IOT Based Occupancy Monitoring Techniques for Energy-Efficient Smart Buildings

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Abstract

In the recent engineering advances the convergence of internet, communication and information technologies will pave the way for new generation. Smart buildings have been equipped with different electronic devices on the basis of Internet of Things (IoT), therefore they are becoming smarter than before. This article surveys the work on occupancy monitoring, energy saving system and security requirements through IoT which is an essential part of smart building. Moreover, we analyze the main parameters that should be considered to be included in any building energy management. This proposed occupancy monitoring develops effective data fusion techniques for improving occupancy monitoring accuracy using multitude of sources. To demonstrate the feasibility and effectiveness of this system, devices such as IR sensors and camera can be integrated with the smart building system

Keywords: *Infrared (IR), Internet of Things (IoT), heating, ventilating, and air conditioning (HVAC), building management techniques (BMS)*

INTRODUCTION

Buildings are identified to be one of the biggest customers of electrical power; the United States division of power estimates that constructions consume 70% of the electricity in the US. Contemporary efforts have concerned with making structures more energy effective, together with research that target specified areas comparable to lights and managing IT power consumption within structures. Smart structures are fitting a fact with the integration of building management techniques (BMS) [1] with an underlying monitoring and communication infrastructure that contains smart instruments comparable to sensors, cameras, RFIDs, meters, and actuators. These smart contraptions, along with the communication infrastructure, are referred to as internet of things (IOT). These approaches have exact drawbacks with appreciate to accuracy, fee, intrusiveness, and privateness. Accuracy, price and intrusiveness are inter-related in the feel that with the multiplied pay, we could deploy extra contraptions (reminiscent of more than a few sensors, RFIDS, cameras) and expand the accuracy of the procedure at the same time at the equal time broaden the intrusiveness. As a consequence, anintelligent system to cut back cost is to rely on the existing infrastructure as so much as viable. This routinely addresses the intrusiveness dilemma due to the fact that there shall be no need to installation further contraptions inside the rooms, and additional functions on the users' devices. None the much less, this raises the query of accuracy which could also be severely affected. This paper provides an analysis of the present strategies and support handle as a result recounted issue through selling the use of multi-modal data fusion in order to be gathered from the prevailing IOT network.

A data fusion approach might strengthen the accuracy of occupancy detection at the same time retaining a low intrusiveness. With the aid of exploiting the approach power among he to be had information, data fusion procedures can filter noisy measurements coming from IOT contraptions, and make predictions and inferences about occupancy status. Mainly, we first analyse the versions of the difficulty and the on hand IOT instruments after which survey the existing works with recognize to those assumptions. There are a number of variants once we check with Occupancy Monitoring difficulty. These are interrelated but relying on the purpose of the application, previously, quite a lot of forms of the concern are studied.

Smart buildings are becoming a reality with the integration of Building Management Systems (BMS) [1] with an underlying monitoring and communication infrastructure that consists of smart devices such as sensors, cameras, RFIDs, meters, and actuators. These smart devices, along with the communication infrastructure, are referred to as Internet of Things (IoT). The BMS manage various crucial components of the buildings such as heating, ventilating, and air conditioning (HVAC), gas, lighting, security system, and fire system, and it can communicate with the IoT devices. With the availability of IoTs in commercial buildings, building occupants and environment can be monitored in real time.

In this way, we can have real-time access to occupancy counts in different zones of the building and even locate most of the users carrying a wireless device. This real-time occupancy status information can be used in a variety of applications controlled by the BMS. For example, the smart building systems of the future can adjust their energy consumption by intelligently controlling the HVAC, and respond promptly to any potential issues that can put the building off its track to carbon neutrality [2], [3]. In addition to energy issues, realtime occupancy tracking may also help rescuing survivors in case of emergency response applications [4].

The security or fire system can benefit from this information through the BMS. Finally, this information may also be used to improve building surveillance and security, and help in better deploying the wireless communication infrastructure for fulfilling ubiquitous throughput guarantees throughout the buildings. Due to such advantages of occupancy detection/monitoring, many approaches have been proposed in the literature by considering the use of different devices, assumptions, and goals. These approaches have certain drawbacks with respect to accuracy, cost, intrusiveness, and privacy. Accuracy, cost and intrusiveness are inter-related in the sense that with the increased cost, you can deploy additional devices (such as various sensors, RFIDS, cameras) and increase the accuracy of the system while at the same time increase the intrusiveness. Therefore, a wise method to reduce costs is to rely on the existing infrastructure as much as possible. This automatically addresses the intrusiveness issue since there will be no need to deploy additional devices inside the rooms, and additional applications on the users' devices. Nonetheless, this raises the question of accuracy which may be severely affected. This paper provides an analysis of the existing approaches and help address the aforementioned issue by promoting the use of multi-modal data fusion that will be collected from the existing IoT network. A data fusion process could improve the accuracy of occupancy detection while maintaining a low intrusiveness. By exploiting the synergy among the available data, information fusion techniques can filter noisy measurements coming from IoT devices, and make predictions and inferences about occupancy status.

Specifically, we first analyze the variations of the problem and the available IoT devices and then survey the existing works with respect to these assumptions. We analyze their abilities to address the issues of accuracy, cost, intrusiveness and privacy. We finally consider data fusion approaches and investigate how these techniques can be exploited to come up with more advanced occupancy monitoring techniques that can significantly reduce the energy consumption of the building HVAC systems.

Buildings are known to be one of the largest consumers of electricity; the US Department of Energy estimates that buildings consume 70% of the electricity in the US. Recent efforts have focused on making buildings more energy efficient, including research that target specific areas such as lighting and managing IT energy consumption within buildings. Smart buildings are becoming a reality with the integration of Building Management Systems (BMS) [1] with an underlying monitoring and communication infrastructure that consists of smart devices such as sensors, cameras, RFIDs, meters, and actuators. These smart devices, along with the communication infrastructure, are referred to as Internet of Things (IOT). These approaches have certain drawbacks with respect to accuracy, cost, intrusiveness, and privacy. Accuracy, cost and intrusiveness are inter-related in the sense that with the increased cost, you can deploy additional devices (such as various sensors, RFIDS, cameras) and increase the accuracy of the system while at the same time increase the intrusiveness.

Therefore, a wise method to reduce costs is to rely on the existing infrastructure as much as possible. This automatically addresses the intrusiveness issue since there will be no need to deploy additional devices inside the rooms, and additional applications on the users' devices. None the less, this raises the question of accuracy which may be severely affected. This paper provides an analysis of the existing approaches and help address therefore mentioned issue by promoting the use of multi-modal data fusion that will be collected from the existing IOT network. A data fusion process could improve the accuracy of occupancy detection while maintaining a low intrusiveness. By exploiting the system energy among the available data, information fusion techniques can filter noisy measurements coming from IOT devices, and make predictions and inferences about occupancy status. Specifically, we first analyze the variations of the problem and the available IOT devices and then survey the existing works with respect to these assumptions.

