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Solar powered patient monitoring system

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ABSTRACT

This paper presents an overview of the solar-powered patient monitoring system. A solar-powered patient monitoring system is a Wired and Wireless system that can allow patients to mobile. The developed system includes pulse sensor to measure the patient's pulse rate, as well as the Temperature and humidity sensor to track temperature and humidity of environment picking the best environment that suits the patient's condition. Other parameters that may not be directly linked to the patient but prove to be essential as far as health is concerned are also monitored which include smoke or toxic gas detection and fire detection. The proof of concept was successful and allow multiple patients to be monitored at the same time. This enables the doctor to monitor patient's health parameters which include heartbeat, temperature, and position etc. in real time.

Keywords: *Arduino, ESP 8266 Board, Virtual, Acid battery and solar panel*

1. INTRODUCTION

1.1 Background

The Patient monitoring system is a device which is used with respect to Medical information to improve the patient's health status. Thus, the Patient Monitoring system is one form of Telemedicine [4]. Telemedicine is the use of medical information exchanged from one site to another via electronic communications to enhance the Patient's health status. The Patient Monitoring system, in this case, is very vital in intensive care unit (ICU), emergency rooms, etc. to determine the heartbeat rate, the body temperature of the patient, the environmental humidity, and motion of the body and gas detection. This will serve as a faster and easier way to monitor the patient despite the distance of the health personnel.

The conventional patient monitoring systems use Analog meters in most parameters to be measured. These meters are not always to be trusted as they involve manual settings and adjustments when in use. This has resulted in inaccurate or inconsistent readings leading to wrong prescriptions by the doctors. The existing systems also have high power consumption, expensive and difficult to operate by an ordinary person.

This proposed system has various advantages. It is designed to be easily operated by not only a well - trained technician or doctor but by anyone who wishes to use it. It has the ability to reduce complications which might be due to a shortage of electricity or the unavailability of the doctor during emergency conditions. The system is designed to be used in both offline and online mode, Therefore; these and other complications are reduced. This will serve as a great first aid before any abnormality of a patient gets to a critical stage and therefore provides an alternative to weekly hospital check-ups by delivering health care services even in the unavailability of the doctor in the hospital or nearby homes

The use of the Patient monitoring system in health service areas can reduce the cost of installation and maintenances as compared to the old existing systems. The solar-powered patient monitoring system is smaller in size and flexible in its working principles. For the above benefits, it will be preferable for health personnel to use a patient monitoring system which will give accurate results, less power consumption but highly efficient to detect, help diagnose and provide an idea of the patient health conditions both in home and hospitals.

1.2 Motivation

While most people argue that the human brain being the central processing organ, I believe there is a more important organ when it comes to the survival of the human being; the heart. We have all seen different unfortunate things happening to different kinds of people like blind, dump and deaf, handicapped, limbless amongst other natural disasters. In addition, we have also seen brainless people, yet they are surviving but we have never seen a human without a heart, natural or artificial; once the heart stops working, it automatically leads to death if it is not replaced the soonest time possible. This is the main motivation for choosing this title.

In the developing world, a monitoring system is very expensive and an average family might not be able to afford one. However, we designed a lower cost and less complex system called SOLAR POWERED PATIENT MONITORING SYSTEM that can be afforded by even a low-income earner. Since the heart performs all these to monitor the condition is vital so as to keeping pumping blood at all times. This involves measuring either the pulse rate or heartbeat or heart rate, in which case, these are all the same by default.

In this project, I have included other parameters to be measured like the temperature of the environment along with the humidity conditions to keep patients at ease, a motion sensor to keep track of movements of danger related to the patient and to also sense LPG and other toxic gases in the environment. To enhance its reliability, since we cannot keep a computer as a source of power supply at all times, the mounted solar panel is able to keep the battery alive enough to keep the system operating.

1.3 Objectives

- To design and implement a patient monitoring system for monitoring heartbeat, humidity and temperature of the area, any gas leakage, break out of the fire.
- To develop a wireless system for monitoring the patient's condition over the internet.
- To develop a system that is powered by solar power panel and very cost effective.

1.4 Applications

- It can be used to monitor patients at hospitals.
- It can be used to monitor the movement of mentally ill people within limited areas.
- It can be used in industrial areas for a check for the presence of fire and gases.
- It can be used in weather stations to predict the temperature and humidity conditions of the atmosphere.
- It can also be used at home to monitor sick, the old and children health conditions to avoid unexpected illness.

2 PROPOSED SYSTEM

2.1 Existing System

The existing system is a remote patient monitoring device by using Bluetooth which senses data from a patient and then send to the doctor's mobile. Every patient is connected to a temperature sensor and parameters that are measured are interfaced with the system at the patient end [3]. The patient end system is connected to server and doctor's mobile via Bluetooth. The server stores the central database of all the patients. If the status is normal, the parameter is transmitted to the server and stored in the database. When the status is abnormal, the parameter is immediately intimated to the doctor and the data is stored in the database of the server.

Drawbacks:

- It measures only the patient's temperature.
- The Bluetooth has a short-range communication.
- High current consumption.
- It is expensive compared to our model.

2.2 Proposed System

An improved model is prepared by using low-cost materials like Arduino Nano, heartbeat sensor, etc. having sufficient strength that can be afforded by almost everyone is shown in figure 3.1 and 3.2 to test for the prototype of the developed system. It consists of various sensors like heartbeat, smoke, fire, motion, temperature, and humidity. These sensors are interfaced correctly with the micro-controllers, programmed to pick up the respective parameters intended to measure from the patient and then send the results obtained for interpretation and analysis.

