Design and Development of Wireless Single Phase Induction Drive using DTMF Technology

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Abstract : **The main theme of this paper is, designing and monitoring of wireless single phase induction drive using unipolar SPWM switching pulses which are controlled through DTMF technique. The SPWM is a special type of pulse width modulation in which, the width of the pulses are not identical. This is digital technique for single phase full bridge inverter. The use of the microcontroller makes the system flexible through which it is possible to change the real-time control algorithms without further changes in hardware. It will reduce the overall cost and has a small size of control circuit for the single phase full bridge inverter. As the system is wireless; it reduces the human efforts and increases the efficiency and effectiveness of the system. The system is capable to turn ON and OFF the motor, as well as it also controls the number of pulses per half cycle in PWM gating signal using DTMF decoder. It also monitors the current and speed of the motor and displays it on LCD. The system is built around the PIC microcontroller, where the DTMF decoder is interfaced with microcontroller for wireless communication. The use of microcontroller will reduce the hardware components and helps in writing the control algorithm.**

Keywords: **Wireless monitoring, SPWM, PIC microcontroller, DTMF decoder, communication.**

1. INTRODUCTION

Single phase induction motor has been used widely in discipline industry and household where a simple motor starter can't let vary speed in starting and also running with mechanical load [1-4]. The single phase motors are simple in construction and easy to implement the software for control applications. The single phase microprocessor and computer control of induction motor implemented by various researchers [5-7], however three phase control scheme is given by Vlatkovic and et.al [8Online monitoring and parameter estimation of induction motor

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has proposed by kumbhar and et.al [9,10], while harmonic reduction schemes are represented by Krishnamoorty and et.al [11] for power control drives [12]. May authors also implemented the various SPWM schemes [17-21],] The main idea of this research article is to control the SPWM gating pulses of an AC motor drive by wireless communication using DTMF decoder technique which is implemented by an embedded controller [13]. In case of DTMF technique, every key is having a unique tone, which is decided by combination of keypad's column frequency and row frequency. The DTMF decoder splits the frequencies and then it converts the frequencies in to binary values. Hence the induction motor is controlled by pressing the different keys from the users mobile unit.

In receiver section the mobile phone is interfaced with DTMF (Dual Tone Multi Frequency) decoder, the decoder detects the signal and then the decoded information is transferred to the microcontroller unit. The controller unit controls induction motor with the help of control circuit [14].

The system is designed around the PIC microcontroller which is commonly used in embedded applications for computing and smart decision-making capabilities to machines, products, and processes. Microcontrollers are capable to interact with electrical or electronic devices, sensors and actuators to automate systems. The MikroC software, by Microchip is used for debugging the source code of PIC microcontroller and simulated in PIC simulator IDE [15].

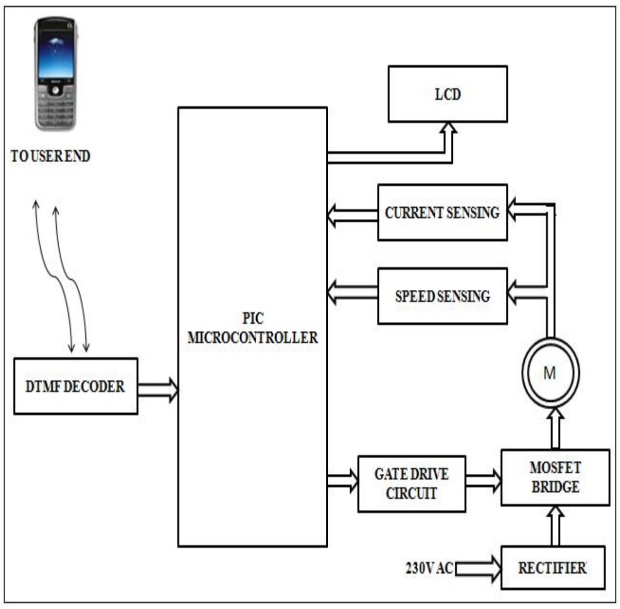
PIC 18F4550 is used for experimental purpose having 40 pin, High-Performance, Enhanced Flash, USB Microcontrollers with nanoWatt Technology [16].

2. BLOCK DIAGRAM AND METHODOLOGY

Figure 1 shows an overall system block diagram to control the MOSFET bridge inverter fed single phase induction motor drive using DTMF decoder.