There are a number of variations when we refer to Occupancy Monitoring problem. These are interrelated but depending on the goal of the application, in the past, various forms of the problem are studied Occupancy Detection: This problem studies whether a space is occupied or not at a given time. This is typically in the form of binary answers which does not tell how many people exist if the space is occupied. The spaces considered here are typically offices or private spaces. Occupancy detection of the public spaces (e.g., meeting rooms, aisles, cafeterias), on the other hand, is more challenging. Typically, these public spaces can either be monitored via other means (e.g., cameras) or by default considered occupied for HVAC applications.

• **Occupancy Counting:** The goal of this problem is to determine the total number of people in a building at a given time. There are two versions of this problem: First, counting all the people in the whole building. Second, counting people based on some predefined zones.[2] [3] The zones can be defined, for example, using HVAC zones, offices, or Wi-Fi access point (AP) coverage areas. The granularity of the zones differs in most of the studies.

• **Occupancy Tracking:** This problem can be considered as the superset of the all of the above problems. It not only detects people, but also counts, locates, and tracks them. The solutions to this problem can utilize the well-known user localization algorithms that run on the network side rather than the user devices.

• **Occupancy Event/Behavior Recognition:** This problem is mostly related with the activities of the users once they are detected at certain locations. The activities can be individual or collective. Through occupancy event/behavior recognition, the behavior analysis of the individuals can be done and used for intelligent HVAC control. When Buildings used for both commercial and residential purpose will consume more amount of energy. In some developed countries almost 40% of energy consumption is due to buildings. In order to reduce the amount of energy consumption smart buildings were introduced. Smart building means by using some sensors, camera and data fusion technique occupancy monitoring, energy efficiency will be provided and it will be displayed on the mobile or laptop screen through Internet of Things (IoT).The IoT can be defined as connecting everyday objects like smart-phones, TVs, sensors and computers to the internet where the devices are smartly linked together generating new forms of communication between things and people. By using IOT, we can have real-time access to occupancy counts in different zones of the building. Human interaction is not necessary because the devices are interacting with the machines.

EXISTING SYSTEM

Existing Architecture:

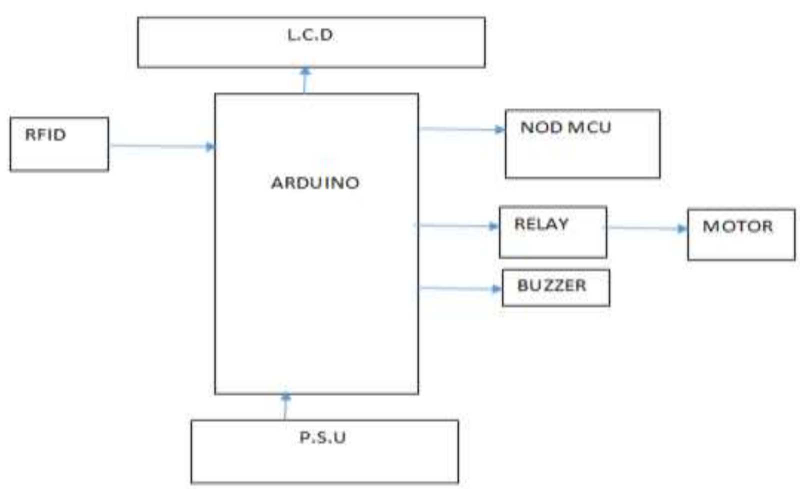


Fig 1: Block Diagram

The architecture of Point-n-Press consists of two parts: 1) the Point-n-Press remote controller (PPRC) and 2) a number of target devices, which embed in the Point-n-Press control box (PPCB) for interacting with the PPRC, as shown in Fig. 3.1. The detailed architectures of the PPRC and target devices are illustrated in Fig. 3.2. The functions of the components in the PPRC are described as follows.

- Interface Generator creates a UI according to the properties and descriptions of the target device and its current state.

- Device Profile Registry stores the information of the current target device, such as its current state and dependency between each state.

Underlying communication interfaces are used between the PPRC and the target devices, including IR, Wi-Fi, and Bluetooth. A gravity sensor (G sensor) is utilized to detect the movement of the PPRC. An IR transceiver is used to detect and identify a certain target device as the PPRC is pointed to a specific target device. Each target device, which is controlled by the PPRC, is composed of two parts:

(1) the PPCB and

(2) the home appliance. Note that even a non-UPnP conventional and legacy appliance with IR capability can be adapted and controlled with the proposed control system via the PPCB mechanism. The functions of the components in the PPCB are detailed as follows With the G sensor in the PPRC, the system can detect that the PPRC has been shaken (i.e., preparing to perform some control operations) and may be used for controlling appliances. The PPRC then sends a “Be Ready” signal to the PPCB in the vicinity via a Bluetooth or Wi-Fi wireless network. When a PPCB receives the “Be Ready” signal, the PPCB initializes and enables its internal IR receiver. Once the PPRC is fixed on and pointed to a specific PPCB, the IR receiver of the PPCB subsequently receives the signal that was transmitted from the IR transmitter of the PPRC using directionality of the IR characteristic. During this time, the Target Control component of the PPCB simultaneously transmits the DCP to the URC Control component of the PPRC via a Bluetooth or Wi-Fi wireless network. After registering the received DCP to the Device Profile Registry component, the URC Control component generates a control UI via the Interface Generator component

according to the DCP and state dependencies of the FSM.

PROPOSED SYSTEM

Proposed Architectue:

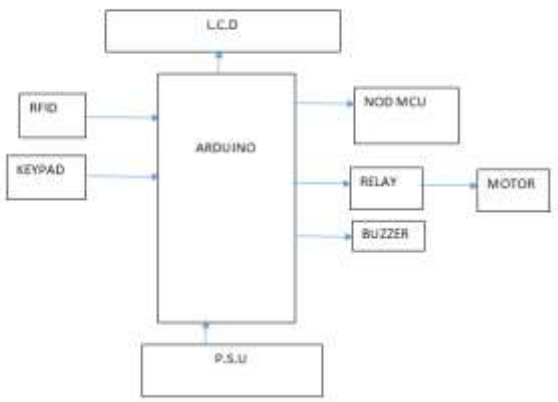


Fig 2: Block diagram

BLUETOOTH COMMUNICATION:

Introduction:

Bluetooth is a wireless technology standard for exchanging data over short distances (using short-wavelength UHF radio waves in the ISM band from 2.4 to 2.485 GHz) from fixed and mobile devices, and building personal area networks (PANs). Invented by telecom vendor Ericsson in 1994, it was originally conceived as a wireless alternative to RS-232 data cables. It can connect several devices, overcoming problems of synchronization.