The proposed system consists of two main controllers; Arduino Nano and Node MCU. The most important parameters, which need regular supervision by the doctor are kept offline; controlled by the Arduino Nano. This is because the system should not depend on the availability of the Internet when a patient's life is at risk. A patient's health conditions especially the heart conditions need regular observations for any abnormalities. Other sensors controlled by the Arduino Nano are motion, fire, and smoke. The DHT11 temperature and humidity sensor are directly connected to the Node MCU through pin D0.

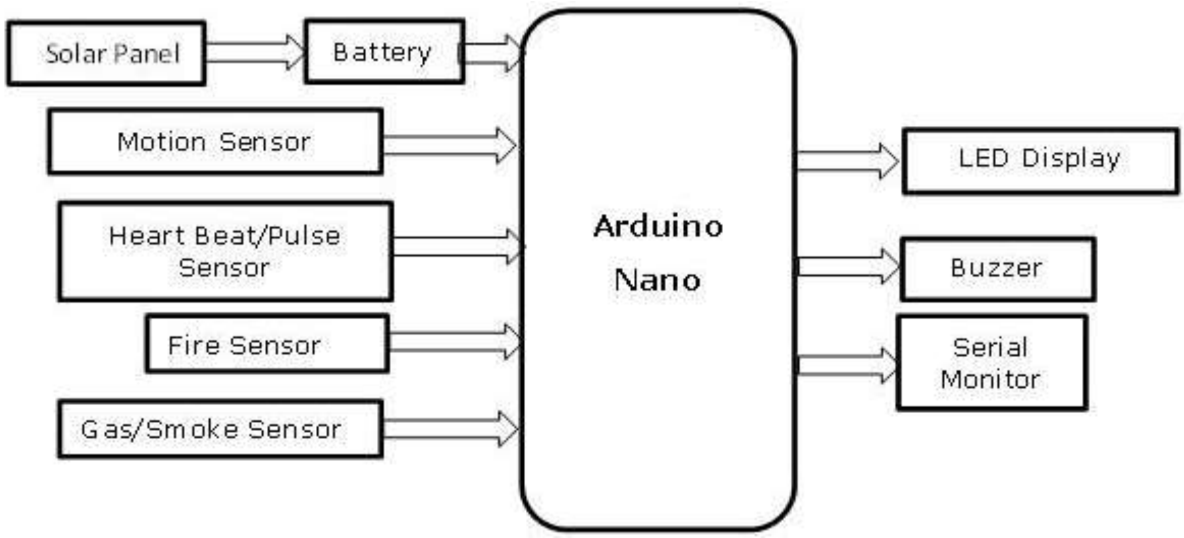


Fig 2.1: Block Diagram of Arduino Nano Microcontroller

Since temperature and humidity conditions of the environment hardly cause patients' lives at risk in hospitals and since the DHT11 sensor is not directly connected to the patient for collection of data, it is wise to use Node MCU in which the temperature and humidity conditions of the patient's environment can be monitored online anywhere by the doctor as long as his phone is connected to the Internet. The Node MCU has remarkable features which we will see later in the subsequent chapters.

2.3 Block Diagrams

The block diagram 3.1 shows the different sensors connected to the microcontrollers. The solar panel is exposed to the sun's rays which are converted to energy. The energy charges the lead-acid battery which in turn powers the microcontroller boards. The various sensors connected to the analog pins of the Arduino boards are programmed to sense data from the patient and send their response to the microcontroller units which is then decoded by the computer [22]. The Arduino Nano interprets the results and shown on the displays like LEDs, buzzer or serial monitor.

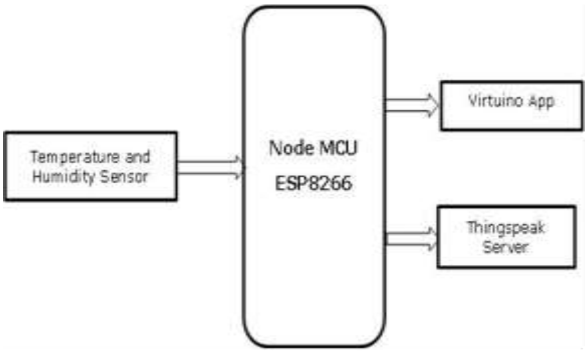


Fig 3.1: Block Diagram of Node MCU Microcontroller

Similarly, the DHT11 connected to the Node MCU is programmed to detect the environmental temperature and humidity to be analyzed and interpreted by the microcontroller and computer connected to the Node MCU. The output of the sensor can be seen on the Virtual app,

3. HARDWARE IMPLEMENTATION

As far as patient monitoring is concerned, the related parameters of the patient should be measured continuously and the most important of them should be posted online for the doctor or nurses to access anytime, anywhere when needed. This project will provide a solution for enhancing the reliability and flexibility by improving the performance and power management of the patient monitoring system. In the current proposed system, the patient health is continuously monitored and the acquired data is analyzed at a centralized ARM microcontroller. If a particular patient's health parameter falls below the threshold value, an automatic indicating device will glow or sound to call the attention of the Doctor or assigned nurses. The design and implementation of the Solar Powered Patient Monitoring System consist of the following hardware components.

3.1 PIR Sensor

The Pyro electric Infrared (PIR) sensor is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view. It is embedded within a Fresnel lens and motion detection circuit extending to the external three output lead terminals. These terminals are denoted as Vcc, Aout and GND to be connected to the power supply of 5V, analog input pin and ground of a microcontroller respectively. This sensor is very sensitive and with low noise. The output is a standard 5V active low output signal. This module also provides an optimized circuit that has a motion detecting range of up to 6 meters away which can be used in alarm systems, motion-activated lighting and robotic applications. The output can be connected to a microcontroller pin directly to monitor a signal or connected to a transistor to drive DC loads like bell, buzzer, siren, relay, up to-coupler (e.g. PC817, MOC3021) etc. The PIR sensor and Fresnel are fitted onto a PCB board inside a case with the detecting lens protruding outwards.

