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# Predictive monitoring of Patient Health Parameters using Data Mining Techniques

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**ABSTRACT:** Most of the patients those who are undergoing medical treatment in hospital are non-ambulatory and it would be really useful for them if there is predictive monitoring system. Recent trends in technology have paved the better way for communication, recording and display device in healthcare department, which helps in monitoring medical parameters and post operational delays. One of the recent trends in technology using IOT (Internet of things) is determined, which is used in variety of healthcare operations or applications. Here, in this project PIC16F887 microcontroller acts as a bridge which communicates to the sensors placed in the patient's body such as temperature sensor, drip level sensor, heart beat sensor, pressure sensor and also it gets the data of the sensors and sends the data through the WIFI to the doctor, where, they monitor health care parameters and access at any time they need.

**KEYWORDS:** Medical treatment, Internet of things, PIC16F887, Health care parameters, Sensors.

### I. INTRODUCTION

The Internet of things (IoT) is the network of physical devices, vehicles, and other embedded with electronics, software, sensors, actuators, and network connectivity which enable these objects to collect and exchange data. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure. Experts estimate that the IoT will consist of about 30 billion objects by 2020. The IoT allows objects to be sensed or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, virtual power plants, smart homes, intelligent transportation and smart cities.

"Things", in the IoT sense, can refer to a wide variety of devices such as heart monitoring implants, biochip transponders on farm animals, cameras streaming live feeds of wild animals in coastal waters, automobiles with built-in sensors, DNA analysis devices for environmental/food/pathogen monitoring, or field operation devices that assist fire fighters in search and rescue operations. Legal scholars suggest regarding "things" as an "inextricable mixture of hardware, software, data and service". These devices collect useful data with the help of various existing technologies and then autonomously flow the data between other devices. The quick expansion of Internet-connected objects is also expected to generate large amounts of data from diverse locations, with the consequent necessity for quick aggregation of the data, and an increase in the need to index, store, and process such data more effectively.

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## II. RELATED WORK

Bourouis [6] has discussed about ubiquitous healthcare system. It is an emerging technology that provides easy healthcare service to patients, and convenient to diagnose patient's health condition. It provides increase in accuracy, efficiency and availability of medical treatment so people can monitor their health by an online medium without visiting the hospital or clinic. Yuce[3] has discussed about Healthcare monitoring system where the patient carries a set of WBAN devices and the patient is ambulatory, but is always on the reach of the gateway that binds the sensors with the medical central unit. These devices communicate remotely through the internet with a monitoring medical central unit installed in a hospital or clinic responsible for monitoring patients health status. [7,8]. Caregivers can connect through the internet via computers or mobile devices to the medical central unit to supervise patient's data processed and analysed by dedicated applications. The object is to address the data privacy of the mobile WBAN sensors exchanged with the remote medical central unit.

Kumar [4] has discussed about security for healthcare techniques. Introducing new technologies in healthcare system without considering security makes patient privacy vulnerable. The physiological data or report of an each and every individual patient is highly sensitive. The wireless medical sensors produce or collected large data which must be secured from security attacks. The success of healthcare applications mainly depends on patient security and privacy. Amna Abdullah [8] has discussed the implementation of the Wireless Health Monitoring System and its components are ECG Electrodes, LM35 Temperature Sensor, Blood Pressure Sensor, Blood Glucose Sensor, and Microsoft Pro Tablet. The system operates as the medical professionals used three electrodes of ECG on the patient's body and connect the arduino shield with a temperature sensor, a blood glucose level sensor and a blood pressure sensor. From the arduino shield they connect a wireless node and the Tablet or the Smartphone that has Lab View software running on it to take reading of the patient's physiological data. The data are saved according to the time and presented in a report format and the data is then published in the internet by using tablet or smart phone so that the patients report can be accessed by the authorized healthcare persons from remote locations at any time. P.Deepika [9] has provided different types of classification techniques in the field of Heart Disease prediction that include mainly five different classification algorithms namely Classification by decision tree, Bayesian Classification, Neural Networks, Support vector machine, Classification based on association are out of which Neural networks give 100% accuracy while decision trees and naive bayes provide 99.62% and 90.74% accuracy according to K.Thenmozhi [10].

