Microcontroller Based Speed Control of Induction Motor using Wireless Technology

P. Nagasekhara Reddy

Abstract-Induction motors are the most extensively used motors in most power-driven home appliances, agricultural and industrial applications. Simple and rugged design, low cost, low maintenance and direct connection to an AC power source are the chief advantages of an AC induction motor. Many applications need variable speed operation and one of them is a simple fan load. The DTMF generator which generates the analogue output signal for the corresponding button pressed using key pad. This analogue output is fed to the FM Transmitter and sent through the antenna. At the other end, the FM Receiver picks up the signal and feeds it to the signal decoder, there the decoding takes place and this decoding data is given to the PIC Micro controller. The software in the PIC receives the signal and accordingly drives the SCR Circuit, which in turn is connected to load serially. Simulation of DTMF is carried out using SIMULINK and in the experimental work a prototype model is built through the PIC microcontroller (PIC 16F873) which is used to generate the PWM pulses for speed control of the motor. The main aim of the this paper is to design an real time electronic control system that can be used to control the speed of motors kept at remote locations using an embedded technology.

Index Terms - Induction Motor (IM), DTMF(dual tone multiple frequency), Transmitter, Receiver, Pulse Width Modulation (PWM), Peripheral Interface Controller (PIC), DTMF, wireless technology, Speed control.

I. INTRODUCTION

Many industrial applications require adjustable speed and constant speed for improvement of quality product. The rapid advances in automation and process control, the field of adjustable speed drives continuously growing. Modern Technology offers various alternate techniques in the selection of speed of the drive system [1-2]. The DC Motors was the choice for variable speed drive application until 1980"s.Induction motors are used in many applications such as HVAC, Industrial drives control, automotive control, etc. In recent years there has been a great demand in industry for adjustable speed drives [3-4], fan, pump, Compressors, domestic applications and paper machines etc [5]. Till the initiation of power semiconductor elements and components, the DC Motor had been very popular in the area of adjustable speed motor drives, even though it suffers from many dis-advantages. Due to progress of semi-conductor Technology and advent of Microcontroller has transformed the research and development towards control of AC drives [6]. The microcontroller provides the pulse width variation signal which is given to the SCR driver circuit, which in turn provides the required frequency for the desired speed. Pulse Width Modulation (PWM) is a common technique for speed control which can overcome the problem of the poor starting performance of a motor.

Manuscript received July, 2013.

Mr. P.Nagasekhara Reddy, Sr.Assistant Professor, Department of Electrical and Electronics Engineering,MGIT, Hyderabad-500075, Andhra Pradesh, India

It combines the technique of PWM generation and the control of speed of motor by variable frequency method using microcontroller [7-8]. The basic principle involved in this paper is variable frequency where, the speed can be controlled by using PWM waves generated by PIC 16F873 Microcontroller [9-10]. The input of the motor is 230V, 2.5A (180W). This has lot of domestic and industrial applications in our daily life. The wireless technology also helps the disables, handicapped, paralyzed people and also the elder people used these technology further betterments. The main objective of this paper is to control the speed of the single phase induction motor by variable frequency method using wireless technology by PIC 16F873microcontroller.

II. FUNCTIONAL BLOCK DIAGRAM DESCRIPTION

When the user presses a specific key the DTMF Generator generates the Corresponding DTMF analogue output. This analogue output is fed to the FM Transmitter. The FM Transmitter is initially tuned either to work in the FM range between 88MHZ to108 MHZ. The options are provided to vary the frequency depending on the FM Receiver. Parameter such has amplitude and frequency can be varied by varying the corresponding potential meters. The DTMF provides an output that is combination of two different Frequencies of the specific key pressed. So the output from the FM Transmitter will be the Combination of the carrier frequency and analogue frequency generated by the DTMF IC. At the other end the FM Receiver picks up the signals by tuning in to the carrier frequency Of the FM Transmitter. The output of the FM Receiver is fed to the DTMF Receiver, the Receiver accordingly generates the BCD (Binary coded Decimal) output from this IC. The Output that is digital is fed to the PIC Micro Controller. The PIC is initially programmed with the help of the PIC programmer. This PIC Programmer is connected to the PC through the parallel port. The software is developed using the assembly language of the PIC. This programming is done using the software Called MPLAB. This software is provided by the company called Microchip Incorporation, USA. We have chosen PIC as the Micro Controller because it is has RISC processor.