Fig. 3.2: Pin Diagram of PIR sensor

3.2 Operating Principle

Pyro electric devices such as the PIR sensor have elements made of a crystalline material that generates an electric charge when exposed to infrared radiation. The changes in the amount of infrared striking the element changes the voltage generated, which are measured by an on-board amplifier built within the PIR. The device contains a special filter called a Fresnel lens, which focuses the infrared signals onto the element. As the ambient infrared signals change rapidly, the amplifier trips the output to indicate motion. When an object, such as a human, passes in front of the background, such as a wall, the temperature at that point in the sensor's field of view will rise from room temperature to body temperature, and then back again. The sensor converts the resulting change in the incoming infrared radiation into a change in the output voltage, and this triggers the detection. The PIRs (Passive Infra-Red) come in many configurations for a wide variety of applications. The most common models have numerous Fresnel lenses or mirror segments, an effective range of about ten meters (thirty feet), and a field of view less than 180 degrees.

3.3 Differential Detection

Pairs of sensor elements may be wired as opposite inputs to a differential detection. In such a configuration, the PIR measurements cancel each other so that the average temperature of the field of view is removed from the electrical signal; an increase of IR energy across the entire sensor is self-cancelling and will not trigger the device. This allows the device to resist false indications of change in the event of being exposed to brief flashes of light or field-wide illumination.

3.4 Warm-up time

The PIR sensor requires a 'warm-up' time in order to function properly. This is due to the settling time involved in 'learning' its operational environment. This could be anywhere from one to two minutes. The sensor will work almost better when given this time.

Table 1: Pin Description of PIR

Pin No.	Pin Notation	Pin Name	Pin Description
1	VCC	Power Supply	To +5V DC regulated power supply
2	OUT	Digital Input Pin	To declared input pin of the microcontroller
3	GND	Ground	To power supply ground: 0V

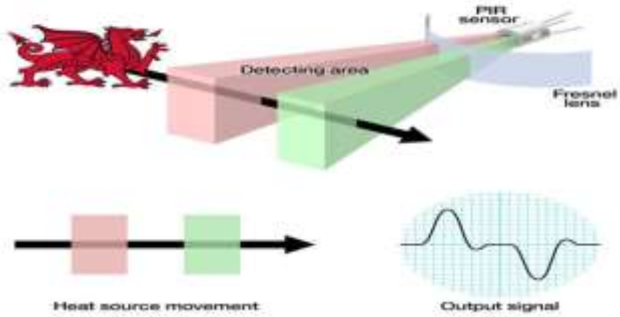


Fig. 3.3: Working of PIR sensor

3.5 Using the PIR sensor
The PIR sensors are a little more complicated than many other DIY sensors because there are multiple variables that affect the sensor's input and output. This can be explained with the help of the diagram below. The PIR sensor basically has two slots in it; each slot is made of a special material that is sensitive to IR. The lens used here is not really doing much and the two slots can 'see' out past some distance. When the sensor is in an idle state, both the slots detect the same level of IR, the ambient amount radiated from the room or outdoor walls. When a warm body like human or animal passes by the sensor's detecting range, it first intercepts one half of the sensor, which causes a positive differential change between the two halves. When the warm body leaves the sensing area, the reverse occurs, whereby the sensor generates a negative differential change. The change pulses are what is detected and interpreted as motion.

3.6 Operating Range
The PIR sensor has a range of approximately ten meters (thirty feet). This can vary with the environmental conditions. The sensor is designed to adjust to slowly changing conditions that would happen normally as the day progresses and the environmental conditions change but responds by making its output high when sudden changes occur, such as when there is motion.

Therefore, sensor nodes lifetime totally depends on battery and network's lifetime depends on the lifetime of sensor nodes. The amount of power drained from a battery should be checked. Since Sensor nodes are usually small, light and cheap and the size of the battery is limited. Sensor nodes are deployed in an unattended environment where battery replacement is not possible in the network which consists of thousands of nodes. Hence, energy consumption is a vital factor to prolong sensor nodes lifetime.

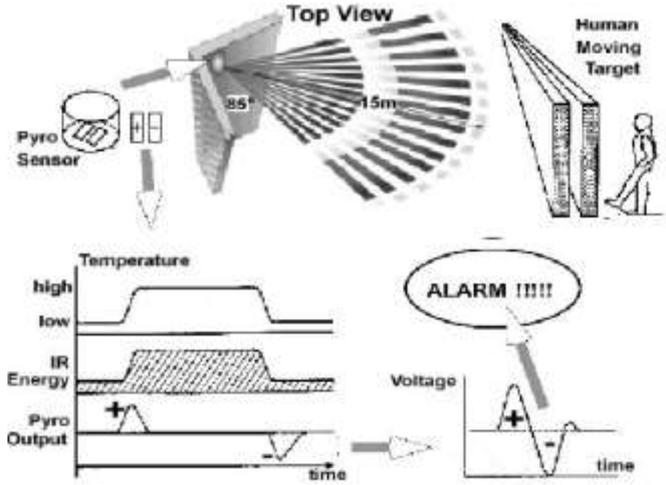


Fig. 3.4: Operating range of PIR sensor

4. SMOKE/GAS SENSOR
In a hospital, when a patient is in a critical condition especially when the patient is finding it hard to breathe, certain helping techniques are employed to help him/her breathe. One of this is providing the patient with oxygen supply. Not only in breathing difficulties but also the supply of oxygen is needed for various cells and tissues to continue functioning while surgery is in progress. As health personnel, it is their primary responsibility to know as well as monitor the gas being supplied to the patient. This process involves setting up certain measures during ordering and implantation of the gas tanks in the hospital environment for the patients. The engineering behind these proceedings is to study and know the different threshold levels for the various or most of the toxic gas that might be harmful to the patient and using these thresholds to set up a limit for safety beyond which the patient being monitored will be subjected to danger. This can be indicated by an alarm, LED or other output devices calling the attention of the health personnel in-charged that an unfamiliar gas is detected.