The research work presents the designing and development of a wireless embedded system around PIC microcontroller 18F4550 to monitor the parameters of induction motor. DTMF technique is used in which the number keys 1 and 2 are used to turn ON and OFF the motor respectively, keys 3,5 and 7are used to generate PWM gating pulses**.**

To detect the motor parameters, the current transformer with shunt wire arrangement is used for current measurement and opto-interrupter device which provides the single pulse per revolution is used for speed measurement. At the same time these parameters are displayed on LCD



3. HARDWARE ENVIRONMENT

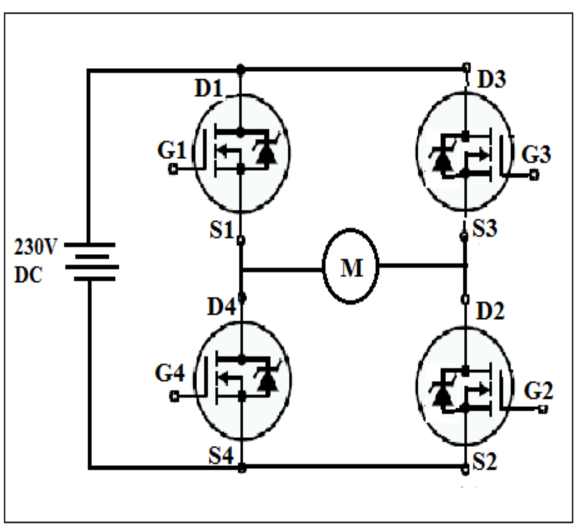


Fig.2 H-Bridge Inverter

The H-Bridge circuit that we are using consists of four power MOSFET‘s which act as fast switching devices. This H-bridge uses MOSFET‘s to improve the efficiency of the bridge. The power MOSFET used for the H-BRIDGE inverter is IRFP450. A special purpose IC IR2110 is used to drive the H-BRIDGE. Each IC can drive one top side MOSFET and bottom side MOSFET in sequence S_1, S_2 and S_3, S_4.

4. BRIEF DISCUSSION OF DTMF DECODER

The DTMF decoder; M-8870 is used for wireless communication. It is a full DTMF Receiver that integrates both band split filter and decoder functions into a single 18-pin DIP or SOIC package, manufactured using CMOS process technology. The M-8870 offers low power consumption (35 mW max) and precise data handling. The M-8870 decoder uses a digital counting technique to determine the frequencies of the limited tones and to verify that they correspond to standard DTMF frequencies [21].

In the course of a call, if any button is pressed, a tone corresponding to the button pressed is heard at the other end of the call. This tone is called "Dual Tone Multiple-Frequency" (DTMF) tone. The received tone is processed by the microcontroller with the help of DTMF decoder. Use of a mobile phone for motor control can overcome limitations which can be faced in RF based technique. It provides the advantage of robust control, working range as large as the coverage area of the service provider, no interference with other controllers and up to twelve controls [22]. Table 1 shows the functional decode table of MT8870.

F_{LOW}	F_{HIGH}	KEY	TOW	Q_4	Q_3	Q_2	Q_1
697	1209	1	H	0	0	0	1
697	1336	2	H	0	0	1	0
697	1477	3	H	0	0	1	1
770	1209	4	H	0	1	0	0
770	1336	5	H	0	1	0	1
770	1477	6	H	0	1	1	0
852	1209	7	H	0	1	1	1
852	1336	8	H	1	0	0	0
852	1477	9	H	1	0	0	1
941	1209	0	H	1	0	1	0
941	1336	*	H	1	0	1	1
941	1477	#	H	1	1	0	0
697	1633	A	H	1	1	0	1
770	1633	B	H	1	1	1	0
852	1633	C	H	1	1	1	1
941	1633	D	H	0	0	0	0
-	-	ANY	L	Z	Z	Z	Z
L = logic Low, H = Logic High, Z = High Impedance							

Table 1. Functional decoder table

5. SOFTWARE ENVIRONMENT

The source code for PIC is generated in MikroC which is a full-featured C compiler for PIC microcontrollers from Microchip [15].

The figure 3 shows the actual software flow of the system. The microcontroller is initialized by declaring the input and output ports. When user makes a call to the mobile which is set at auto-answering mode and interfaced with the microcontroller, the signal is received through DTMF decoder. When the user will press key '1' on his mobile then the DTMF decoder will detect the corresponding signal and it will send decoded information towards the microcontroller. The microcontroller will generate single gating PWM pulse as per the received information for firing the bridge inverter through which the motor is turned ON. When key 3 will be pressed then microcontroller generates 3 pulses per half cycle of PWM gating signal. Similarly when keys 5 and 7 are pressed then microcontroller will generate 5 pulses and 7 pulses per half cycle of gating signal respectively. Finally when key 2 is pressed then gating pulses are removed and motor is turned OFF.