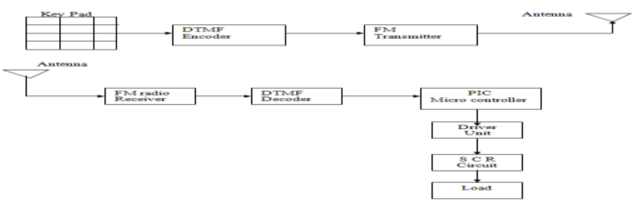

Fig. 1. Block diagram of speed control of induction motor using wireless technology.

The chips come in variety of packages and are very flexible. The main advantages of PIC is it has the data retaining capacity of almost 100 years and secondly all the PIC micro controller are flash micro controller and also occupies very less space and easy to program. Hence the software in the PIC identifies the BCD output from the DTMF Receiver. Accordingly the PIC drives the voltage controller limit consisting of transmitter, SCR's etc., this output is fed to the AC Motor which is given in serial through the power supply. Depending on the button pressed by the user the PIC generated PWM Pulse Width Modulation) that helps to drive the circuit and hence the motor. The small of the pulse width faster the speed of the AC Motor. It depends on the user requirement any different speed can be set and trigger accordingly. This has lot of domestic and industrial applications in our daily life. The wireless technology also helps the disables, handicaps, paralyzed people and also the elder people used this technology further betterments. Thus it increases the overall efficiency of the system and acts to be more users friendly and cost effective in the procurement of these systems.

III. DTMF GENERATOR

The DTMF system uses eight different frequency signals transmitted in pairs to represent sixteen different numbers, symbols or letters. These tones lie within the speech band of 300 to 3400Hz, and are chosen one tone from the higher group and the other from the lower group of frequencies. Each dialed digit is represented by a pair of sine wave tones. A valid DTMF signal is the sum of two tones, one from a lower group (697 to 941Hz) and the other from a higher group (1209 to 1633Hz). Each group contains four individual tones. The DTMF dialing scheme is as shown in Fig.2. The DTMF encoder (UM 91215B) is most widely used to transfer information between radio transceivers and remote control applications in industries. Approximate low and high frequencies tone signals are selected by pressing suitable keys in the key pad. The output of the DTMF encoder is taken out from the tone out pin and this signal is applied to the FM transmitter to transmit the signal in to the medium.

High tone group

Low tone		1209Hz	1336Hz	1477Hz	1633Hz
	697HZ	1	2	3	A
	770HZ	4	5	6	B
	852HZ	7	8	9	C
	941HZ	*	0	#	D

Fig.2. DTMF dialing key pad for generation of tones

IV. FM TRANSMITTER AND FM RECEIVER

This is a small but quite powerful FM transmitter for better modulation. It has an output power of 2 watts and works with 5V DC, which makes it easily portable. This FM transmitter based on BF494 works with a 5V DC and can operate with the frequency range of 80-108MHz. The transmitted signal is Frequency Modulated (FM), which means that the carrier's amplitude stays constant and its frequency varies according to the amplitude variations of the audio signal. When the input signal's amplitude increases (i.e. during the positive half cycles) the frequency of the carrier increases too, on the other hand when the input signal decreases in amplitude (negative half cycle or no signal) the carrier frequency decreases accordingly. The output frequency in the transmitter is adjustable from 80 to 108 MHZ, which is the FM band radio broadcasting frequency range. It receives radio signals transmitted by the FM Transmitter through Jack and the signals are fed to the DTMF decoder. Output of the FM radio receiver is given to DTMF decoder.