Combustion gas sensor is used in gas leakage detecting equipment for the detection of LPGs, Iso-butane, propane, methane, hydrogen, alcohol, LNG combustion gases, etc. However, the sensor does not get triggered by the noise.

A smoke sensor is a device that senses smoke, typically as an indicator of toxic fumes. Commercially, security devices issue a signal to a fire alarm control panel as part of fire alarm system, while household or hospital smoke detectors, also known as smoke alarms, generally issue a local audio or visual alarm from the detector itself. In this project, a gas detector is used and is discussed later in this section, coupled with a buzzer and LED to indicate the presence of a foreign gas unwanted in the patient's environments. The MQ series of gas sensors use a small heater inside with an electro-chemical sensor. They are sensitive to a range of gasses and are used indoors at room temperature. They output their readings as analog voltages.

4.1 Operating Principle
In this project, the MQ2 gas sensor is used and is explained in details in this section. These gas sensor modules consist of a steel exoskeleton under which a sensing element is housed. This sensing element is subjected to the current through connecting leads. This current is known as heating

current. When gasses come close to the sensing element, they get ionized and are then absorbed by the sensing element. Depending on the strength of the gasses, there will be a change in the resistance of the sensing element which alters the value of the current going out of it. The MQ2 also has an on-board LM358N Op Amp IC that amplifies the signal strength before passing it to the output leads. The sensor can measure concentrations of flammable gas of 300 to 10,000 ppm.

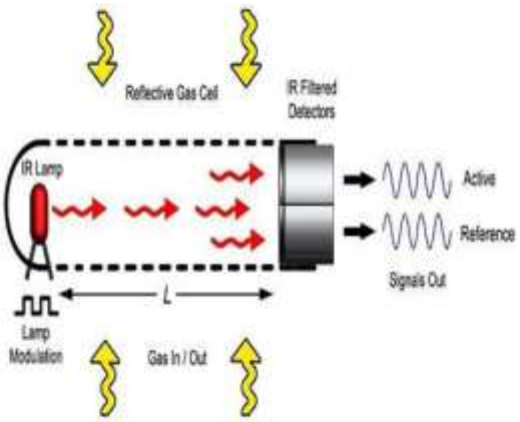


Fig. 4.1: Working of gas/smoke

Fig. 4.2: Pin diagrams of gas sensor

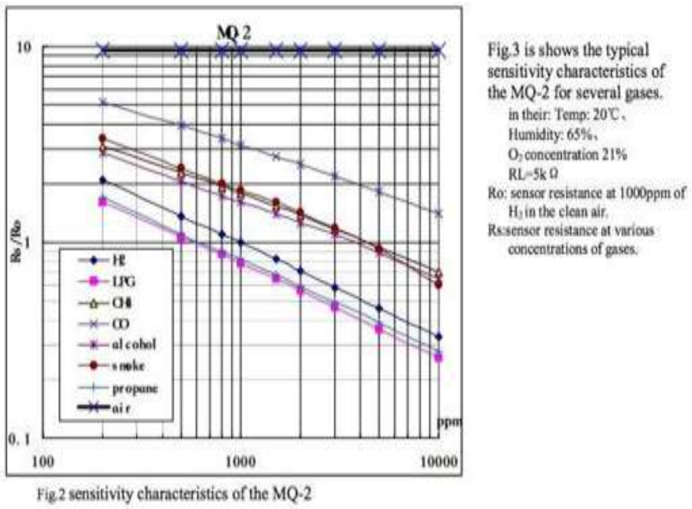


Fig 4.3: Typical sensing characteristics of MQ-2 for gasses

5. FIRE SENSOR

The hospital environment is equipped with different kinds of chemicals, and electronic devices and most of the electronic devices are power dependent and would not be a surprise when a fire breaks. Since oxygen is widely used in hospitals, it is very important to monitor the patient's surroundings for any possible cause of fires. Oxygen supports combustion and when present in a larger quantity may cause severe burns to the patient or the entire building. For this reason, a flame sensor is included in this project to provide a fire-free and safe environment for the patient.

A fire detector is a sensor designed to detect and respond to the presence of flame or fire. The responses to flame detection depend on the installation, but can include surrounding alarm, deactivating a fuel line (such as a propane or natural gas line), and activating a fire suppression system (such as a fire extinguisher or water tank through tap line). When used in applications such as industrial or hospital furnaces, their role is to provide confirmation that the furnace is properly lit; in this case, they take no direct action beyond notifying the operator or control system. A flame detector can often response faster and more accurately than a gas/smoke or heat detector due to the mechanism it uses to detect the flame or fire. In a hazardous environment, such as a petrochemical processing plant, hospital, failing to detect gas leaks, fires or explosions could prove disastrous. However, more efforts are still needed to help in distinguishing dangerous gas leaks or flames from annoying false alarms.

5.1 Operating Principle

IR sensors like all other photo sensors works on the principle that a photon of sufficient energy can excite electrons so that the resistance of the circuit is changed. Among the many different types of flame sensor, ultraviolet flame sensors, near IR array flame sensors, infrared flame sensors and IR3 flame detection sensors are the most prominent. An IR sensor consists of an emitter, detector and associated circuitry. The circuit required to make an IR sensor consist of two parts: the emitter circuit and the receiver circuit. The emitter is simply an IR LED and the detector simply an IR photodiode which is sensitive to IR light of the same wavelength as that emitted by the IR LED. When IR light falls on the photodiode, its resistance and correspondingly, its output voltage change in proportion to the magnitude of the IR light received.

