ISSN 2250-3153

Human Body Respiration Measurement Using Digital Temperature Sensor with I2c Interface

Archita Agnihotri

University of R.G.P.V, Bhopal, (M.P)

Abstract- Vital signs are measurements of the body's most basic functions. The four main vital signs routinely monitored by medical professionals and healthcare providers include the following body temperature, pulse rate, respiration rate (rate of breathing), blood pressure (Blood pressure is not considered a vital sign, but is often measured along with the vital signs.) Vital signs are useful in detecting or monitoring medical problems. Vital signs can be measured in a medical setting, at home, at the site of a medical emergency, or elsewhere. This paper aims at measurement of respiration rate using digital sensor extending the methods of measuring it with help of thermistor, chest expansion etc. The respiration rate is measured with the help of TMP100 a Digital temperature sensor which monitor the slightest change in temperature during inhale & exhale. Wireless GSM MODEM, which is serially interfaced with microcontroller, sends the collected data to the physician. The theory, design procedures, experimental results and discussions of these systems are presented.

I. Introduction

The respiration rate is the number of breaths a person takes per minute. The rate is usually measured when a person is at rest and simply involves counting the number of breaths for one minute by counting how many times the chest rises. Respiration rates may increase with fever, illness, and with other medical conditions. When checking respiration, it is important to also note whether a person has any difficulty breathing. Normal respiration rates for an adult person at rest range from 15 to 20 breaths per minute. Respiration rates over 25 breaths per minute or fewer than 12 breaths per minute (when at rest) may be considered abnormal. Here respiration rate is measured with the help of TMP100 temperature sensor. Communication between a mobile phone client and a server unit is achieved through programming the client using attention commands (AT commands). The experimental setup can be operated for monitoring from anywhere covered by the Cellular (GSM) service by exchanging SMS messages with the remote mobile device. At the consultation unit, dedicated application software is required to manage the follow of SMS messages from the Mobile and display the, respiration rate, of the patient .The device which can be widely used for medical equipment in diagnosis at hospital and clinics. The special of this device is it will display the measured respiration rate per minute. The device consists of electronic circuit system, embedded system that is microcontroller program.. One of the advantage of this device is it will be built integrated and standalone device with small size and lightweight. One of the main purposes of homecare telemedicine is to develop a wireless, low-cost and use friendly system, which allows patients to measure their own vital signs, and provide the health care professionals with the facility to remotely monitor the patient's vital signs quickly and easily. The externally worn device is placed directly on the finger, allowing acquisition of the electrocardiogram without the use of leads. The 8-bit microcontroller-based transmitter digitizes the preconditioned respiration rate and identifies the signal in real-time Data is output from the microcontroller. When it is necessary to output data from the device, the digital data is transmitted in form of SMS to physician. At the monitoring station, the transmitted data is demodulated by the receiver and the data received by mobile phone .A P89V51RD2 microcontroller was then interfaced to the device to collect the data from it’s devices, process them, store them and feed them to a transmitter. A high performance RF Module Tri-Band GSM/ 300/900/ 1800/ 1900 MHz transmitter and receiver were then used to wirelessly transmit and receive the vital sign data from the micro-controller to the consultation unit, a dedicated application software is required to manage the follow of SMS messages from the Mobile and display the vital parameter of the patient”. Old age problems are very common these days, as the social structure has evolved into satellite family systems where children after attaining their adulthood no longer live with their parents anymore and the old souls are left to cater for themselves. Typically, aged people live a secluded and reclusive life with multiple problems of memory disorder, depression, falls and unsteadiness, poor nutrition, problems with self-care and other complex chronic medical conditions.

