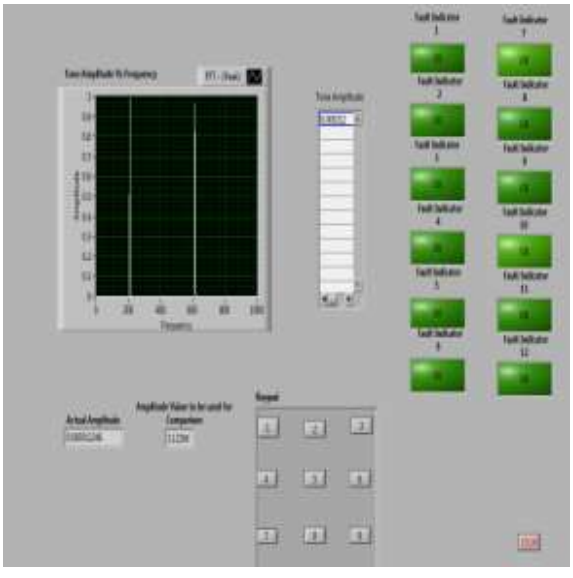

Figure 3(b): Result for pressing the key 2

When key 2 is pressed on the DTMF keypad, comparison is done between the given value and the preset value, which is 5A. As the given value given is 4A, which is greater than the preset value, thus fault is shown in the indicator. The indicator shows the green colour, which is set as default colour for no fault.

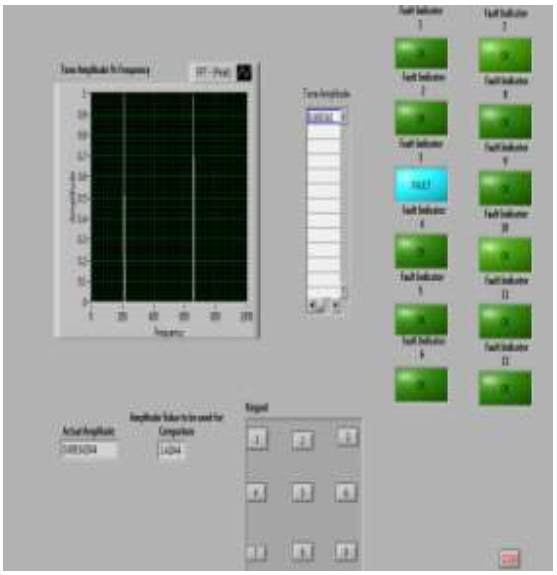

Figure 3(c): Result for pressing the key 3

When key 3 is pressed on the DTMF keypad, comparison is done between the given value and the preset value, which is 5A. As the given value given is 8A, which is greater than the preset value, thus fault is shown in the indicator. The indicator shows the cyan colour, which is set as default colour for fault.

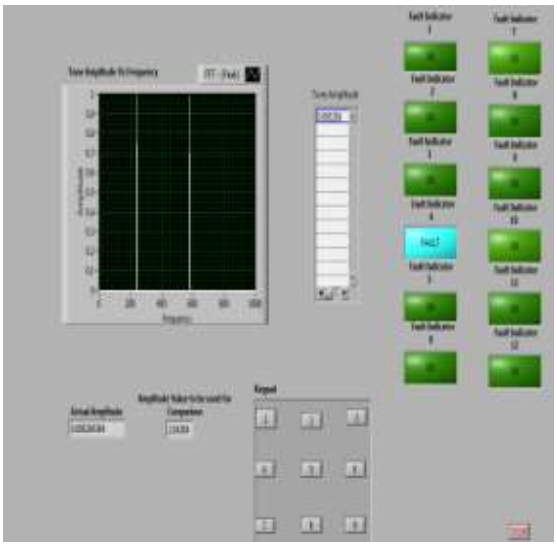

Figure 3(d): Result for pressing the key 4

When key 4 is pressed on the DTMF keypad, a comparison is done between the given value and the

IJERT

preset value, which is 230V. As the given value given is 240V, which is greater than the preset value, thus fault is shown in the indicator. The indicator shows the cyan colour, which is set as default colour for fault.