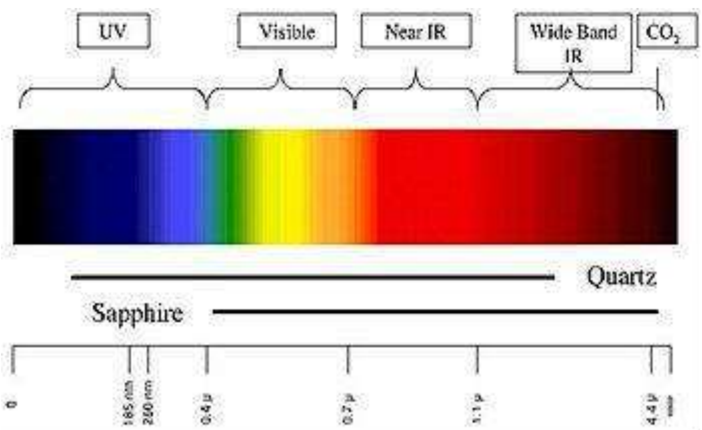


Fig. 5.1: Wavelengths for flame sensor IR detection

Fig. 5.2: Fire sensor

6. TEMPERATURE AND HUMIDITY SENSOR

DHT11 is a Humidity and Temperature Sensor which generates calibrated digital output. DHT11 can be interfaced with any microcontroller like Arduino, Raspberry Pi, etc. and can obtained instantaneous results. DHT11 is a low cost humidity and temperature sensor which provides high reliability and long-term stability.

6.1 Working principle

The DHT11 sensor consists of a humidity sensing component, a NTC temperature sensor (or thermistor) and an IC on the back side of the sensor. For measuring humidity, a humidity sensing component is used which has two electrodes with moisture holding substrate between them. As the humidity changes, the conductivity of the substrate changes or the resistance between these electrodes changes. This change in resistance is measured and processed by the IC which makes it ready to be read by a microcontroller. On the other hand, for measuring temperature, the sensor uses a NTC temperature sensor or a thermistor. A thermistor is actually a variable resistor that changes its resistance with the change in temperature. These sensors are made by sintering of semi conductive materials such as ceramics or polymers in order to provide larger changes in the resistance with just small changes in temperature. The term “NTC” means “Negative Temperature Coefficient”, which means that the resistance decreases with increase in temperature.

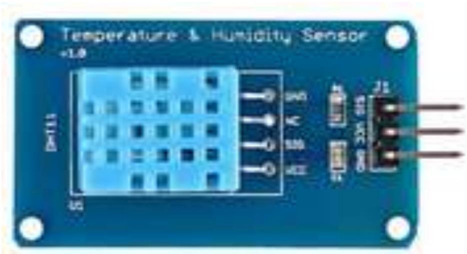


Fig. 6.1: Temperature and Humidity sensor

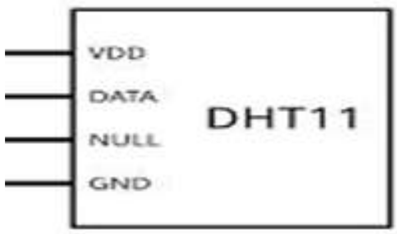


Fig. 6.2: Pin Diagram of temperature and humidity sensor

7. HEARTBEAT DETECTION

Heartbeat sensor is designed to give a digital output of the heartbeat when a finger is placed on it. In the detecting process, 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). It works on the principle of light modulation by blood flow through the finger at each pulse.

7.1 Working Principle

The sensor consists of a super bright red LED and a light detector. The LED needs to be super bright as the maximum light must spread around the placed finger and be detected by the detector. When the heart pumps a pulse of blood through the blood vessels, the finger becomes slightly more opaque and so less light reaches the detector. With each heart pulse, the detector signal varies. This variation is converted to an electrical pulse. This signal is amplified and triggered through an amplifier which produces an output logical signal of 5V. The output signal is also indicated by a LED which blinks on each heartbeat.

Fig. 7.1: Pulse sensor Pin

8. ARDUINO BOARDS

In the existing system, the Arduino Uno microcontroller board is used to monitor only the patient’s heartbeat. This board has a lot of disadvantages like less power supply pins, analog, and digital pins and in fact, it has only one 5V and 3.3V pins as an output to be interfaced with sensors and power requiring devices. Considering these drawbacks, the microcontroller is upgraded to Arduino Nano whose features will be discussed in this chapter.