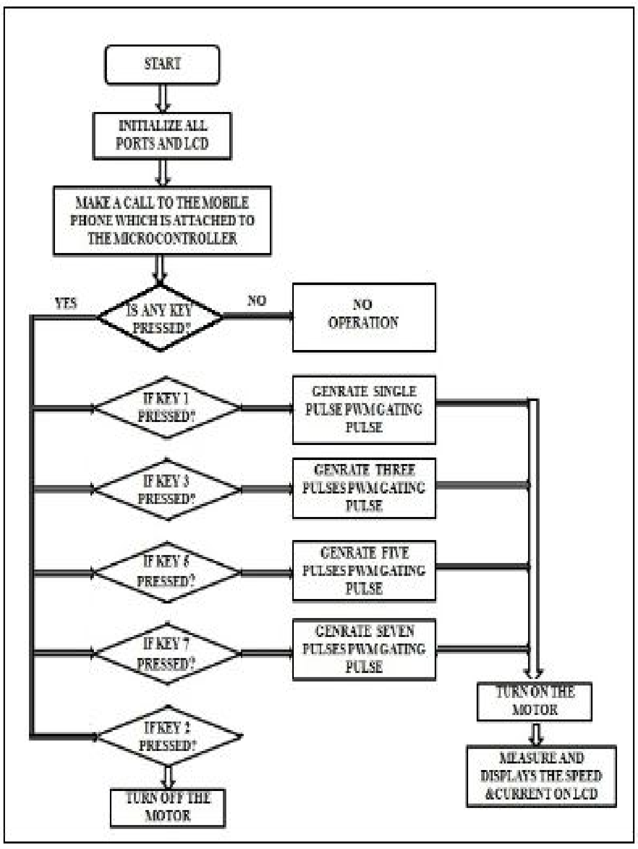


Fig. 3 Software flow of the system

6. RESULT AND CONCLUSION

The opto-coupler is used for the speed sensing. The disk contains one hole at its periphery. As the disk rotates and for every rotation one pulse is produced which is sensed by the sensor and the using the software speed of the induction motor drive is displayed on the display. The fig 4 shows the voltage-speed graph of induction motor.

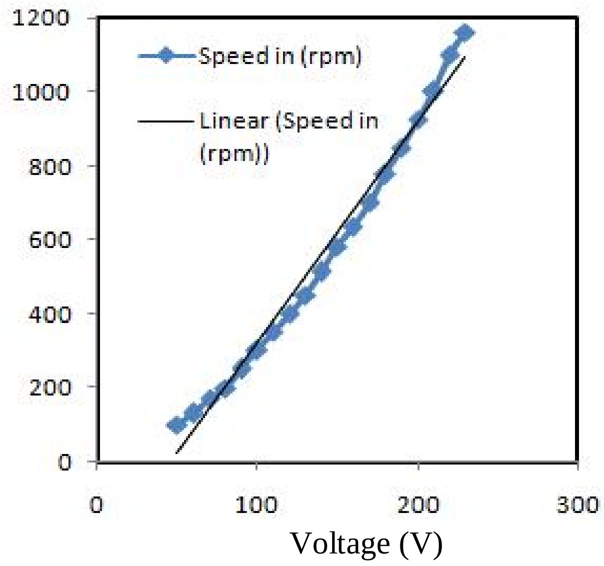


Fig.4. Speed voltage characteristics

From the above figure it is seen that the increase in the input voltage will also increases the speed of the induction motor. The trend line and the actual speed of the drive shows that the variation is not linear. This is due to the losses in the machine and the harmonics in the power supply. For better performance the supply must be free from the harmonics and software will help to display the correct speed on the display. The current sensing arrangement consists of the shunt wire in series with the motor winding across which the output is given to the buffer amplifier or isolation transformer. The proportional output will be scaled into the current on the display. Initial reading needs some correction which is applied through the software to get the correct reading.