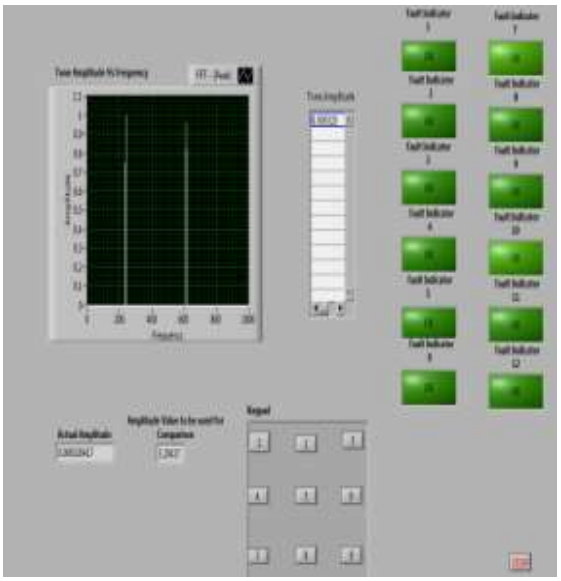

Figure 3(e): Result for pressing the key 5

When key 5 is pressed on the DTMF keypad, a comparison is done between the given value and the preset value, which is 230V. As the given value given is 220V, which is smaller than the preset value, thus no fault is shown in the indicator. The indicator shows the green colour, which is set as default colour for no fault.

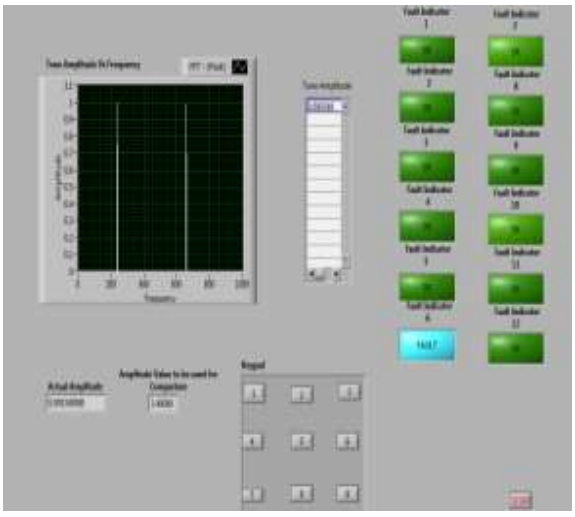

Figure 3(f): Result for pressing the key 6

When key 6 is pressed on the DTMF keypad, a comparison is done between the given value and the preset value, which is 230V. As the given value given is 260V, which is greater than the preset value, thus fault is shown in the indicator. The indicator shows the cyan colour, which is set as default colour for fault.

5. Conclusion

The paper gives a protection scheme for distribution line from over current and over voltage. Here DTMF technology is used for the detection of over current and over voltage in distribution line. If there is any over current or over voltage in the distribution line, then the fault indicator indicates the fault, as cyan colour in the indicator. If not, the fault indicator indicates no fault, as green colour in the indicator. For fault condition the relays can trip the circuit breaker attached to it and protect the distribution line from any damage from over current or over voltage. If there is no fault, the relay does not have to trip. The technology used here is quiet simple, cost effective and can be used by the user from any place, as proposed in the paper. So by using DTMF technology over current and over voltage protection can be done and indicated. Using DTMF differential protection and directional protection can also be done in the distribution lines. Thus by every DTMF keypad switch a number of relays can be used for protection in distribution line.

IJERT

6. References

[1] Guner Arsalan, "*Dual-Tone Multiple Frequency (DTMF) detector implementation*", May 1998.

[2] Sumit Kumar Sengupta, Asif Iqbal, Mahesh Kumar Gupta, "Mobile Controlled Crane using DTMF Technology Via PLC System for Industrial Application & Security", Proceedings published in *International Journal of Computer Applications®* (IJCA,) 2nd National Conference on Information and Communication Technology (NCICT) 2011.

[3] Debapratim Sarkar, Saikat Das Adhikari, "Remote Operation of Household Gadgets Using Mobile Phone", Department of Electronics & Communication Engineering Techno India College of Technology Rajarhat, New Town, Mega City, Kolkata 700 156.

[4] Mohammad K. Abuzalata, "Pulse-Width-Modulation DC Chopper using LabView Software", *American Journal of Applied Sciences* 9 (2): 208-212, 2012 ISSN 1546-9239 © 2012 Science Publications.

[5] Matthew D. Felder, James C. Mason, and Brian L. Evans, Senior Member, IEEE, "Efficient Dual-Tone Multi-Frequency Detection Using the Non-Uniform Discrete Fourier Transform".

[6] D P Kothari, I J Nagrath, *Power System Engineering*, Tata McGraw Hill Publishing Company Limited, New Delhi-110 008, Second Edition, 2008.