Fig. 7.2: Arduino Nano

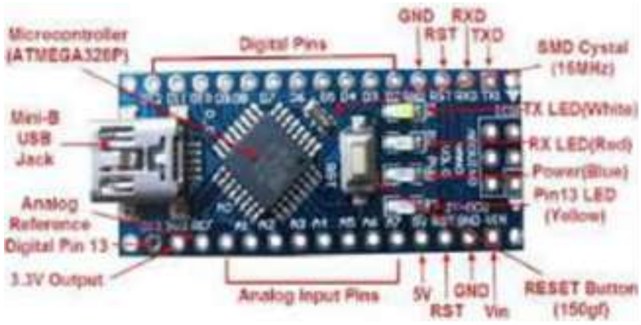
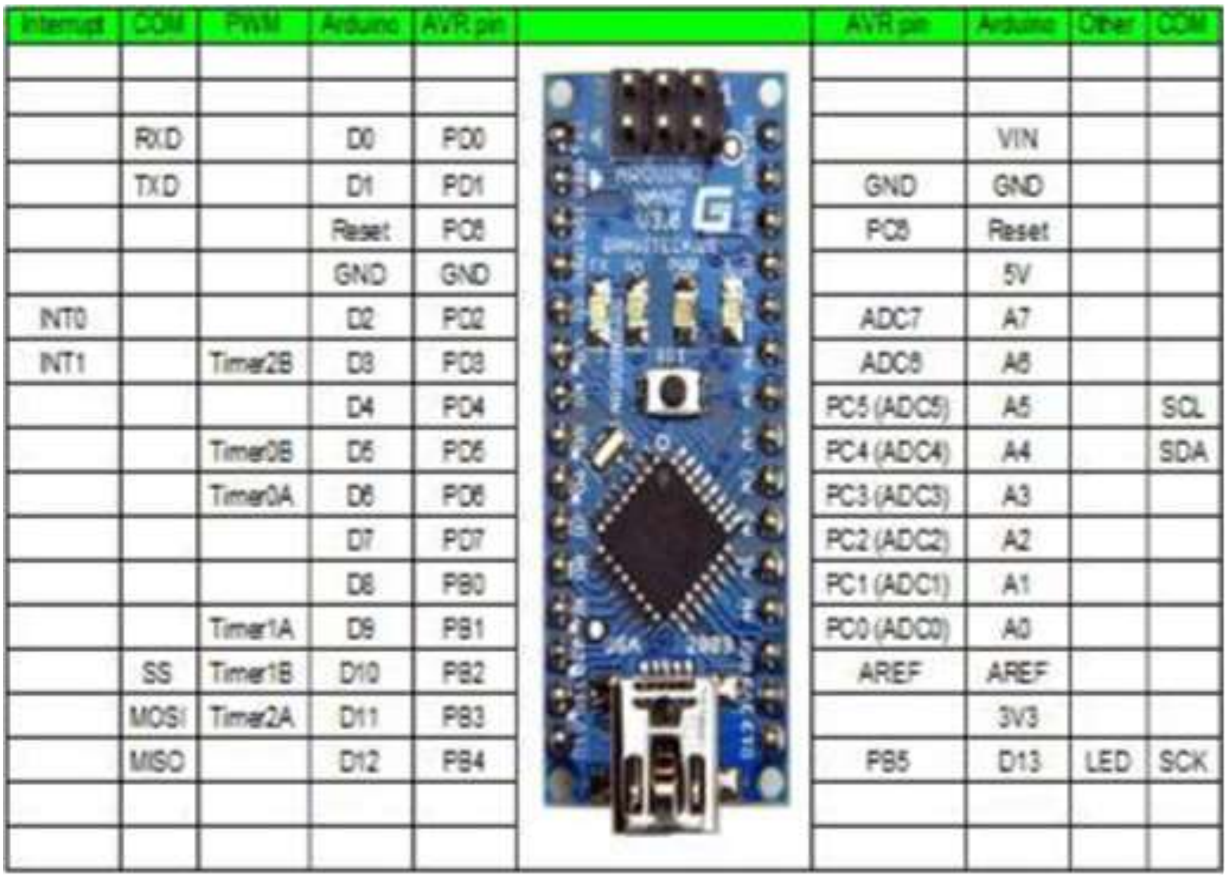


Fig. 7.3: Pin Diagram of Nano Board

8.1 Schematic Diagram of Arduino

The Arduino Nano microcontroller might seem small but it is more powerful and has better features as compared to Arduino Uno, Arduino Yun, Arduino Diecimila etc. It has 14 digital and 7 analog pins. It also has 5V as well as a 3. 3 supply.

Its cost is low and the size is just an excellent feature for space management in the hospital environment; this has given the project a remarkable outlook. The Arduino Nano incorporates a number of enhancements and new features. Improved power consumption, increased connectivity and great IO are among the improvements to this powerful, small and lightweight ARM-based controller.



Interrupt	COM	PWM	Arduino	AVR pin	AVR pin	Arduino	Other	COM
	RXD		D0	PD0		VIN		
	TXD		D1	PD1	GND	GND		
			Reset	PC6	PC6	Reset		
			GND	GND		5V		
INT0			D2	PD2	ADC7	A7		
INT1		Timer2B	D3	PD3	ADC6	A6		
			D4	PD4	PC5 (ADC5)	A5		SCL
		Timer0B	D5	PD5	PC4 (ADC4)	A4		SDA
		Timer0A	D6	PD6	PC3 (ADC3)	A3		
			D7	PD7	PC2 (ADC2)	A2		
			D8	PB0	PC1 (ADC1)	A1		
		Timer1A	D9	PB1	PC0 (ADC0)	A0		
	SS	Timer1B	D10	PB2	AREF	AREF		
	MOSI	Timer2A	D11	PB3		3V3		
	MISO		D12	PB4	PB5	D13	LED	SCK

9. SOLAR PANEL

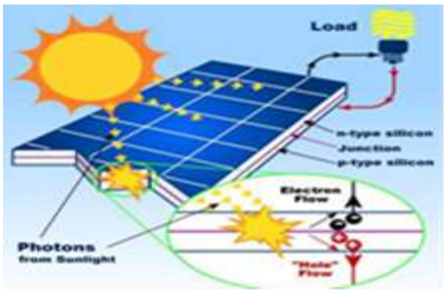


Fig. 9.1: Solar Panel

9.1 Operation

In simple terms, a solar panel works by allowing photons or particles of light to knock electrons free from atoms generating a flow of electricity. Solar panels actually comprise many smaller units called photovoltaic cells. Many cells linked together make up a solar panel. Each photovoltaic cell is basically a sandwich made up of two slices of semi-conducting material usually silicon. A couple of other components of the cell turn these electrons into usable power. Metal conductive plates on the sides of the cell collect the electrons and transfer them to wires. At that point, the electrons can flow like any other source of electricity. To work, photovoltaic cells need to establish an electric field. Much like a magnetic field, which occurs due to opposite poles, an electric field occurs when opposite charges are separated. To get this field, manufacturers "dope" silicon with other materials, giving each slice of the sandwich a positive or negative electrical charge. Specifically, they seed phosphorous into the top layer of silicon, which adds extra electrons, with a negative charge, to that layer. Meanwhile, the bottom layer gets a dose of boron, which results in fewer electrons, or a positive charge. This all adds up to an electric field at the junction between the silicon layers. Then, when a photon of sunlight knocks an electron free, the electric field will push that electron out of the silicon junction.