V.DTMF RECEIVER

The 8870 DTMF Integrated Receiver a small 18-pin package configuration which operates with 5V power supply. The 8870 internal architecture separates the high and low Tones of the received pair, followed by a digital decode section which verifies both the frequency and duration of the received tones before passing to the output bus. The oscillator generates the stable frequency oscillation to provide DTMF tones. 8870 IC is the DTMF decoder which will decode the DTMF signals transmitted through the FM transmitter. The decoder section employs digital counting techniques to determine the frequencies of the incoming tones and to verify that they correspond to standard DTMF frequencies. When the detector recognizes the presence of two valid tones (this is referred to as the "signal condition" in some industry specifications) the "Early Steering" (ESt) output will go to an active state. The DTMF receiver receives the registered decoded tone pair signals from the FM radio receiver which is received from the antenna. This signal is decoded and is applied to the PIC 16F873 micro controller to drive the motor control circuit to control the speed of the motor at required speed.

VI. PIC MICRO CONTROLLER (PIC16F873)

The PIC architecture is based on a configuration known as a *Harvard machine structure* where separate memories are used for the program and data which are accessed via separate buses PIC is the IC, which was developed to control peripheral devices. The PIC16F873 device is a 28-pin package, 8- bit micro controller that belongs to RISC family having a program memory and data memory. The PIC 16F873 has three ports namely PORT A, PORT B and PORT C. This PIC micro controller has only 35 single word instructions. Using these instructions the software program is written and compiled in a PC and then downloaded to the ROM as machine code. MPLAB is a powerful tool used to simulate and debug the code for a variety of micro controllers. Program can be developed using an Assembly program. This PIC micro controller has a wide operating voltage range of 2.0V to 5.5V. The PIC16F8XX families of devices are CMOS microcontrollers consisting of the PIC16F83, PIC16C83, PIC16F84, PIC16C84, PIC16F87X and PIC16LF8X types. CMOS technology offers a number of advantages over other technologies such as they consume very less power, operate over quite a wide voltage range and have quite electrical noise.

VII. POWER SUPPLY CIRCUIT

Generally speaking, the correct voltage supply is most important for the proper functioning of the micro controller system. For a proper function of any micro controller, it is necessary to provide a stable source of supply when you turn it on. The power supply circuit for powering the microcontroller is shown Fig.3. In order to function properly, or in order to have stable 5V at the output, the input voltage on pin 1 of LM7805 should be between 7V to 24V. Depending on current consumption of device we will use the appropriate type of voltage stabilizer LM7805. There are several versions of LM7805. For current consumption of up to 1A we should use the version TO-220 case with the capability of additional cooling.

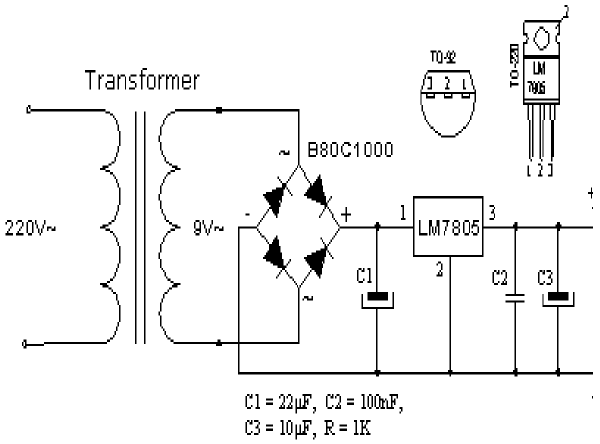

Fig.3. Power supply unit for the microcontroller, Transmitter and receiver unit

VIII. CONTROL CIRCUIT

The connection diagram of Motor control circuit from the PIC microcontroller is shown in Fig 4.