II. Background Study

Respiration rate is a key indicator of ventilation. Abnormal respiration rate, either too high (tachypnea), too low (bradypnea), or absent (apnea), is a sensitive indicator of physiologic distress that requires immediate clinical intervention. In spite of its clinical importance, respiration rate is the last core vital sign without a reliable and continuous monitoring method that patients can easily tolerate.The lack of a reliable respiration rate measurement is a major contributor to avoidable adverse events. The most common method for respiration rate measurement is by physical assessment, either by counting chest wall movements or by auscultation of breath sounds with a stethoscope. Multiple studies have shown manual methods to be unreliable in acute care settings, especially on the general care floor, where the majority of patients receive care. Even if they were reliable, manual methods are limited by their intermittent nature.Two continuous methods for respiration rate monitoring are used in multiparameter monitors, thoracic impedance pneumography and capnography monitoring. The thoracic chest wall expands and contracts during the respiratory cycle from which respiration rate can be determined by measuring changes in electrical impedance associated with this movement. Monitoring of respiration rate by thoracic impedance is convenient if the patient is already monitored for ECG, but the method is prone to inaccurate readings due to a number of factors including: ECG electrode placement, motion artifact, and physiologic events non-related to respiration rate that causes chest wall movement (e.g. coughing, eating, vocalization, crying). Another significant limitation is insensitivity to obstructive apnea where chest wall movement is often present in the absence of any actual air exchange obstructive apnea). These limitations have rendered thoracic impedance monitoring for respiration rate unreliable in most acute care settings. capnometers that continuously monitor ventilation for non-intubated patients require a nasal airway cannula that draws a continuous gas sample for spectrographic measurements within the capnometer. Capnometry measurement of respiration rate is the most frequent technology used by anesthesiologists. This method is sensitive to central, obstructive, and mixed apneas. The primary limitations of continuous respiration rate monitoring by capnometry are low patient tolerance of the nasal cannula and the added nursing workload to respond to dislodged or clogged cannulas during the patient stay

III. Previous work

Studies related to the remote collection and use of physiological information have been published across multiple disciplines including computer vision [1], image and signal processing [2], human-computer interaction [3], biomedical engineering [4], plant science [5] and robotics [6].Traditional approaches include using devices such as ther- mistors to measure the air temperature changes near the nasal region [7], respiratory belt transducers to measure changes in the circumference of the chest or abdomen [8] and battery- powered wearable sensors to detect the sound created by turbulence occurring in the human respiratory system [9]. Unfortunately, these devices are impractical for use in many real-world scenarios which require patient mobility or for patients who are disinclined to wearing sensors of any kind. One of the first published works which measures breathing rate remotely uses an active radar detector to measure movements of the chest caused by cardiac and breathing events [10]. Since then, other non-contact modalities have been explored including laser doppler vibrometry (LDV) [11], radio frequency scanners [12] and mid-wave infrared video cameras [13]. One study remotely collects physiological information using LDV to deduce the stress state of an individual based on vibrations of the skin directly covering the carotid artery [14]. The main drawbacks to this approach include problems with accurate tracking due to variances in patient physiology and the prohibitive cost of the technology.

The biomedical engineering field has published a great deal of research dedicated to the acquisition of a wide variety of physiological information. A recent study uses a midwave infrared camera to capture breathing and heart rate based on air temperature changes near the nasal region [14]. This particular implementation was designed for polysomnography and relies initially on the manual identification of a primary region of interest in order to track the outer extent of the nostril region. Because of the large amount of image and data processing required and the small size of the nostril location to be tracked, segmentation becomes challenging and computationally expensive. Grossman *et al.* [9] compared respiration and cardiac pa- rameters measured by the Vivometrics Lifeshirt ambulatory monitor in 40 subjects during normal daily activities for when heart rate was less than 110 beats per minute. This heart rate range was chosen as it was claimed to be the primary range of cardiac parasympathetic control. They found that ambulatoryrespiratory sinus arrhythmia (high-frequency heart rate variabil- ity calculated using a peak–valley algorithm) was significantly associated with variations in respiratory rate and tidal volume (average R = 0.8).The modes of collecting physiological data described in these studies have been effective but each method still requires that the subject be fitted with the proper biofeedback sensors. In some controlled settings and with certain subjects, this may not be an issue. However, their efficacy in dynamic environments where people cannot be fitted with biofeedback sensors or in certain medical or therapeutic settings where persons are averse to wearing sensors is still somewhat limited. This paper presents a complementary approach in which one important physiological indicator - breathing is collected using a non-contact modality.

IV. Proposed system

The proposed system has been divided into measurement of resoiration rate, which is described, with the help of a block diagram [c]. Hardware development involves design and development of sensor circuit, Philips microcontroller circuit and MAX232 circuit. PROTEL DXP is used for simulation, schematic capture, and printed circuit board (PCB) design. The whole program is written and assembled using EMBEDDED C language. The program is written based on the P89v51rd2 specific instruction. Microcontroller is used to perform the signal processing from the sensor circuit. MAX232 connects the microcontroller circuit to GSM modem via RS232 cable. An alert message will be sent to mobile phone by modem.