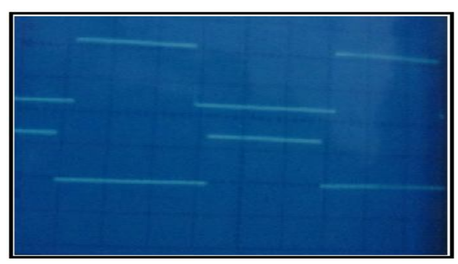


Fig.4a. Photographs of Single PWM with Resistive Load

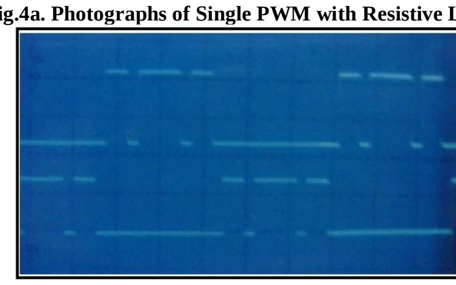


Fig. 4b.S Photographs of three PWM with Resistive Load

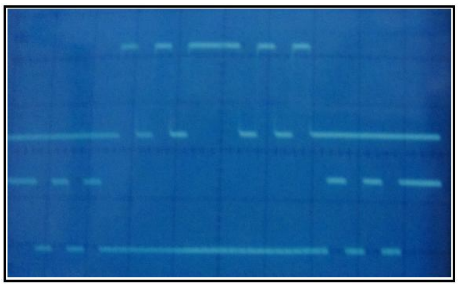


Fig.4c. Photographs of five PWM with Resistive Load

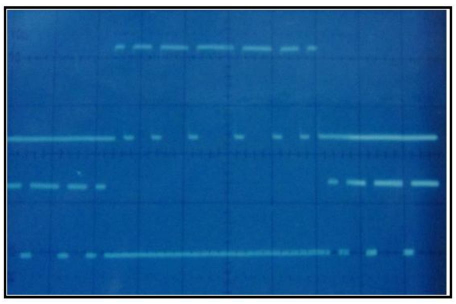


Fig.4d. Photograph of seven PWM with Resistive Load

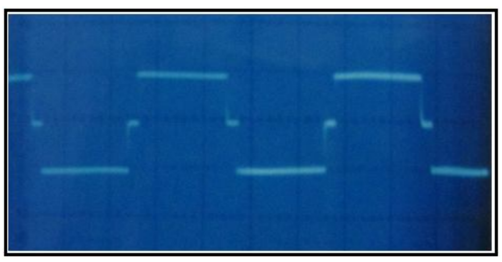


Fig.5b. Photographs of single PWM with InductiveLoad

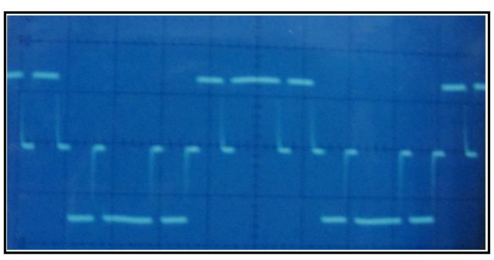


Fig.5a. Photographs of Three PWM with Inductive Load

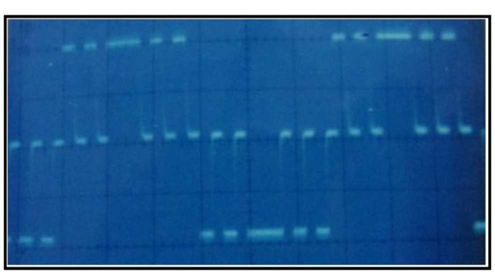


Fig 5c.Photographs of Five PWM with Inductive Load

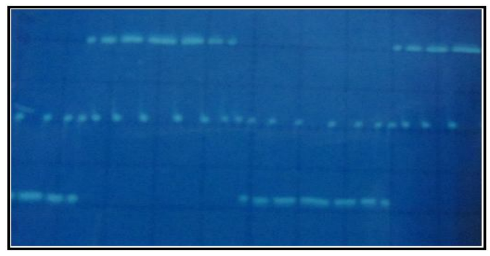


Fig.5d. Photographs of Seven PWM with Inductive Load

The system is tested for the resistive and inductive load and the output waveforms are recorded which are shown in the fig 4 and fig, 5.

The use of increasing the number of pulses per half cycle reduces the harmonic contents which improves the system performance drastically. The use of seven pulse modulation shows the better performance as that of single, three and five pulse width modulation. However increase in pulses per half cycle beyond seven pulses decreases the performance because switching losses increases and the power is wasted in switching. The better performance is observed at seven pulses.

7. REFERENCES

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