## III. PROPOSED SYSTEM

In the broadest definition, a sensor is an electronic component, module, or subsystem whose purpose is to detect events or changes in its environment and send the information to other electronics, frequently a computer processor. A sensor is always used with other electronics, whether as simple as a light or as complex as a computer. Sensors are used in everyday objects such as touch-sensitive elevator buttons (tactile sensor) and lamps which dim or brighten by touching the base, besides innumerable applications of which most people are never aware. With advances in micro machinery and easy-to-use microcontroller platforms, the uses of sensors have expanded beyond the traditional fields of temperature, pressure or flow measurement, for example into MARG sensors. Moreover, analog sensors such as potentiometers and force-sensing resistors are still widely used. Applications include manufacturing and machinery, airplanes and aerospace, cars, medicine, robotics and many other aspects of our day-to-day life. A sensor's sensitivity indicates how much the sensor's output changes when the input quantity being measured changes. For instance, if the mercury in a thermometer moves 1 cm when the temperature changes by 1 °C, the sensitivity is 1 cm/°C (it is basically the slope  $Dy/Dx$  assuming a linear characteristic). Some sensors can also affect what they measure; for instance, a room temperature thermometer inserted into a hot cup of liquid cools the liquid while the liquid heats the thermometer. Sensors are usually designed to have a small effect on what is measured; making the sensor smaller often improves this and may introduce other advantages. Technological progress allows more and more sensors to be manufactured on a microscopic scale as micro sensors using MEMS technology. In most cases, a micro sensor reaches a significantly higher speed and sensitivity compared with macroscopic approaches.

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## ***Pressure Sensor***

Pressure sensors monitor a patient's condition by providing accurate and reliable diagnostics in a broad range of conditions. These devices are specifically designed for applications where high quality and reliability are especially important and are constructed using materials with a proven history in the health care industry. Pressure sensors are based on piezoresistive technology and offer a wide range of functions and features—from basic, to fully amplify and temperature compensated devices. The fully amplified series can be easily connected to an MCU. There are also digital pressure sensors that provide additional flexibility by eliminating the need for a separate ADC component. These pressure sensors communicate on both I2C and serial peripheral interface SPI buses, providing a direct connection to the main system processor for communication simplicity and flexibility. The new low-voltage pressure sensor series is designed to meet power efficiency demands to extend longevity for simpler, cost-sensitive medical and portable electronics. Pressure sensors combine advanced micromachining techniques, thin film metallization and bipolar semiconductor processing to provide accurate, highly reliable sensors at competitive prices.

## ***Heartbeat Sensor***

Heart beat sensor is designed to give digital output of heart beat when a finger is placed on it. When the heart beat detector is working, the beat LED flashes in unison with each heartbeat. This digital output can be connected to microcontroller directly to measure the Beats per Minute (BPM) rate. It works on the principle of light modulation by blood flow through finger at each pulse.

## ***PIC16F887 Microcontroller***

The PIC16F887 is one of the latest products from Microchip. It features all the components which modern microcontrollers normally have. For its low price, wide range of application, high quality and easy availability, it is an ideal solution in applications such as: the control of different processes in industry, machine control devices, measurement of different values etc.

## ***MAX 232***

The MAX232 IC is used to convert the TTL/CMOS logic levels to RS232 logic levels during serial communication of microcontrollers with PC. The controller operates at TTL logic level (0-5V) whereas the serial communication in PC works on RS232 standards (-25 V to + 25V). This makes it difficult to establish a direct link between them to communicate with each other. The intermediate link is provided through MAX232. It is a dual driver/receiver that includes a capacitive voltage generator to supply RS232 voltage levels from a single 5V supply. Each receiver converts RS232 inputs to 5V TTL/CMOS levels. These receivers (R1 & R2) can accept  $\pm 30V$  inputs. The drivers (T1 & T2), also called transmitters, convert the TTL/CMOS input level into RS232 level. The transmitters take input from controller's serial transmission pin and send the output to RS232's receiver. The receivers, on the other hand, take input from transmission pin of RS232 serial port and give serial output to microcontroller's receiver pin. MAX232 needs four external capacitors whose value ranges from  $1\mu F$  to  $22\mu F$ .

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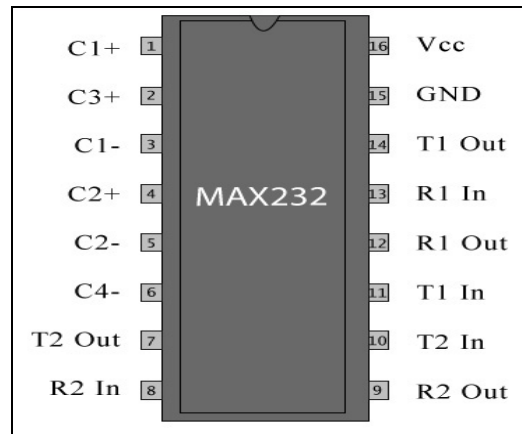