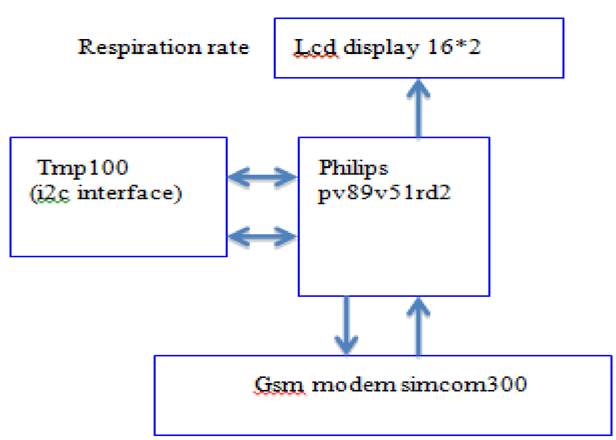
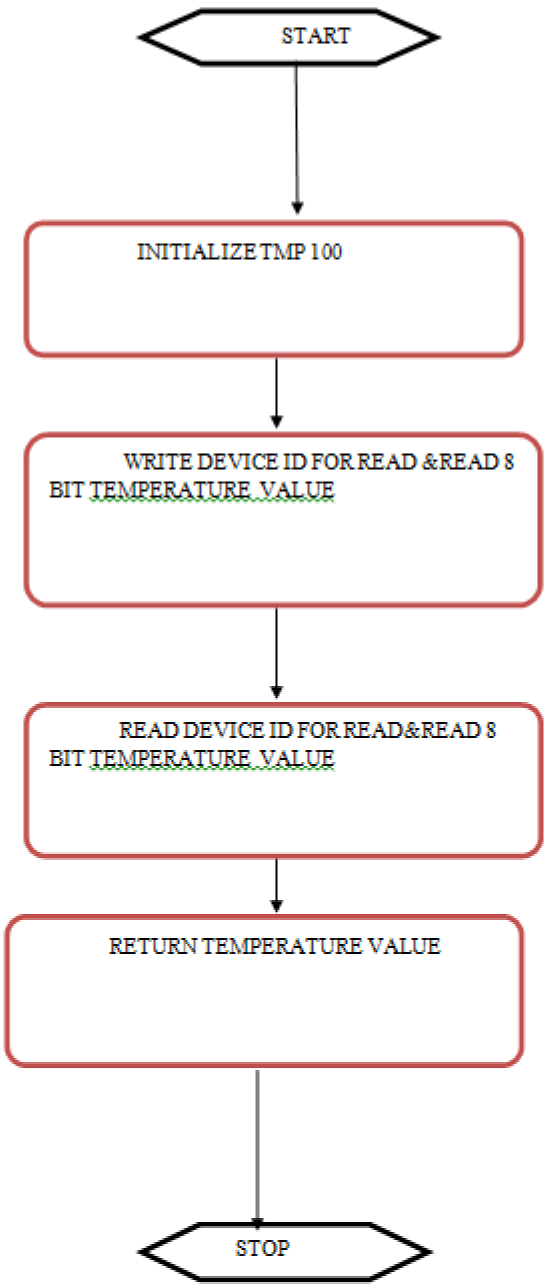
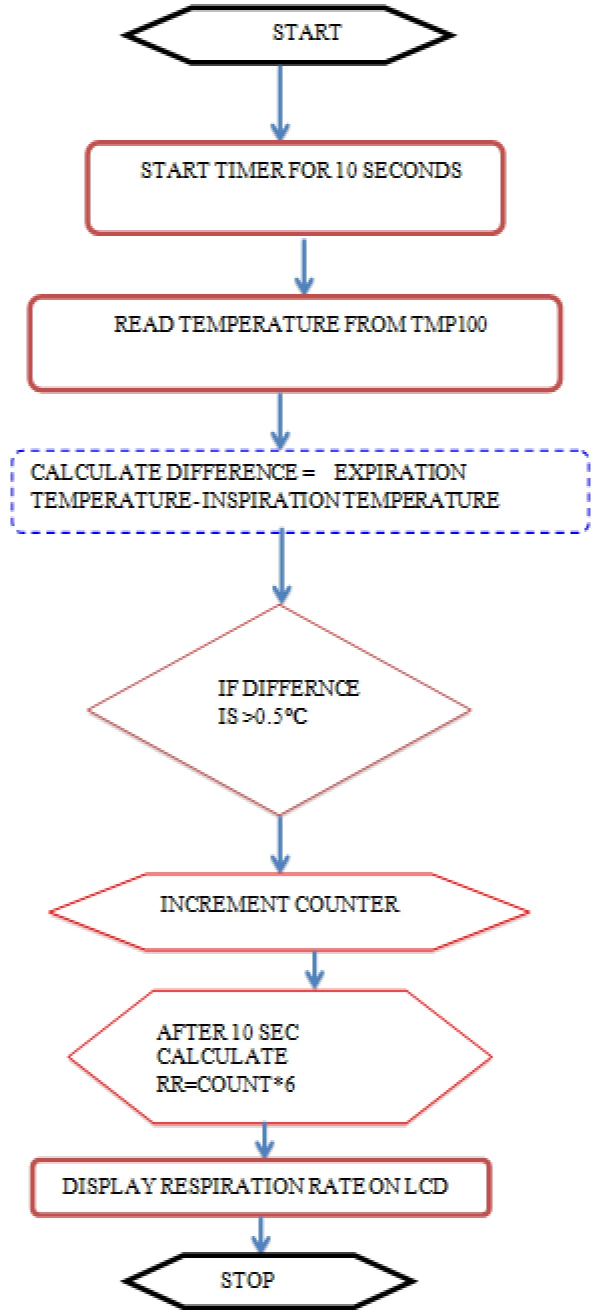