Bluetooth is managed by the Bluetooth Special Interest Group (SIG), which has more than 19,000 member companies in the areas of telecommunication, computing, networking, and consumer electronics. Bluetooth was standardized as IEEE 802.15.1, but the standard is no longer maintained. The SIG oversees the development of the specification, manages the qualification program, and protects the trademarks. To be marketed as a Bluetooth device, it must be qualified to standards defined by the SIG.

Implementation:

Bluetooth operates in the range of 2400–2483.5 MHz (including guard bands). This is in the globally unlicensed (but not unregulated) Industrial, Scientific and Medical (ISM) 2.4 GHz short-range radio frequency band. Bluetooth uses a radio technology called frequency-hopping spread spectrum. The transmitted data are divided into packets and each packet is transmitted on one of the 79 designated Bluetooth channels. Each channel has a bandwidth of 1 MHz Bluetooth 4.0 uses 2MHz spacing which allows for 40 channels. The first channel starts at 2402 MHz and continues up to 2480 MHz in 1 MHz steps. It usually performs 1600 hops per second, with Adaptive Frequency-Hopping (AFH) enabled.

Originally, Gaussian frequency-shift keying (GFSK) modulation was the only modulation scheme available; subsequently, since the introduction of Bluetooth 2.0+EDR, π/4-DQPSK and 8DPSK modulation may also be used between compatible devices. Devices functioning with GFSK are said to be operating in basic rate (BR) mode where an instantaneous data rate of 1 Mbit/s is possible. The term Enhanced Data Rate (EDR) is used to describe π/4-DPSK and 8DPSK schemes, each giving 2 and 3 Mbit/s respectively. The combination of these (BR and EDR) modes in Bluetooth radio technology is classified as a "BR/EDR radio".

Bluetooth is a packet-based protocol with a master-slave structure. One master may communicate with up to seven slaves in a piconet; all devices share the master's clock. Packet exchange is based on the basic clock, defined by the master, which ticks at 312.5 µs intervals. Two clock ticks make up a slot of 625 µs; two slots make up a slot pair of 1250 µs. In the simple case of single-slot packets the master transmits in even slots and receives in odd slots; the slave, conversely, receives in even slots and transmits in odd slots. Packets may be 1, 3 or 5 slots long, but in all cases the master transmit will begin in even slots and the slave transmit in odd slots.0

Communication:

A master Bluetooth device can communicate with a maximum of seven devices in a piconet (an ad-hoc computer network using Bluetooth technology), though not all devices reach this maximum. The devices can switch roles, by agreement, and the slave can become the master (for example, a headset initiating a connection to a phone will necessarily begin as master, as initiator of the connection; but may subsequently prefer to be slave).

The Bluetooth Core Specification provides for the connection of two or more piconets to form a scatter net, in which certain devices simultaneously play the master role in one piconet and the slave role in another.

At any given time, data can be transferred between the master and one other device (except for the little-used broadcast mode.) The master chooses which slave device to address; typically, it switches rapidly from one device to another in a round-robin fashion. Since it is the master that chooses which slave to address, whereas a slave is (in theory) supposed to listen in each receive slot, being a master is a lighter burden than being a slave. Being a master of seven slaves is possible; being a slave of more than one master is difficult. The specification is vague as to required behaviour in scatter nets.

Many USB Bluetooth adapters or "dongles" are available, some of which also include an IrDA adapter.

Bluetooth Profiles:

To use Bluetooth wireless technology, a device has to be able to interpret certain Bluetooth profiles, which are definitions of possible applications and specify general behaviours that Bluetooth enabled devices use to communicate with other Bluetooth devices. These profiles include settings to parameterize and to control the communication from start. Adherence to profiles saves the time for transmitting the parameters anew before the bi-directional link becomes effective. There are a wide range of Bluetooth profiles that describe many different types of applications or use cases for devices.

Bluetooth Vs. Wi-Fi Technology:

Bluetooth and Wi-Fi (the brand name for products using IEEE 802.11 standards) have some similar applications: setting up networks, printing, or transferring files. Wi-Fi is intended as a replacement for high speed cabling for general local area network access in work areas. This category of applications is sometimes called wireless local area networks (WLAN). Bluetooth was intended for portable equipment and its applications. The category of applications is outlined as the wireless personal area network (WPAN). Bluetooth is a replacement for cabling in a variety of personally carried applications in any setting and also works for fixed location applications such as smart energy functionality in the home (thermostats, etc.).

Wi-Fi and Bluetooth are to some extent complementary in their applications and usage. Wi-Fi is usually access point-centred, with an asymmetrical client-server connection with all traffic routed through the access point, while Bluetooth is usually symmetrical, between two Bluetooth devices. Bluetooth serves well in simple applications where two devices need to connect with minimal configuration like a button press, as in headsets and remote controls, while Wi-Fi suits better in applications where some degree of client configuration is possible and high speeds are required, especially for network access through an access node. However, Bluetooth access points do exist and ad-hoc connections are possible with Wi-Fi though not as simply as with Bluetooth. Wi-Fi Direct was recently developed to add a more Bluetooth-like ad-hoc functionality to Wi-Fi.

Devices

Bluetooth exists in many products, such as telephones, tablets, media players, robotics systems, handheld and console gaming equipment, and some high definition headsets, modems, and watches. The technology is useful when transferring information between two or more devices that are near each other in low-bandwidth situations. Bluetooth is commonly used to transfer sound data with telephones (i.e., with a Bluetooth headset) or byte data with hand-held computers (transferring files).

Bluetooth protocols simplify the discovery and setup of services between devices. Bluetooth devices can advertise all of the services they provide. This makes using services easier, because more of the security, network address and permission configuration can be automated than with many other network types.

Specifications & Features:

The Bluetooth specification was developed as a cable replacement in 1994 by Jaap Haartsen and Sven Mattisson, who were working for Ericson Lund, Sweden. The specification is based on frequency-hopping spread spectrum technology.

The specifications were formalized by the Bluetooth Special Interest Group (SIG). The SIG was formally announced on 20 May 1998. Today it has a membership of over 19,000 companies worldwide. It was established by Ericsson, IBM, Intel, Toshiba and Nokia, and later joined by many other companies.

All versions of the Bluetooth standards are designed for downward compatibility. That lets the latest standard cover all older versions.