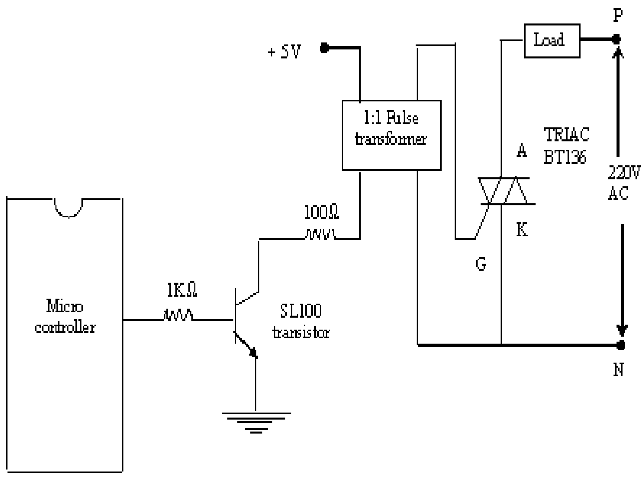

Fig.4. SCR drive and control circuit

The PIC micro controller, according to the key pressed in the DTMF keypad, generates the PWM signals. This PWM signals are fed to the transistor base for switching action. When pulse is given to the transistor from the micro controller +5V is coupled to the gate of the triac through the pulse transformer and hence the firing angle is varied depending on the t_{ON} of the pulse fed to the transistor base. By varying the t_{ON} and t_{OFF} of the pulse fed from the micro controller to the transistor the firing angle of the triac is varied and hence the speed variation of the AC motor. The pulse transformer is used to isolate the 220V supply, so as to protect the PIC micro controller. The software in the PIC will decode the digital data obtained from the DTMF Receiver. After decoding the data it will check for the password. If it found to be correct, it will give a short beep. Once the password is correct it takes the command from the user, and depending on the command received by the user the PIC will accordingly generate a Pulse Width Modulation output at a fixed known frequency. As the user presses different buttons the PIC decodes the same and generates the frequencies as required by the user. This PWM Output is connected to the signal conditioning circuit and to the load.

ALGORITHM:

Step 1: start
Step 2: initialize all ports
Step 3: check for the password
Step 4: if passwords if correct then check for the key.
Step 5: scan all the keys
Step 6: if key selected =1 run machine at 300 rpm.
Step 7: if key selected =2 run machine at700 rpm.
Step 8: if key selected =3 run machine at 1000 rpm.
Step 9: if key selected =4 run machine at 1200 rpm.
Step 10: if key selected =5 stop the machine otherwise go to loop.
Step 11: to come out of the loop press key=66
Step 12: check again for password.

Hence, depending on the frequency the motor rotates obtaining various speeds as specified by the user. From experimental results it is evident that Micro controller based remote speed control scheme provides satisfactory performance and the speed of the drive can be varied over a wide range by changing the reference speed setting.

IX. EXPEREMENTAL VALIDATION

This paper concerned on the experimental studies on simple motor load for speed control using wireless Technology through the microcontroller. The experiment is conducted by placing motor at a distance of about 20-25 meters and tested the motor to obtain various speeds by pressing the different keys in the keypad. Here t_{ON} is maintained constant and t_{OFF} is varied accordingly.

Selected key	Frequency	Speed of the motor drive
1	80 Hz	300 rpm
2	148.58 Hz	700 rpm
3	259.7Hz	1000 rpm
4	414.9Hz	1200 rpm

he Transmitter section and Receiver section for speed control of AC Motor using wireless technology is shown in Fig .5 and Fig.6 respectively.

The speed of the motor for various keys selected in key pad is shown in table 1. The generated pulse pattern for various speed of the motor drive is shown from Fig.7 to Fig.10.

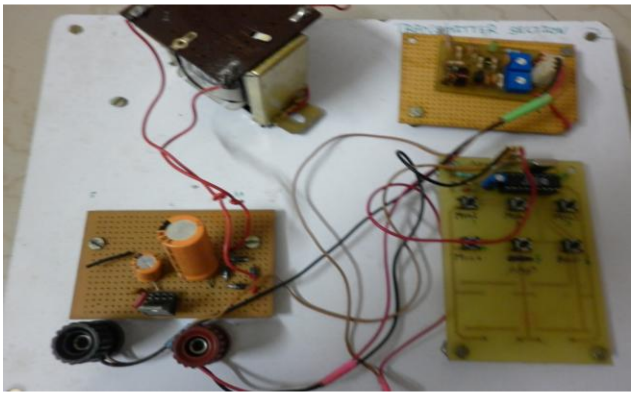

Fig.5.Transmitter section for speed control of Induction motor using wireless technology