Fig 1: block diagram of respiration rate

Tmp100 is interfaced using I2C logic to microcontroller.it read & write by SCL & SDA pins. TMP100 provide 11 bits temperature reading on every inhale & exhale during respiration by nasal activity. During every inhale & exhale temperature vary, the difference for temperature for each inhale & exhale is counted for one minutes and total count is done by microcontroller which is displayed on LCD. GSM modem is connected to pin 10(RX) and pin 11(TX) pin of microcontroller p89v51rd2. The TX pin of GSM is connected with RX of microcontroller and RX of GSM is connected with TX pin of p89v51r82. AT commands are given to GSM modem at which GSM modem response by “OK”. Detail working can be explained using flow chart.





1. Respiration sensor

TMP100

The TMP100 are two-wire, serial output temperature sensors available in SOT23-6 packages. Requiring no external components, the TMP100 are capable of reading temperatures with a resolution of 0.0625°C.The TMP100 feature SM Bus and I2C interface compatibility, with the TMP100 allowing up to eight devices on one bus. The TMP101 offers SM Bus alert function with up to three devices per bus. The TMP100 are ideal for extended temperature measurement in a variety of communication, computer, consumer, environmental, industrial, and instrumentation applications. The TMP100 and are specified for operation over a temperature range of−55°Cto+125°C.

ISSN 2250-3153

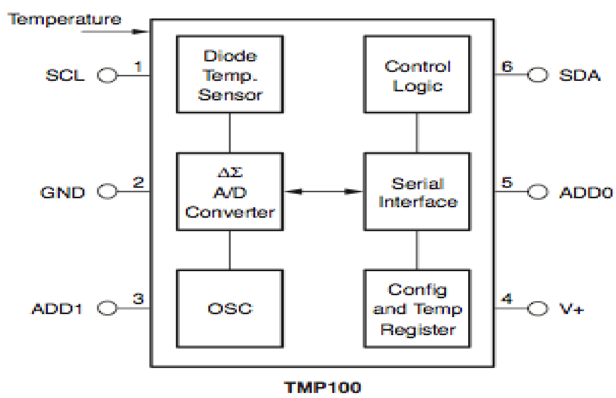


FIG3: tmp100

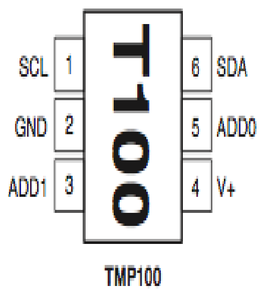


Fig4: top view of tmp100

POINTER REGISTER

The internal register structure of the TMP100. The 8-bit Pointer Register of the TMP100 is used to address a given data register. The Pointer Register uses the two LSBs to identify which of the data registers should respond to a read or write command. Table 1 identifies the bits of the Pointer Register byte. Table 2 describes the pointer address of the registers available in the TMP100 a. Power-up Reset value of P1/P0 is 00

Fig5: Internal register structure of TMP100

TEMPERATURE REGISTER

The Temperature Register of the TMP100 is a 12-bit read-only register that stores the output of the most recent conversion. Two bytes must be read to obtain data first 12 bits are used to indicate temperature with all remaining bits equal to zero. Data format for temperature is summarized in Table 1. Following power-up or reset, the Temperature Register will read 0°C until the first conversion is complete. The user can obtain 9, 10, 11, or 12 bits of resolution by addressing the Configuration Register and setting the resolution bits accordingly. For 9-, 10-, or 11-bit resolution, the most significant bits in the Temperature Register are used with the unused LSBs set to zero.

CONFIGURATION REGISTER

The Configuration Register is an 8-bit read/write register used to store bits that control the operational modes of the temperature sensor. Read/write operations are performed MSB first. The format of the Configuration Register for the TMP100 followed by a breakdown of the register bits. The power-up/reset value of the Configuration Register is all bits equal to 0. The OS/ALERT bit will read as 1 after power-up/reset.