9.2 Efficiency

Solar efficiency relates to the amount of available energy from the sun that gets converted into electricity. Back in the 1950s, the first solar cells were capable of taking 6% of the energy from the sun and converting it into electricity. If they were configured to be the same array of 60 (as shown in Fig. 4.25), would have created a current of about 20 watts electricity, about a third of what would be needed to light up a 60-watt incandescent bulb. As of 2012, solar cells could convert 15% of the energy hitting them from the sun into power and now solar cell efficiency is closer to 20%.

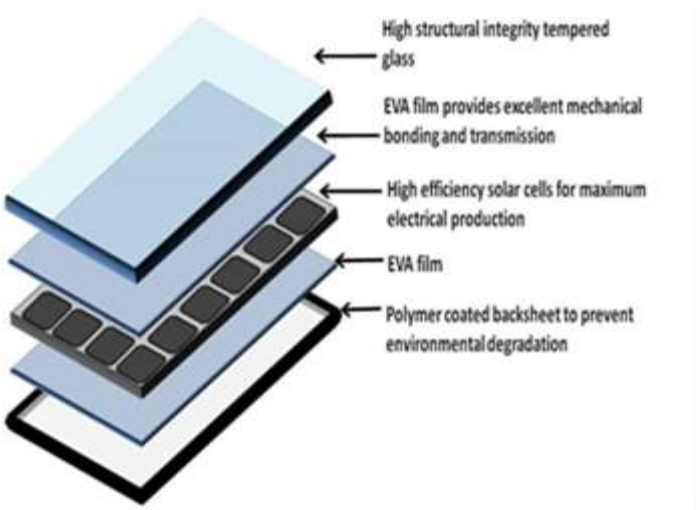


Fig. 9.2: Layers of Solar Panel

10. APPLICATIONS

- Monitoring the movement and location of a patient in hospital or rehabilitation Centres.
- Motion-activated nightlight.
- Alarm systems.
- Security applications to monitor movement in restricted areas.
- Gas leakage detection in hospitals
- Toxic gas detection
- Fire/Safety detection system
- Smoke detection
- Alcohol detection
- Hospitals and clinics in patient monitoring systems.
- Hydrogen stations
- Gas cookers
- Industrial heating and drying systems
- Domestic heating systems
- Industrial gas turbines
- To maintain food quality in production, storage, and transportation.
- A patient monitoring system in hospitals, clinics as well as in the home.
- HVAC (Heating, Ventilation and Air Conditioning) Systems
- Weather Stations
- Medical Equipment for measuring humidity
- Home Automation Systems
- Automotive and other weather control applications.
- Digital Heart Rate Monitor
- Patient Monitoring System
- Bio-Feedback control of robotics and applications

11. RESULTS

The proposed systems are tested on the model of patient monitoring. The heartbeat sensor detects the patient's heartbeat and sends the response to the serial monitor via the micro-controller for viewing and analysis purpose. The gas sensor detects the presence of LPG and other toxic gases in the hospital environments. The Fire sensor detects the presence of fire, the motion sensor indicates the patient's mobility and the temperature and humidity sensor senses and sends the environmental and humidity conditions which are then sent to the microcontrollers for interpretation.

The developed prototype of solar-powered patient monitoring system responds well to the various parameters aimed to measure when connected to a patient and indicates clearly when the threshold level of a parameter is reached or about to be exceeded.