-Bluetooth v1.0 and v1.0B

-Bluetooth v1.1

-Bluetooth v1.2

-Bluetooth v2.0 + EDR

-Bluetooth v2.1 + EDR

-Bluetooth v3.0 + HS

-Ultra-wideband

-Bluetooth Smart (v4.0 & 4.1)

This version is the latest one developed. The Bluetooth SIG completed the Bluetooth

Core Specification version 4.0 (called Bluetooth Smart) and has been adopted as of 30 June 2010. It includes Classic Bluetooth, Bluetooth high speed and Bluetooth low energy protocols. Bluetooth high speed is based on Wi-Fi, and Classic Bluetooth consists of legacy Bluetooth protocols.

Bluetooth low energy (BLE), previously known as Wibree is a subset of Bluetooth v4.0 with an entirely new protocol stack for rapid build-up of simple links. As an alternative to the Bluetooth standard protocols that were introduced in Bluetooth v1.0 to v3.0, it is aimed at very low power applications running off a coin cell.

Our Module:

The internet of Things (IoT) is viewed as an innovation and financial wave in the worldwide data industry after the Internet. The IoT is a wise system which associates all things to the Internet with the end goal of trading data and conveying through the data detecting gadgets as per concurred conventions. It accomplishes the objective of keen recognizing, finding, following, observing, and overseeing things [1]. It is an augmentation and extension of Internet-based system, which grows the correspondence from human and human to human and things or things and things.

Table 1: PIN Definitions

PIN DEFINITIONS

PIN	PIN NAME	DETAILS
GND	Ground	Ground Level of Power supply
5V	Power Supply	Power Supply Input (5V)
RXD	Receive	Pin for Data Reception
TXD	Transmit	Pin for Data Transmission
RST	Reset	Reset Input (Internally Pulled-Up)

In the IoT worldview, many articles encompassing us will be associated into systems in some shape [4]. It is a current correspondence paradigm that envisions a near future, in which the objects of regular day to day existence will be outfitted with microcontrollers, handsets for computerized correspondence, and reasonable convention stacks that will make them ready to speak with each other and with the clients, turning into a vital piece of the Internet [5]. The IoT idea, consequently, goes for making the Internet much more immersive and unavoidable. Moreover, by empowering simple get to and association with a wide assortment of gadgets, for example, for example, home apparatuses, reconnaissance cameras, checking sensors, actuators, showcases, vehicles, et cetera, the IoT will encourage the advancement of various applications that make utilization of the possibly gigantic sum and assortment of information created by such questions give new administrations to subjects, organizations, and open organizations. This worldview in reality finds application in a wide range of areas, for example, home mechanization, modern robotization, therapeutic guides, versatile human services, elderly help, clever vitality administration and brilliant networks, car, traffic administration, and numerous others [6]. Now coming the main topic, Environmental issues like environmental change have gotten much consideration as of late, and natural checking make us ready to pick up an expansive comprehension of regular environmental forms. Environmental monitoring procedures is a basic assignment for both researchers and specialists. From past decade environmental data has gotten an extremely quick advancement and wide applications in checking environmental processes. Environmental informatics includes particular natural issues identified with the uses of software engineering and frameworks building methods, administration information framework, and ecological data framework, which were intended to gather, process and trade information since the 1980s. Automatic data acquisition has been quickly expanded by assortment of advancements, for example, remote detecting, land data framework, worldwide situating framework et cetera. From the 2000s, the multiplication of programmed information securing innovations, for example, radio recurrence recognizable proof and sensor advances, was acquainted with make choice emotionally supportive networks and coordinated ecological data systems and furthermore conveyed new essentialness to environmental monitoring. The fast advancement and wide utilization of natural informatics has huge enhanced environmental monitoring and viability. In the most recent decade, the internet of things (IoT), an idea depicting how the internet reaches out into people groups' regular daily existences through a remote system of particularly identifiable objects[1], is anticipated to have the capacity to advance the whole procedure of environmental monitoring[2]. Present developments in innovation principally concentrate on controlling and checking of various exercises. These are progressively rising to achieve the human needs. Most of this innovation is centered around proficient observing and controlling diverse exercises. A proficient natural observing framework is required to screen and evaluate the conditions if there should arise an occurrence of surpassing the endorsed level of parameters (e.g., temperature, humidity, CO). At the point when the objects like environment outfitted with sensor gadgets, microcontroller and different programming applications turns into a self-securing and self-observing condition and it is likewise called as smart environment. In such environment when some occasion happens the alert alarms automatically. The impacts due to the natural changes on creatures, plants and human creatures can be checked and controlled by smart environmental monitoring system. By embedded intelligence insight into the earth makes environment intelligent with different destinations, this is one of the application that smart environment targets. Human needs requests distinctive sorts of observing frameworks these are relies on upon the sort of information accumulated by the sensor gadgets. Occasion Detection based and Spatial Handle Estimation are the two classes to which applications are arranged. At first the sensor gadgets are sent in condition to detect the parameters (e.g., Temperature, Humidity, Pressure, rain and CO and so on.) while the information obtaining, computation and controlling activity (e.g., the varieties in the temperature, weight, mugginess and CO levels as for the predetermined levels). Sensor gadgets are put to gather the information to anticipate the conduct of a specific territory of intrigue.

The primar A weather station is a setup well-equipped with instruments and sensors to measure different atmospheric conditions to forecast the weather information like temperature, pressure, humidity, wind speed and direction, rainfall etc. and predict the upcoming natural calamities after studying the trend of climate change. So the grandness of a live weather station is limitless providing a plethora of information which are very essential in innumerable fields straddling from local disaster monitoring to global level alertness to weather researchers to industry and so on.

Wireless Sensor networks (WSNs) are the technology that is the combination of low cost and low power array of sensors and embedded unit (microcontrollers) that could provide ubiquitous computing [1] to detect the environmental changes, and log a chunk of collected data to a centralized remote server wirelessly. The term “Internet of Things” (IoT), coined by Kevin Ashton in 1999 [2], has been in use for several years and continues to be of interest, specifically when it comes to technological progress [3].

HARDWARE INTRODUCTION

ARDUINO UNO

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. The Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode.

The Board Has The Following New Features:

1.0 pinout: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible with both the board that uses the AVR, which operates with 5V and with the Arduino Due that operates with 3.3V. The second one is a not connected pin, that is reserved for future purposes.

Stronger RESET circuit.

Atmega 16U2 replace the 8U2.

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards.