BYTE	D7	D6	D5	D4	D3	D2	D1	D0
1	OS/ALERT	R1	R0	F1	F0	POL	TM	SD

Table 1: configuration register

CONVERTER RESOLUTION (R1/R0)

The Converter Resolution Bits control the resolution of the internal Analog-to-Digital (A/D) converter. This allows the user to maximize efficiency by programming for higher resolution or faster conversion time. Table 2 identifies the Resolution Bits and relationship between resolution and conversion time.

R1	R0	RESOLUTION	CONVERSION TIME (typical)
0	0	9 Bits (0.5°C)	40ms
0	1	10 Bits (0.25°C)	80ms
1	0	11 Bits (0.125°C)	160ms
1	1	12 Bits (0.0625°C)	320ms

Table2: resolution of tmp100

SERIAL INTERFACE

The TMP100 operate only as slave devices on the I2C bus and SM Bus. Connections to the bus are made via the open-drain I/O lines SDA and SCL. The TMP100 and support the transmission protocol for fast (up to 400kHz) and high-speed (up to 3.4MHz) modes. All data bytes are transmitted most significant bit first.

2.5.4.5.1SERIAL BUS ADDRESS

To program the TMP100 and TMP101, the master must first address slave devices via a slave address byte. The slave address byte consists of seven address bits, and a direction bit indicating the intent of executing a read or write operation. The TMP100 features two-address pins to allow up to eight devices to be addressed on a single I2C interface. describes the pin logic levels used to properly connect up to eight devices. *Float* indicates the pin is left unconnected. The state of pins ADD0 and ADD1 is sampled on the first I2C bus communication and should be set prior to any activity on the interface.

TIMING DIAGRAMS

The TMP100 are I2C and SM Bus compatible. Figure6 to Figure 8 describe the various operations on the TMP100 and TMP101. Bus definitions are given below. Parameters for Figure 5 are defined in Table 13.

Bus Idle: Both SDA and SCL lines remain HIGH.

Start Data Transfer: A change in the state of the SDA line, from HIGH to LOW, while the SCL line is HIGH, defines a

START condition. Each data transfer is initiated with a START condition.

Stop Data Transfer: A change in the state of the SDA line from LOW to HIGH while the SCL line is HIGH defines a STOP condition. Each data transfer is terminated with a repeated START or STOP condition.

Data Transfer: The number of data bytes transferred between a START and a STOP condition is not limited and is determined by the master device. The receiver acknowledges the transfer of data.

Acknowledge: Each receiving device, when addressed, is obliged to generate an Acknowledge bit. A device that acknowledges must pull down the SDA line during the Acknowledge clock pulse in such a way that the SDA line is stable LOW during the HIGH period of the Acknowledge clock pulse. Setup and hold times must be taken into account. On a master receive, the termination of the data transfer can be signaled by the master generating a Not-Acknowledge on the last byte that has been transmitted by the slave.

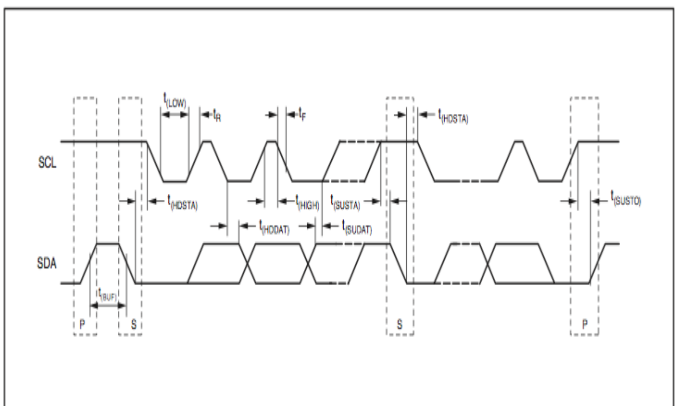


Fig 6: I2C timing diagram

WRITING/READING TO THE TMP100

Accessing a particular register on the TMP100 is accomplished by writing the appropriate value to the Pointer Register. The value for the Pointer Register is the first byte transferred after the I2C slave address byte with the R/W bit LOW. Every write operation to the TMP100 requires a value for the Pointer Register. (Refer to Figure 6) When reading from the TMP100, the last value stored in the Pointer Register by a write operation is used to determine which register is read by a read operation. To change the register pointer for a read operation, a new value must be written to the Pointer Register. This is accomplished by issuing an I2C slave address byte with the R/W bit LOW, followed by the Pointer Register Byte. No additional data are required. The master can then generate a START condition and send the I2C slave address byte with the R/W bit HIGH to initiate the read command. See Figure 12 for details of this sequence. If repeated reads from the same register are desired, it is not necessary to continually send the Pointer Register bytes as the TMP100 will remember the Pointer Register value until it is changed by the next write operation.