Fig 1 Pin Diagram – MAX 232

### **GSM Module**

A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves. A GSM modem can be an external device or a PC Card / PCMCIA Card. Typically, an external GSM modem is connected to a computer through a serial cable or a USB cable. A GSM modem in the form of a PC Card / PCMCIA Card is designed for use with a laptop computer. It should be inserted into one of the PC Card / PCMCIA Card slots of a laptop computer. Like a GSM mobile phone, a GSM modem requires a SIM card from a wireless carrier in order to operate. As mentioned in earlier sections of this SMS tutorial, computers use AT commands to control modems. Both GSM modems and dial-up modems support a common set of standard AT commands. You can use a GSM modem just like a dial-up modem's provides recommendations, not requirements. The GSM specifications define the functions and interface requirements in detail but do not address the hardware. The reason for this is to limit the designers as little as possible but still to make it possible for the operators to buy equipment from different suppliers. The GSM network is divided into three major systems: the switching system (SS), the base station system (BSS), and the operation and support system (OSS). The basic GSM network elements are shown in below figure Like a GSM mobile phone, a GSM modem requires a SIM card from a wireless carrier in order to operate. As mentioned in earlier sections of this SMS tutorial, computers use AT commands to control modems. Both GSM modems and dial-up modems support a common set of standard AT commands.

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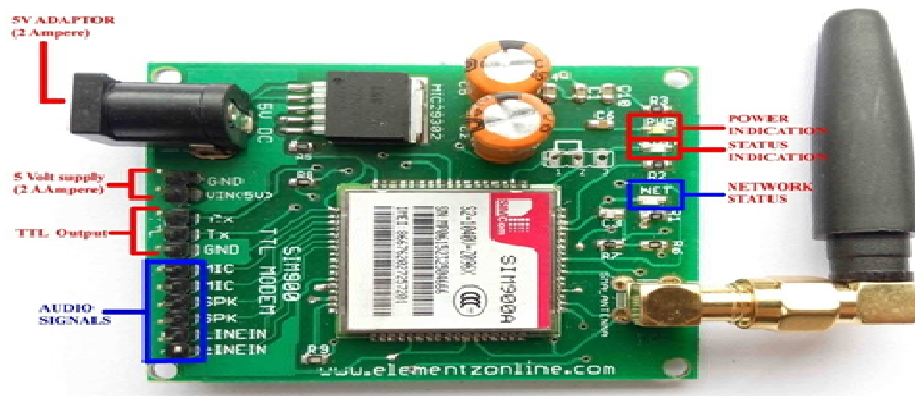


Fig 2 SM9100 Module

## GSM Modem Applications

GSM provides recommendations, not requirements. The GSM specifications define the functions and interface requirements in detail but do not address the hardware. The reason for this is to limit the designers as little as possible but still to make it possible for the operators to buy equipment from different suppliers. The GSM network is divided into three major systems: the switching system (SS), the base station system (BSS), and the operation and support system (OSS). The basic GSM network elements are shown in below figure Like a GSM mobile phone, a GSM modem requires a SIM card from a wireless carrier in order to operate. As mentioned in earlier sections of this SMS tutorial, computers use AT commands to control modems. Both GSM modems and dial-up modems support a common set of standard AT commands. You can use a GSM modem just like a dial-up modem.