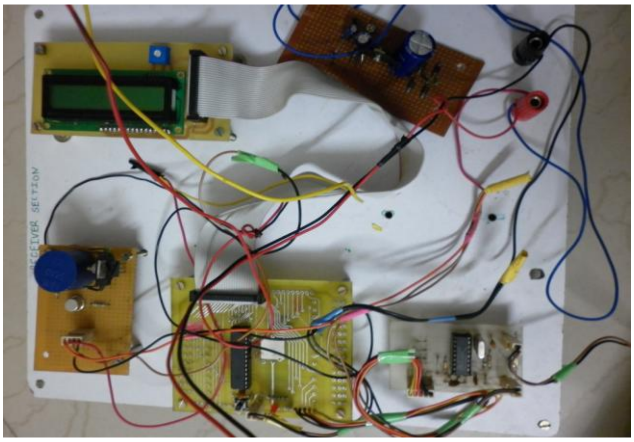

Fig.6. Receiver section and Drive circuit for speed control of Induction motor using wireless technology

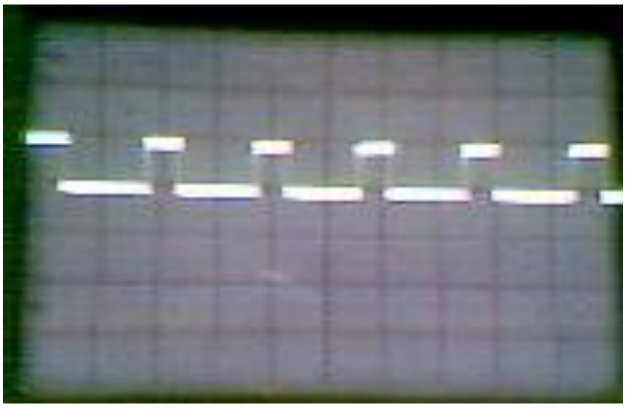

Fig.7.Pulse pattern for a speed of 300 rpm

Fig.8.Pulse pattern for a speed of 700 rpm

Fig.9.Pulse pattern for a speed of 1000 rpm

Fig.10.Pulse pattern for a speed of 1200 rpm

X. CONCLUSION

This is the one of the method in controlling the speed, which is employed for AC motor drives. The speed control of AC Motor is performed using wireless technology by the PIC 16F873 microcontroller. It has high reliability and long life at low cost and compact. The experimental results are analyzed and, it's found that the speed of the induction motor is controlled in Normal, step up, step down speed requirement smoothly using wireless technology keeping 22 meters as the distance between transmitter and receiver section.

REFERENCES

1. Rakesh Parekh (2003). AC Induction Motor Fundamentals. Microchip Technology Inc.
2. Seyi Stephen OLOKEDE, 2008. Design of a Clap Activated Switch. Leonardo Journal of Sciences ISSN 1583-0233
3. Muhammad H. Rashid: "Power Electronics Circuits, Devices & Application" PHI, New Delhi,2001
4. W. Leonhard, Control of Electrical Drives, Springer-Verlag Berlin Heidelberg, New York, Tokyo, 1985.
5. B.K. bose, "Adjustable speed AC drives – A technology status review", IEEE transaction, Vol.70, No.2, PP-116-33, Feb-1982.
6. V.K. Varma & Dr. Promod Agarwal, Short term summer course on "Micro controlled A.C. drives" University of Roorkey (U.P.) – April – 1995.
7. R.Saravanan and F.X.Edwin Deepak, "development of single phase induction motor adjustable speed control using pic-16f877 microcontroller" International Conference on Computing and Control Engineering (ICCCE 2012), 12 & 13 April, 2012.
8. Microchip Technology, 2001, PIC16F877A Data sheet, www.microchip.com.
9. Minas, G., Martins, J.S. & Couto, C. (1999). A Microcontroller Based Voltage Space Vector Modulator Suitable for Induction Motor Drive. *IEEE International Symposium, 2, 469 – 473*.
10. Padmaraja Yedamale. (2002). Speed Control of 3-Phase Induction Motor Using PIC18 Microcontrollers. Microchip Technology Inc.

AUTHORS PROFILE

Mr.P. Nagasekhar Reddy received his M.Tech degree from Jawaharlal Nehru technological University, Hyderabad, India in 2005. He is presently working as Sr. Assistant Professor, MGIT, Hyderabad. Also, he is pursuing his Ph.D from Jawaharlal Nehru technological University, Hyderabad, India. He published 19 research papers in various international journals and conferences. His research interests include PWM techniques and control of electrical drives.