.

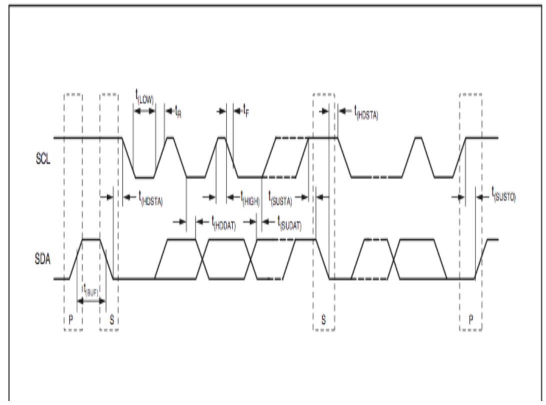


Fig 7: timing diagram for write word format

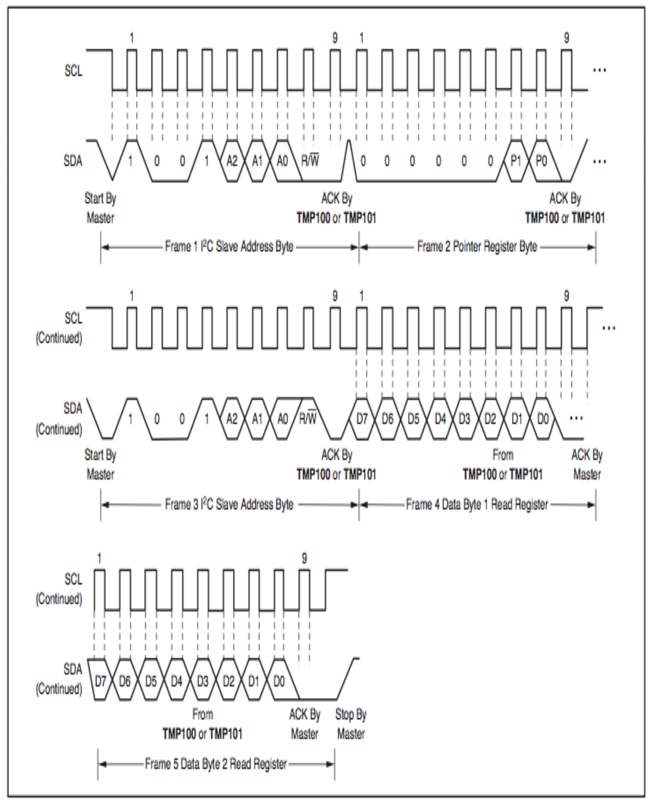


Fig 8: timing diagram for read word format

2. GSM MODEM

The interface between modem and host is a textual protocol called Hayes AT-Commands. These commands enable phone setup, dialing, text messaging.

ISSN 2250-3153

Command	Description
AT	Check if serial interface and GSM modem is working.
ATE0	Turn echo off, less traffic on serial line.
AT+CNMI	Display of new incoming SMS.
AT+CPMS	Selection of SMS memory.
AT+CMGF	SMS string format, how they are compressed.
AT+CMGR	Read new message from a given memory location.
AT+CMGS	Send message to a given recipient.
AT+CMGD	Delete message.

Table 3: at commands

AT-Command set

The protocol used by GSM modems for setup and control is based on the Hayes AT- Command set. The GSM modem specific commands are adapted to the services offered by a GSM modem such as: text messaging, calling a given Phone number, deleting memory locations etc. Since the main objective for this application note is to show how to send and receive text messages, only a subset of the AT-Command set needs to be implemented. The European Telecommunication Standard Institute (ETSI) GSM 07.05 defines the AT-Command interface for GSM compatible modems. From this document some selected commands are chosen, and presented briefly in this section. This command subset will enable the modem to send and receive SMS messages. For further details, please consult GSM 07.05.The following section describes the AT-Command set. The commands can be tried out by connecting a GSM modem to one of the PC's COM ports. Type in the test- command, adding CR + LF (Carriage return + Line feed = \r\n) before executing. Also see chapter 3.1 for further details.