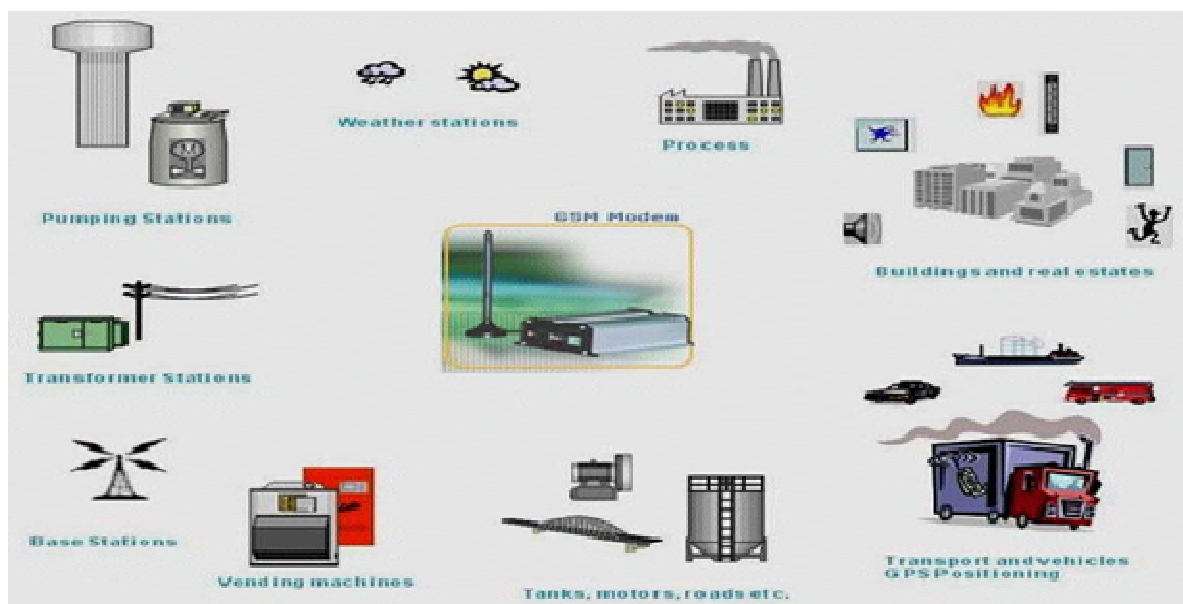


Figure 3 GSM Modem Applications

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## IV. DESIGN METHODOLOGY

In the proposed system we present a health monitoring system that uses the sensors for collecting data from patients, intelligently predicts patient’s health status and provides feed- back to doctors through their mobile devices having android application. The patients will participate in the health care process by their mobile devices and thus can access their health information from anywhere any time. Patient’s data (temperature, heart rate, ECG, position) will be frequently measured and sent to server as shown in the figure. Period of sending (say every 1 min) can be set. Monitoring person learns patient specific threshold. Say the regular body temperature of a patient is 24°C whereas one person feels feverish if his body temperature is 32°C. By employing an averaging technique over a relatively long time, Observer can learn these thresholds for patients. By using the system the healthcare professionals can monitor, diagnose, and advice their patients all the time. The health parameters data are stored and published online. Hence, the healthcare professional can monitor their patients from a remote location at any time. Our system is simple and patient's data can be easily accessed.

The mikroC PRO for PIC is a powerful, feature-rich development tool for PIC microcontrollers. It is designed to provide the programmer with the easiest possible solution to developing applications for embedded systems, without compromising performance or control. PIC and C fit together well: PIC is the most popular 8-bit chip in the world, used in a wide variety of applications, and C, prized for its efficiency, is the natural choice for developing embedded systems. mikroC PRO for PIC provides a successful match featuring highly advanced IDE, ANSI compliant compiler, broad set of hardware libraries, comprehensive documentation, and plenty of ready-to-run examples.

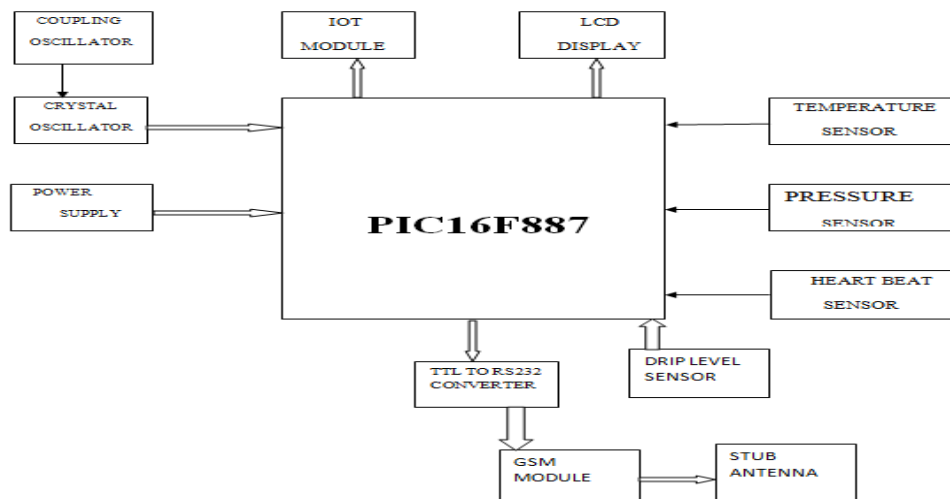


Fig 4 Block Diagram of the Proposed System

In this design, the PIC microcontroller is used as a gateway communicate to the various sensors such as temperature sensor, heartbeat sensor, ECG sensor, sensor for keeping a track of drip level (blood or saline).The microcontroller picks up the sensor data and sends it to the network through a Wi-Fi and hence provides real time monitoring of the health care parameters for doctors. The controller is also connected with buzzer to alert the caretaker about variation in sensor output. At the time of extremity situation alert message is sent to the doctor through the android application connected to the cloud server. Hence quick provisional medication can be easily done by this system. Also an additional subsystem is



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provided for prediction of heart disease for the patient based on his/her health parameters. This system is efficient with low power consumption capability, easy setup, high performance and time to time response.

### V. CONCLUSION

By using the system the healthcare professional can monitor, diagnose and advise their patients all the time. The health parameters data are stored and published online. Hence, the healthcare professional can monitor their patients from a remote location at any time. Our system is simple and patient's data can be easily accessed. The entire concept of IOT stands on sensors, gateway and wireless network which enable users to communicate and access the application/environment. The Future work of the project is very essential in order to make the design system more advanced. In the designed system the enhancement would be connecting more sensors to internet which measures various other health parameters and would be beneficial for patient monitoring i.e. connecting all the objects to internet for quick and easy access. Establishing a Wi-Fi mesh type network to increase in the communication range.

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