Arduino Pin Diagram:

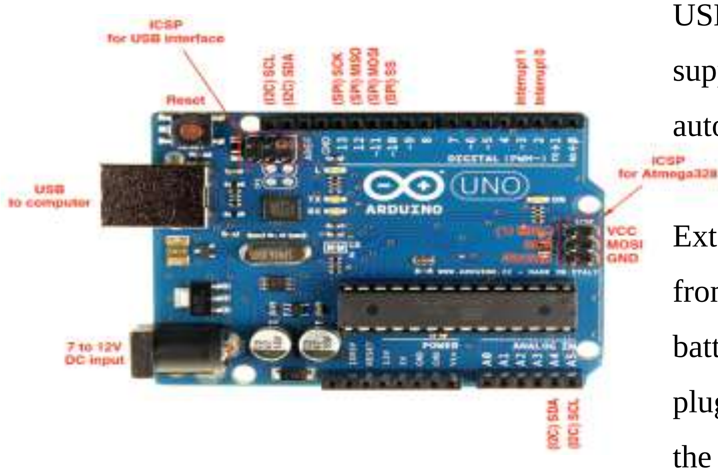


Fig.3 AURDINO BOARD

Power:

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically.

External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.

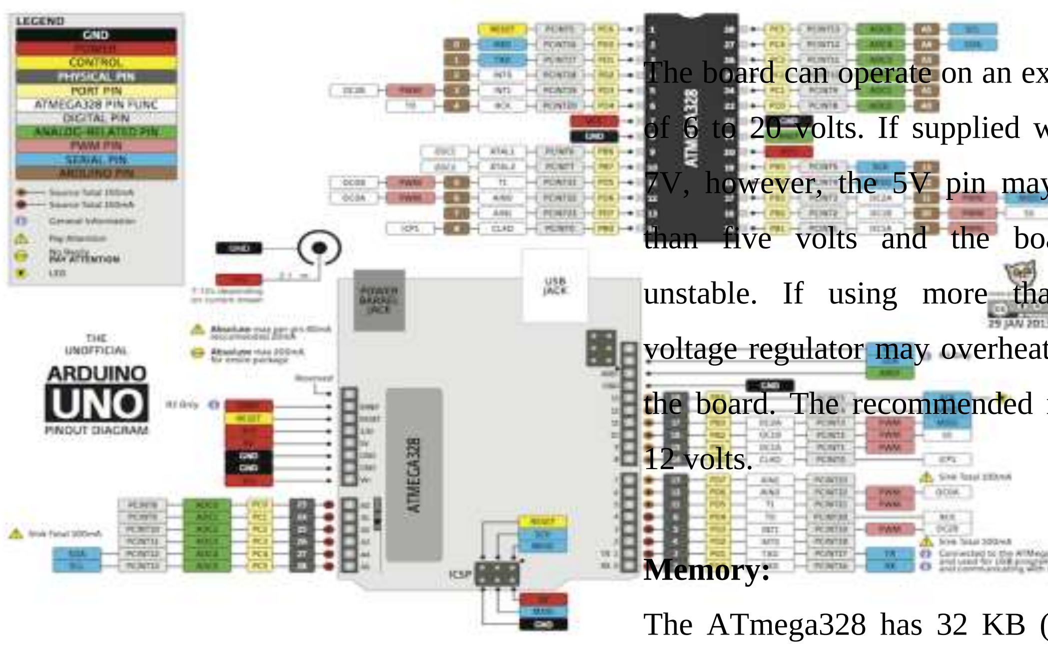


Fig.4 PIN DESCRIPTION

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

Memory:

The ATmega328 has 32 KB (with 0.5 KB used for the bootloader). It also has 2 KB of

SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

Input and Output:

Each of the 14 digital pins on the Uno can be used as an input or output, using pinmode,digitalwrite , and digitalreadfunctions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms.

Communication:

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

USB Overcurrent Protection:

The Arduino Uno has a resettable polyfuse that protects your computer's USB ports from shorts and overcurrent. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If more than 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed.

Automatic (Software) Reset:

Rather than requiring a physical press of the reset button before an upload, the Arduino Uno is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2/16U2 is connected to the reset line of the ATmega328 via a 100 nanofarad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino software uses this capability to allow you to upload code by simply pressing the upload button in the Arduino environment. This means that the bootloader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload.

This setup has other implications. When the Uno is connected to either a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the bootloader is running on the Uno. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, make sure that the software with which it communicates waits a second after opening the connection and before sending this data.
The Uno contains a trace that can be cut to disable the auto-reset. The pads on either side of the trace can be soldered together to re-enable it.

Physical Characteristics

The maximum length and width of the Uno PCB are 2.7 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension. Four screw holes allow the board to be attached to a surface or case. Note that the distance between digital pins 7 and 8 is 160 mil (0.16"), not an even multiple of the 100 mil spacing of the other pins.

16x2 LCD DISPLAY

Liquid crystal displays (LCD’s) have materials which combine the properties of both liquids and crystals. Rather than having a melting point, they have a temperature range within which the molecules are almost as mobile as they would be in liquid, but are grouped together in an ordered form similar to a crystal.

The LCD’s are lightweight with only a few millimetres thickness. Since the LCD’s consume less power they are compatible with low power electronic circuits and can be powered for long durations.

The LCD’s are used extensively in watches, calculators and measuring instruments is the simple seven-segment displays, having a limited amount of data.

The following figure shows a general purpose alphanumeric LCD, with two lines of 16 characters:

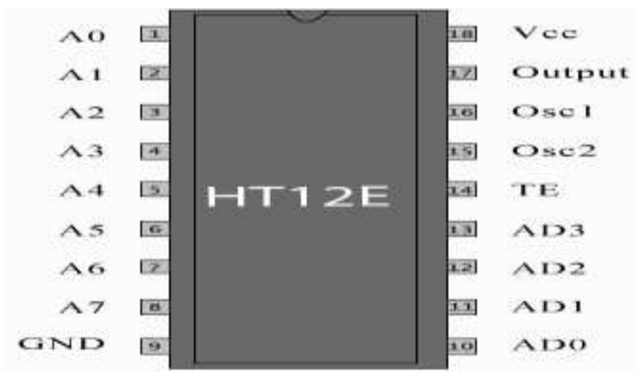
Fig 5: LCD

HT12E:

HT12E is an encoder integrated circuit of 212 series of encoders. They are paired with 212 series of decoders for use in remote control system applications. It is mainly used in interfacing RF and infrared circuits. The chosen pair of encoder/decoder should have same number of addresses and data format.

Simply put, HT12E converts the parallel inputs into serial output. It encodes the 12 bit parallel data into serial for transmission through an RF transmitter. These 12 bits are divided into 8 address bits and 4 data bits.

HT12E has a transmission enable pin which is active low. When a trigger signal is received on TE pin, the programmed addresses/data are transmitted together with the header bits via an RF or an infrared transmission medium. HT12E begins a 4-word transmission cycle upon receipt of a transmission enable. This cycle is repeated as long as TE is kept low. As soon as TE returns to high, the encoder output completes its final cycle and then stops.