S.NO	Command	Description	Result
1	AT\r\n	Check whether communication is established	Ok
2	ATE0\r\n	ECHO off	Ok
3	AT+CMGF=1\r\n	Switch to text mode	Ok
4	AT+CMGS= mobile number\r\n	Send SMS to the mobile number	>
5	AT+CMGR=sms number\r\n	Read the sms with message index number stored in the SIM card	CMGR: "REC UNREAD", "+919685474985", "0", "10/02/21,10:09:38 "MESSAGE DATA"
6	AT+CMGD=sms number\r\n	Delete the sms with message index number stored in the SIM card.	Delete the SMS with message index number stored in the SIM card.

Table4: gives an overview of the implemented AT-

3. **P89V51RD2 Microcontroller**

The P89V51RD2 is an 80C51 microcontroller with 64KB Flash and 1024 bytes of data RAM. A key feature of the P89V51RD2 is its X2 mode option. The design engineer can choose to run the application with the conventional 80C51 clock rate (12 clocks per machine cycle) or select the X2 mode (6 clocks per machine cycle) to achieve twice the throughput at the same clock frequency. Another way to benefit from this feature is to keep the same performance by reducing the clock frequency by half, thus dramatically reducing the EMI. The Flash program memory supports both parallel programming and in serial In-System Programming (ISP). Parallel programming mode offers gang programming at high speed, reducing programming costs and time to market. ISP allows a device to be reprogrammed in the end product under software control. The capability to field/update the application firmware makes a wide range of applications possible. TheP89V51RD2 is also In-Application Programmable (IAP), allowing the Flash program memory to be reconfigured even while the application is running.