11.1 Project output response

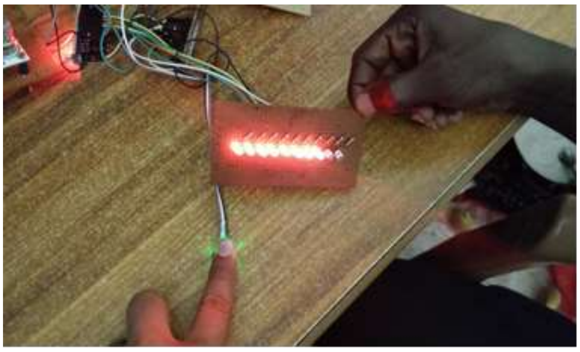


Fig. 11.1: Heartbeat Response

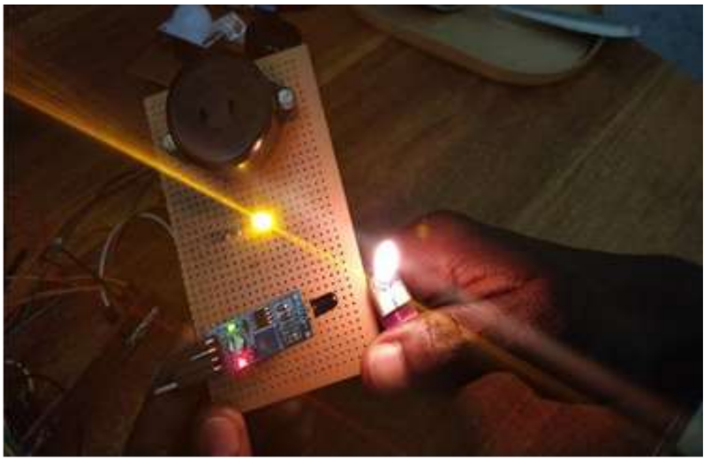


Fig. 11.2: Fire Response

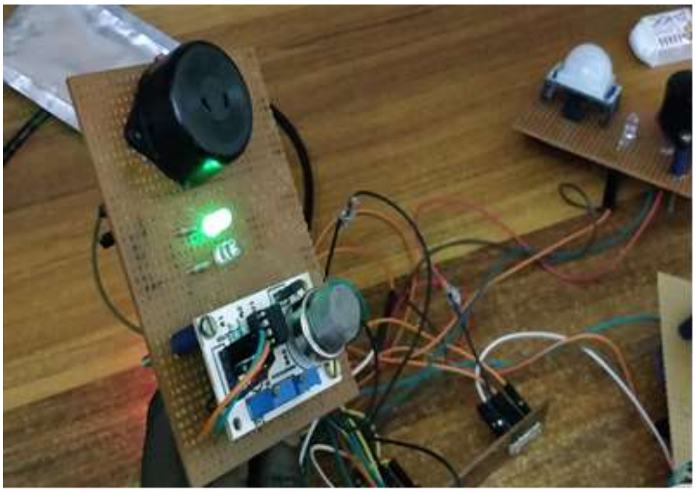


Fig. 11.3: Gas Response

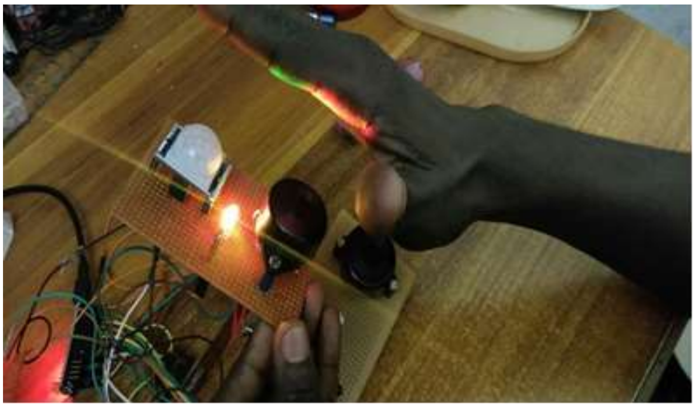


Fig. 11.4: Motion Response

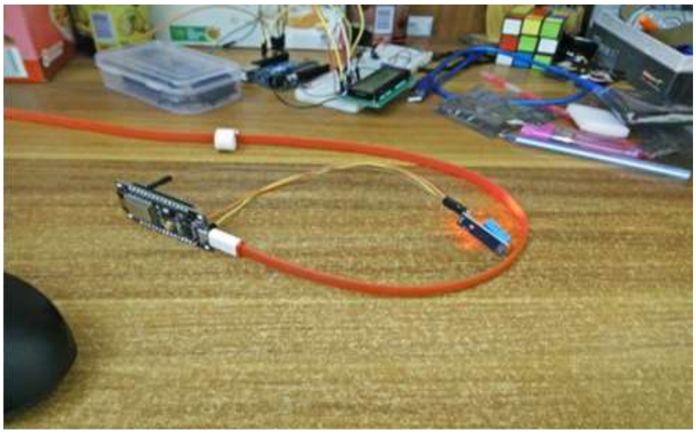
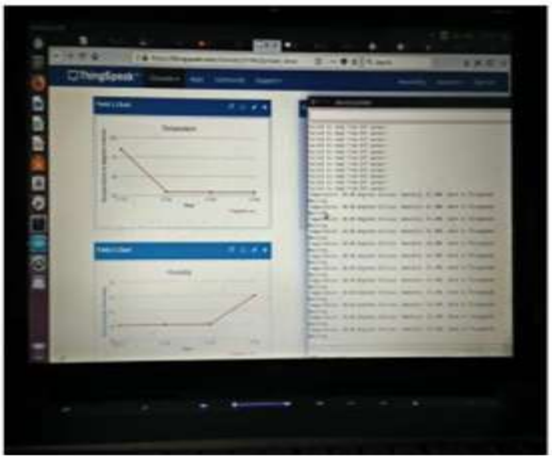


Fig. 11.5: DHT11 connections



12. CONCLUSIONS

A model of patient monitoring system using low cost materials and having sufficient strength as shown in the Fig. 6.6 is developed to test for the prototype. All the materials and devices are selected based on the datasheets and standards of measurements. It is feasible to implement sensor communication between computer and micro-controller.

The proposed system is controlled by Arduino Nano and ESP 8266 micro-controllers. They collect information from the sensors, make decisions and send the interpretation to the computer or the cloud. If the sensors are interrupted, then the doctor will be notified of the effects and calling his or her attention to the interruption.

12.1 Future Scope

This paper presents the design and implementation of a low cost solar powered patient monitoring system for hospital and general users. The efficiency is increased due to the usage of Arduino Nano and Wi-Fi modules. The Wi-Fi module and Nano prove to be smart, economic and provides efficient platform for implementing the patient monitoring both at home and hospitals. It presents two advantages as: necessary action can be taken in short span of time in case of emergency conditions and design of a PCB which limits the size requirement. The reduced in size makes it more applicable for commercial manufacturing and distribution. The Arduino boards are open source application with its ever-growing community and development provides a great hope in the near future.

The proposed work is based on embedded system design and programming. It involves four basic concepts such as designing the hardware, uploading the relative codes to the microcontrollers, verifying the functionality of the hardware with the relative codes and finally checking the working of the entire proposed system.

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