HT12D:

HT12D is a decoder integrated circuit that belongs to 212 series of decoders. This series of decoders are mainly used for remote control system applications, like burglar alarm, car door controller, security system etc. It is mainly provided to interface RF and infrared circuits. They are paired with 212 series of encoders. The chosen pair of encoder/decoder should have same number of addresses and data format.

In simple terms, HT12D converts the serial input into parallel outputs. It decodes the serial addresses and data received by, say, an RF receiver, into parallel data and sends them to output data pins. The serial input data is compared with the local addresses three times continuously. The input data code is decoded when no error or unmatched codes are found. A valid transmission in indicated by a high signal at VT pin.

HT12D is capable of decoding 12 bits, of which 8 are address bits and 4 are data bits. The data on 4 bit latch type output pins remain unchanged until new is received.

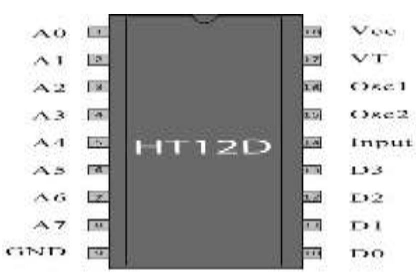


Fig.7: Pin diagram

WIFI MODULE

The ESP8266 is a System on a Chip (SoC), manufactured by the Chinese company Espressif. It consists of a Tensilica L106 32-bit micro controller unit (MCU) and a Wi-Fi transceiver. It has 11 GPIO pins* (General Purpose Input/Output pins), and an analog input as well. This means that you can program it like any normal Arduino or other microcontroller. And on top of that, you get Wi-Fi communication, so you can use it to connect to your Wi-Fi network, connect to the Internet, host a web server with real web pages, let your smartphone connect to it, etc

The possibilities are endless! It's no wonder that this chip has become the most popular IOT device available.

The ESP8266 WiFi Module is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor.

Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much WiFi-ability as a WiFi Shield offers (and that’s just out of the box)! The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community.

This module has a powerful enough on-board processing and storage capability that allows it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. Its high degree of on-chip integration allows for minimal external circuitry, including the front-end module, is designed to occupy minimal PCB area.

The ESP8266 supports APSD for VoIP applications and Bluetooth co-existance interfaces, it contains a self-calibrated RF allowing it to work under all operating conditions, and requires no external RF parts.

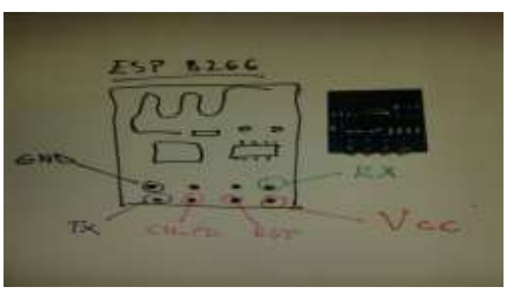
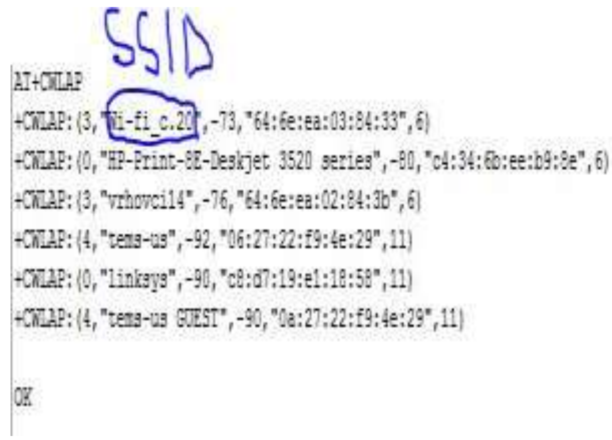


Fig.8: ESP8266 pin diagram

As shown in the picture, ESP8266 has 8 pins, 4 in the row of 2. The first pin on the top left is GND. The two pins right from the GND are GPIO 2 and 0. I'm not going to use these pins, as they are not impirtant for the operation. The pin on the top right side is the RX pin and the pin on the lower left is TX. These are the pins for comunication. The middle pins on the bottom are CH_PD(chip power-down) and RST(reset).

The main thing to remember is, that this device works with 3.3V;even the RX and TX pins. Arduino or many USB to serial converters work with 5V. The solution for this project is in the next step.

Talking to the ESP8266
Relay



RELAY

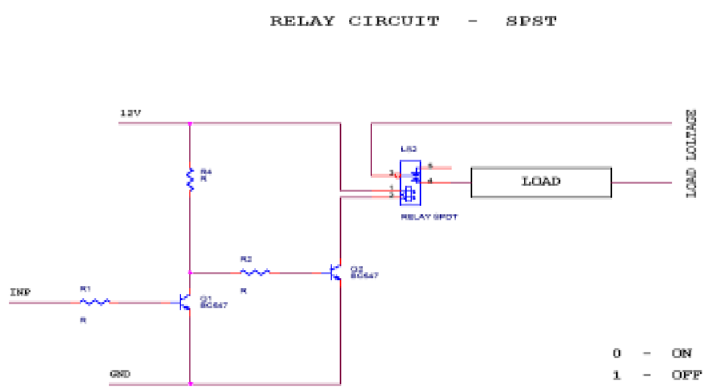


Fig.9: Spst relay

A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and they are double throw (changeover) switches. Relays allow one circuit to switch a second circuit which can be completely separate from the first. For example a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside the relay between the two circuits; the link is magnetic and mechanical.

The coil of a relay passes a relatively large current, typically 30mA for a 12V relay, but it can be as much as 100mA for relays designed to operate from lower voltages.

Most ICs (chips) cannot provide this current and a transistor is usually used to amplify the small IC current to the larger value required for the relay coil. The maximum output current for the popular 555 timer IC is 200mA so these devices can supply relay coils directly without amplification.

Fig.10 relays

Relays are usually SPDT or DPDT but they can have many more sets of switch contacts, for example relays with 4 sets of changeover contacts are readily available. Most relays are designed for PCB mounting but you can solder wires directly to the pins providing you take care to avoid melting the plastic case of the relay. The animated picture shows a working relay with its coil and switch contacts. You can see a lever on the left being attracted by magnetism when the coil is switched on. This lever moves the switch contacts. There is one set of contacts (SPDT) in the foreground and another behind them, making the relay DPDT.

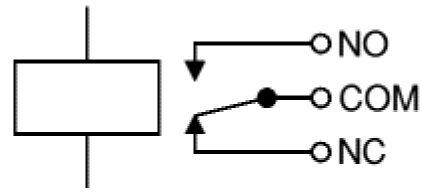


Fig.11 Relay internal diagram

The relay's switch connections are usually labeled COM, NC and NO:

- COM = Common, always connect to this, it is the moving part of the switch.
- NC = Normally Closed, COM is connected to this when the relay coil is off.
- NO = Normally Open, COM is connected to this when the relay coil is on.