CIRCUIT DIAGRAM

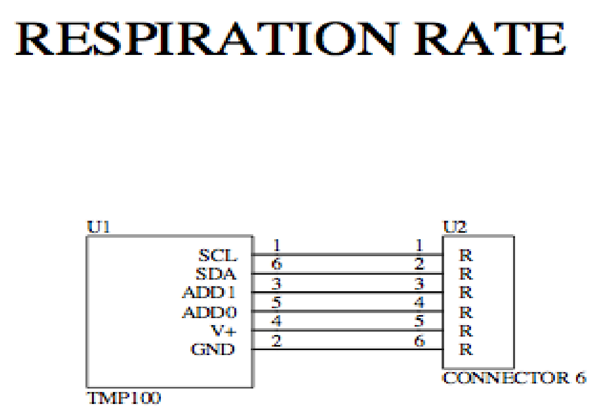


Fig9:circuit diagram of respiration using tmp100

fig10 : pcb layout of respiration

V. RESULT

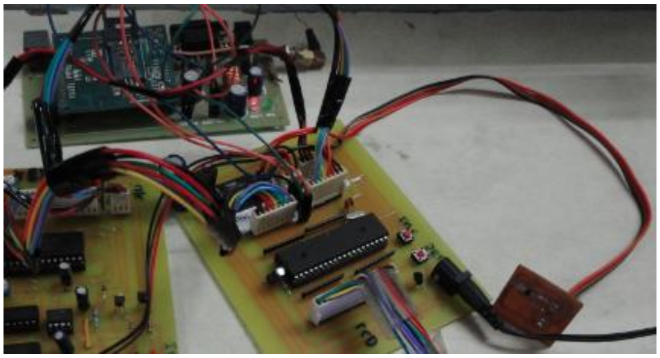


Fig11: GSM interfacing with p89v51rd2

Fig12: output of GSM modem

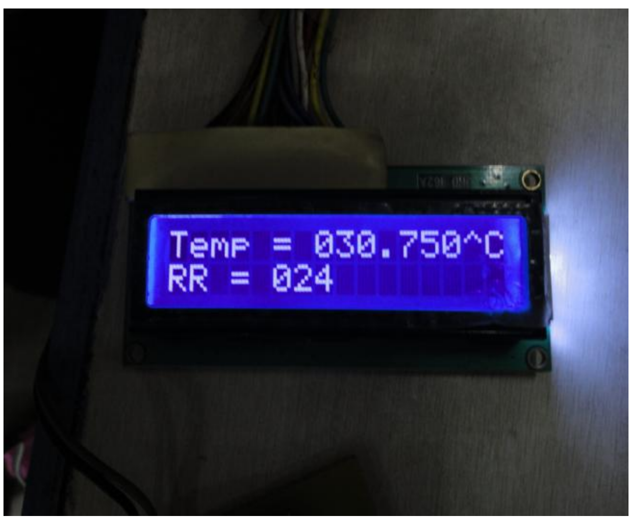


Fig13: output of respiration

VI. CONCLUSIONS

This paper presents a new technique for monitoring changes in the breathing temperature to calculate rerspiration rate. The main objective of our research was to examine the effectiveness of using a non-contact, simple and low cost sensor for accurately measuring breathing rate. Overall, the results obtained from our formal experiments are very promising. Data from the typical test sets clearly demonstrate that a tmp100 sensor, when accurately positioned, can detect subtle temperature changes corresponding to inspiration and expiration. Given the small size of the sensor and the minimal computation required for non-contact breathing monitoring (as compared to existing methods), this research demonstrates the usefulness of this sensing modality for RR .Preliminary experiments highlighted limitations with the methods used to position the sensor, collect ground truth and automatically compute breathing rates, but it is our expectation that they will be reasonably easy to overcome. Collecting ground truth can be accomplished using a respiratory belt transducer or thermistors. Future experiments will engage the study participant in a light activity that will require minimal movement while breathing is monitored. Additionally, sensitivity analysis of imprecise nose detection and an examination of the possible cross-effect of perspiration in the perinasal region will be considered in future tests.

REFERENCES

[1] Kakadiaris, I., Passalis, G., Theoharis, T., Toderici, G., Konstantinidis, I., Murtuza, N.: Multimodal face recognition: Combination of geometry with physiological information. In: Proceedings, IEEE Conference on Computer Vision and Pattern Recognition. pp. 1022–1029 (2005).

[2] Matsukawa, T., Yokoyama, K.: Visualizing physiological information based on 3dcg. Forma 25, 11–14 (2010).

[3] Barreto, A., Zhai, J., Adjouadi, M.: Non-intrusive physiological mon- itoring for automated stress detection in human-computer interaction. In: Lew, M., Sebe, N., Huang, T., Bakker, E. (eds.) Human-Computer Interaction, Lecture Notes in Computer Science, vol. 4796, pp. 29–38. Springer Berlin / Heidelberg (2007).

[4] Murthy, R., Pavlidis, I., Tsiamyrtzis, P.: Touchless monitoring of breath- ing function. In: Proceedings 26th Annual International Conference IEEE Engineering in Medical Biology Society, San Francisco, CA. pp. 1196–1199 (2004)

[5] jones, H., Serraj, R., Loveys, B., Xiong, L., Wheaton, A., Price, A.: Thermal infrared imaging of crop canopies for the remote diagnosis and quantification of plant responses to water stress in field. Functional Plant Biology 36, 978–989 (2009)

[6] Kulic, D., Croft, E.: Physiological and subjective responses to articu- lated robot motion. Robotica 25(1) (2007)

[7] Chen, W., Zhu, X., Nemoto, T., Kanemitsu, Y., Kitamura, K., Yamakosh, K.: Involuntary monitoring of breath rate and heart rate during sleep. In: Magjarevic, R., Nagel, J., Magjarevic, R. (eds.) World Congress on Medical Physics and Biomedical Engineering 2006, IFMBE Proceedings, vol. 14, pp. 4050–4053. Springer Berlin Heidelberg (2007)

[8] Cacioppo, J.T., Tassinary, L.G., Berntson, G.G.: The respiratory system. In: Handbook of psychophysiology, pp. 235–244. Cambridge University Press (2007)

[9] Corbishley, P., Rodriguez-Villegas, E.: Breathing detection: Towards a miniaturized, wearable, battery-operated monitoring system. Biomedi- cal Engineering, IEEE Transactions on 55(1), 196–204 (jan 2008)

[10] Greneker, E.: Radar sensing of heartbeat and respiration at a distance with security applications. In: Proceedings SPIE, Radar Sensing Tech- nology. pp. 22–27 (1997)

[11] Rohrbaugh, J., Sirevaag, E., Singla, N., O'Sullivan, J., Chen, M.: Laser doppler vibrometry measures of physiological function: evaluation of biometric capabilities. IEEE Transactions on Information Forensics and Security 5, 449–460 (2010)

[12] A mini-robot with a long standoff capability to detect motion and breathing inside a compound (September 2011).

[13] Fei, J., Pavlidis, I.: Thermistor at a distance: unobtrusive measurement of breathing. In: IEEE Transactions on Biomedical Engineering. pp. 988–998 (2010)

[14] Fei, J., Pavlidis, I.: Thermistor at a distance: unobtrusive measurement of breathing. In: IEEE Transactions on Biomedical Engineering. pp. 988–998 (2010)

AUTHORS

First Author – Archita Agnihotri received the B.E. degree in Electronics& communication Engineering from the University of R.G.P.V, Bhopal, M.P, in 2010, Pursuing the M.E. degree in Embedded system & VLSI design Engineering from the University of R.G.P.V, Bhopal, (M.P)