Circuit description:

This circuit is designed to control the load. The load may be motor or any other load. The load is turned ON and OFF through relay. The relay ON and OFF is controlled by the pair of switching transistors (BC 547). The relay is connected in the Q2 transistor collector terminal. A Relay is nothing but electromagnetic switching device which consists of three pins. They are Common, Normally close (NC) and Normally open (NO).

The relay common pin is connected to supply voltage. The normally open (NO) pin connected to load. When high pulse signal is given to base of the Q1 transistors, the transistor is conducting and shorts the collector and emitter terminal and zero signals is given to base of the Q2 transistor. So the relay is turned OFF state.

When low pulse is given to base of transistor Q1 transistor, the transistor is turned OFF. Now 12v is given to base of Q2 transistor so the transistor is conducting and relay is turned ON. Hence the common terminal and NO terminal of relay are shorted. Now load gets the supply voltage through relay.

Temperature Sensor:

LM35 is a precision IC temperature sensor with its output proportional to the temperature (in oC). The sensor circuitry is sealed and therefore it is not subjected to oxidation and other processes. With LM35, temperature can be measured more accurately than with a thermistor. It also possess low self heating and does not cause more than 0.1 oC temperature rise in still air.

The operating temperature range is from -55°C to 150°C. The output voltage varies by 10mV in response to every oC rise/fall in ambient temperature, i.e., its scale factor is 0.01V/ oC.

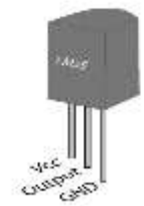


Fig.12 Pin Diagram

In general, a temperature sensor is a device which is designed specifically to measure the hotness or coldness of an object.LM35 is a precision IC temperature sensor with its output proportional to the temperature (in °C).With LM35,the temperature can be measured more accurately than with a thermistor. It also possess low self heating and does not cause more than 0.1 °C temperature rise in still air. The operating temperature range is from -55°C to 150°C.The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy.It has find its applications on power supplies,battery management,appliances,etc.click here for datasheet. The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in °C).It can measure temperature more accurately than a using a thermistor. The sensor circuitry is sealed and not subject to oxidation.The LM35 generates a higher output voltage than thermocouples and may not require that the output voltage be amplified.The LM35 has an output voltage that is proportional to the Celsius temperature.The scale factor is .01V/°C.

The LM35 does not require any external calibration or trimming and maintains an accuracy of +/-0.4°C at room temperature and +/-0.8°C over a range of 0°C to +100°C.Another important characteristic of the LM35 is that it draws only 60 micro amps from its supply and possesses a low self-heating capability.The LM35 comes in many different packages such as TO-92 plastic transistor-like package,T0-46 metal can transistor-like package,8-lead surface mount SO-8 small outline package.

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ˚ Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4˚C at room temperature and ±3⁄4˚C over a full −55 to +150˚C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1˚C in still air.

The LM35 is rated to operate over a −55˚ to +150˚C temperature range, while the LM35C is rated for a −40˚ to +110˚C range (−10˚ with improved accuracy). The LM35 series is available pack aged in hermetic TO-46 transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package. The LM35D is also available in an 8-lead surface mount small outline package and a plastic TO-220 package

LDR:

A Light Dependent Resistor (LDR) or a photo resistor is a device whose resistivity is a function of the incident electromagnetic radiation. Hence, they are light sensitive devices. They are also called as photo conductors, photo conductive cells or simply photocells. They are made up of semiconductor materials having high resistance. There are many different symbols used to indicate a LDR, one of the most commonly used symbol is shown in the figure below. The arrow indicates light falling on it.

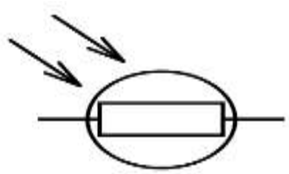


FIG.13: LDR

Lighting switch

The most obvious application for an LDR is to automatically turn on a light at certain light level. An example of this could be a street light or a garden light.

Camera shutter control

LDRs can be used to control the shutter speed on a camera. The LDR would be used the measure the light intensity and the set There are two specification where the DHT11 is better than the DHT22. That's the sampling rate which for the DHT11 is 1Hz or one reading every second, while the DHT22 sampling rate is 0,5Hz or one

the camera shutter speed to the appropriate level.

Humidity Sensor:

The DHT22 is the more expensive version which obviously has better specifications. Its temperature measuring range is from -40 to +125 degrees Celsius with +-0.5 degrees accuracy, while the DHT11 temperature range is from 0 to 50 degrees Celsius with +-2 degrees accuracy. Also the DHT22 sensor has better humidity measuring range, from 0 to 100% with 2-5% accuracy, while the DHT11 humidity range is from 20 to 80% with 5% accuracy.

0 - 50°C / ± 2°C	*Temperature Range*	-40 - 125 °C / ± 0.5 °C
20 - 80% / ± 5%	*Humidity Range*	0 - 100 % / ± 2-5%
1Hz (one reading every second)	*Sampling Rate*	0.5 Hz (one reading every two seconds)
15.5mm x 12mm x 5.5mm	*Body Size*	15.1mm x 25mm x 7.7mm
3 - 5V	*Operating Voltage*	3 - 5V
2.5mA	*Max Current During Measuring*	2.5mA

Fig.14 DHT11 AND DHT22

reading every two seconds and also the DHT11 has smaller body size. The operating voltage of both sensors is from 3 to 5 volts, while the max current used when measuring is 2.5mA.

Fig.15 PIN DIAGRAMS

WORKING PRINCIPLE:

Ok now let's see how these sensors actually work. They consist of a humidity sensing component, a NTC temperature sensor (or thermistor) and an IC on the back side of the sensor.

The DHT11 detects water vapor by measuring the electrical resistance between two electrodes. The humidity sensing component is a moisture holding substrate with electrodes applied to the surface. When water vapor is absorbed by the substrate, ions are released by the substrate which increases the conductivity between the electrodes. The change in resistance between the two electrodes is proportional to the relative humidity. Higher relative humidity decreases the resistance between the electrodes, while lower relative humidity increases the resistance between the electrodes.

The DHT11 measures temperature with a surface mounted NTC temperature sensor (thermistor) built into the unit.

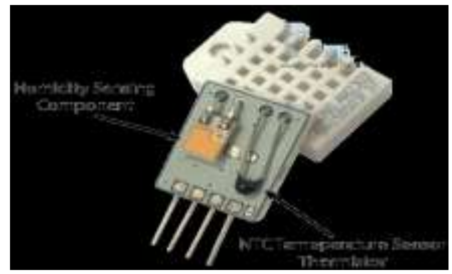


Fig.16 INTERNAL DIAGRAM

For measuring humidity they use the humidity sensing component which has two electrodes with moisture holding substrate between them. So 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.

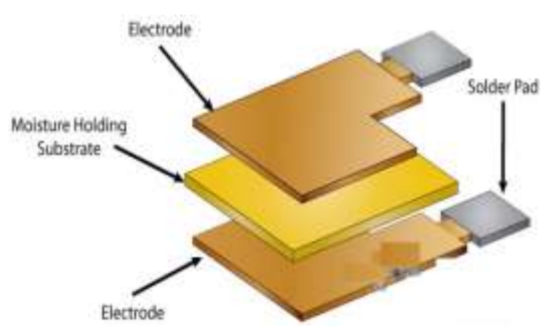


Fig.17 LAYER DIAGRAM

On the other hand, for measuring temperature these sensors use a NTC temperature sensor or a thermistor. A thermistor is actually a variable resistor that changes its resistance with change of the temperature. These sensors are made by sintering of semiconductive 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 of the temperature.

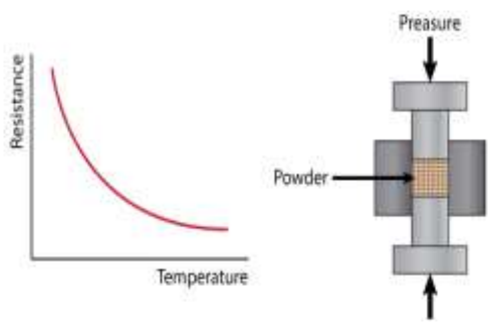


Fig.18 CHARACTERISTICS

Pressure Monitor

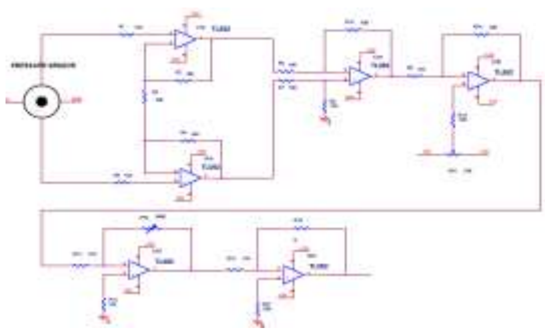


Fig.19: CIRCUIT DIAGRAM

PRESSURE:

Pressure (symbol: p) is the force per unit area applied on a surface in a direction perpendicular to that surface. Mathematically:

$$p = \frac{F}{A}$$

where:

p is the pressure

F is the normal force

A is the area.

Pressure is a scalar, and has SI units of pascals, 1 Pa = 1 N/m2.

Pressure is transmitted to solid boundaries or across arbitrary sections of fluid normal to these boundaries or sections at every point. It is a fundamental parameter in thermodynamics and it is conjugate to volume.

CIRCUIT DESCRIPTION:

This circuit is designed to measure the varying pressure. The pressure is measured by diaphragm which is one type of transducer. When pressure is applied, the diaphragm is moving in the forward side. The diaphragm moving is depends on the pressure. So it generates the voltage pulse depends on the movement of diaphragm. The voltage pulses are in the range of milli voltage. Hence the voltage pulse is given to Instrumentation amplifier section in order to amplify the signals.

The important features of instrumentation amplifier are high gain accuracy, high CMRR, low output impedance. Here the instrumentation amplifier is constructed by TL 082 operational amplifier. The TL 082 is the dual operational amplifier that is two operational amplifiers is fabricated in single chip. Here the instrumentation amplifier acts as differential instrumentation amplifier.

The diaphragm transducer terminals are connected to A1 and A2 amplifier of the differential instrumentation amplifier. The difference of the varying voltage signals from the transducer is amplified by the instrumentation amplifier.

The A4 amplifier is used for zero adjustment. When there is no pressure the diaphragm may be sliding in the forward or reverse side. Due to that instrumentation amplifier delivered some voltage at the output. To avoid this problem A4 amplifier is used for zero adjustment. Hence when there is no pressure the output is zero.

The A5 amplifier acts as gain amplifier in which variable resistors is connected as feedback resistor. By adjusting the feedback resistor we can vary the gain of the output signal. Then the final gain adjusted signal is amplified by the A6 amplifier.

SOFTWARE:

The Arduino Software (IDE) allows you to write programs and upload them to your board. In the Arduino Software page you will find two options:

1) If you have a reliable Internet connection, you should use the online IDE (Arduino Web Editor). It will allow you to save your sketches in the cloud, having them available from any device and backed up. You will always have the most up-to-date version of the IDE without the need to install updates or community generated libraries.

2) If you would rather work offline, you should use the latest version of the desktop IDE.

MANTECH Publications

Journal of Power Electronics and Drives
Volume 3, Issue 1, January-April 2018

V. RESULTS

Fig.20: Hardware setup

The above figure shows the hardware setup of this paper consisting of aurdino , temperature, humidity, pressure, rain and CO sensors. In the wake of detecting the information from various sensor gadgets, which are set specifically range of intrigue. The Wi-Fi association must be set up to exchange sensors information to end client and furthermore send it to the cloud storage for future utilization. The detected information will be consequently sent to the web server, when a legitimate association is built up with server device. The detected information will be put away in cloud (Google Spread Sheets). The information put away in cloud can be utilized for the examination of the parameter and consistent observing reason. The above demonstrates the temperature, humidity, pressure, rain and CO in air at customary time interims. All the data will be put away in the cloud, with the goal that we can give slanting of temperature, humidity, pressure, rain and CO levels in a specific territory at anytime of time.

Fig.21: Weather data updating

ADVANTAGES AND APPLICATIONS

Advantages

- Small In Size
- Easy To Operate
- Quick Response

Appications

Numerous technical benefits may be obtained when combining the functionality of a smart home with online social networking. At first, the authentication mechanisms of SNS can be leveraged to achieve user authentication with just a few lines of code. User authentication would then allow the creation of authorization schemes for each user category. Some SNS even offer the possibility of creating private groups of users. Solely the administrators of these groups can approve requests for new members to join. Therefore, a role-based authorization mechanism can be built without much effort. For example, we exploited this functionality to allow the owner of the smart home to restrict access to his family members, in order to fully manipulate their house through the SNS application.

CONCLUSION

The occupancy monitoring in energy efficient smart buildings with security system using Internet of Things has been presented in this paper. The proposed method was successfully designed, a system that communicates with a mobile device such as a smart phone or laptop via Arduino uno to get the information about occupancy monitoring through door sensors. Our research shows many types of applications for implementing smart buildings and the applications are not limited to those discussed in this paper. This would help reduce the overall cost of the devices as well as the size. But still the size of the circuit has to be reduced. Currently for the prototype, a generic breadboard style board was used.

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