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A Next-Generation Iot-Integrated Arduino System for Intelligent Home Environment Monitoring

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ABSTRACT

To stay informed about home living conditions, a home environment monitoring device was developed using an Arduino platform. Utilizing the Arduino UNO hardware and an array of sensors, the device captures real-time data on indoor temperature, humidity, light levels, and the presence of combustible gases. This information is then uploaded to a monitoring platform, allowing for adjustments to the surrounding environment based on the collected data. Testing has demonstrated that the design effectively gathers and reliably uploads home environment data, meeting the requirements for remote monitoring of living conditions. The device offers several advantages, including low cost, minimal power consumption, a simple structure, and easy installation.

Key Words: Arduino UNO, home environment monitoring, real-time data, sensors, remote monitoring, low cost, low power consumption, simple structure, easy installation.

INTRODUCTION

The rise of the Internet of Things (IoT) has revolutionized the world by integrating electronic sensors and various devices to monitor and control environments in critical situations. These sensors and wireless devices can detect, store, and transmit data to [1] remote storage systems, commonly referred to as the cloud, where the data is analyzed and presented in a user-friendly manner. This cloud-based information is accessible to different end users

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through interfaces designed for various mobile applications, tailored to their needs. The internet plays a crucial role in this transformation, ensuring the efficient, reliable, and fast transfer of data from devices to the cloud and then to end users. The underlying concept of this prototype is that an end system comprises numerous devices or "things" at the host end, hence the term "Internet of Things." These devices, or "things," are equipped to perform tasks such as sensing and transmitting data related to temperature, [2] humidity, pollution levels, and more. The IoT concept is particularly effective in scenarios where manual intervention is infrequent or impractical, such as environmental monitoring.

BLOCK DIAGRAM

Proposed Work Description

The proposed work aims to develop a next-generation IoT-integrated system for intelligent home environment monitoring, utilizing the Arduino platform as the core hardware. The system will be equipped with a suite of sensors to continuously monitor key environmental parameters such as temperature, humidity, light levels, and the presence of combustible gases within a home setting. This data will be collected in real-time and transmitted via wireless communication to a cloud-based platform, where it will be stored and analyzed. The cloud platform will enable remote monitoring and control, allowing users to access and adjust their home environment through an intuitive mobile application or web interface. The system is designed to be cost-effective, energy-efficient, and easy to install, making it accessible for widespread use in smart home applications. The integration of IoT technology will facilitate seamless communication between devices, ensuring that environmental conditions are optimized according to the user's preferences and safety requirements. The expected outcomes include a reliable and scalable monitoring solution that not only enhances comfort and convenience but also contributes to the safety and energy efficiency of modern homes.

HARDWARE REQUIREMENT

- Arduino Board
- Temperature And Humidity Sensor (Dht11/Dht22)
- Gas/Smoke Sensor (Mq-2/Mq-135)
- Light Sensor (LDR)
- Motion Sensor (PIR Sensor)
- Air Quality Sensor (Mq135):
- Sound Sensor
- Water Leak Sensor
- Actuators

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- Bluetooth Module (Hc-05/Hc-06)
- Zigbee Module (Xbee)
- Voltage Regulator

SOFTWARE REQUIREMENT ARDUINO IDE

Arduino is an open-source hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices. It's hardware products are licensed under a CC BY-SA license, while the software is licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL), permitting the manufacture of Arduino boards and software distribution by anyone.

HARDWARE

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards ('shields') or breadboards (for prototyping) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs. The microcontrollers can be programmed using the C and C++ programming languages, using a standard API which is also known as the Arduino Programming Language, inspired by the Processing language and used with a modified version of the Processing IDE. In addition to using traditional compiler [3] tool chains, the Arduino project provides an integrated development environment (IDE) and a command line tool developed in Go. An early Arduino board with an RS-232 serial interface (upper left) and an Atmel ATmega8 microcontroller chip (black, lower right); the 14 digital I/O pins are at the top, the 6 analog input pins at the lower right, and the power connector at the lower left. Most [4] Arduino boards consist of an Atmel 8-bit AVR microcontroller (ATmega8 ATmega168, ATmega328, ATmega1280, or ATmega2560) with varying amounts of flash memory, pins, and features. The 32- bit Arduino Due, based on the Atmel SAM3X8E was introduced in 2012. The boards use single or double-row pins or female headers that facilitate connections for programming and incorporation into other circuits. These may connect with add-on modules termed shields. Multiple and possibly stacked shields may be individually addressable via an I2C serial bus. Most boards include a 5 V linear regulator and a 16 MHz crystal oscillator or ceramic resonator. Some designs, such as the Lily Pad, run at 8 MHz and dispense with the onboard voltage regulator due to specific form-factor restrictions .Arduino microcontrollers are pre-programmed with a boot loader that simplifies the uploading of programs to the on-chip flash memory. The default boot loader of the Arduino Uno is the Opti boot loader. Boards are loaded with program code via a serial connection to another computer. [5] Some serial Arduino boards contain a level shifter circuit to convert between RS-232 logic levels

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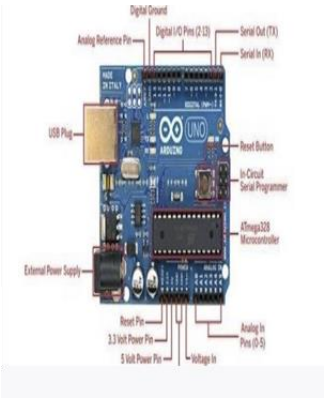
and transistor–transistor logic (TTL) level signals. Current Arduino boards are programmed via Universal Serial Bus (USB), implemented using USB-to-serial adapter chips such as the FTDI FT232. Some boards, such as later-model Uno boards, substitute the FTDI chip with a separate AVR chip containing USB-to- serial firmware, which is reprogrammable via its own ICSP header. Other variants, such as the Arduino Mini and the unofficial Boarduino, use a detachable USB-to- serial adapter board or cable, Bluetooth or other methods. When used with traditional microcontroller tools, instead



of the Arduino IDE, standard AVR in- system programming (ISP) programming is used. The Arduino board exposes most of the microcontroller's I/O pins for use by other circuits. The current Uno provide 14 digital I/O pins, six of which can produce pulse-width modulated signals, and six analog inputs, which can also be used as six digital I/O pins. These pins are on the top of the board, via female 0.1- inch (2.54 mm) headers. Several plug-in application shields are also commercially available. The Arduino Nano and Arduino-compatible Bare Bones Board and arduino boards may provide male header pins on the underside of the board that can plug into solder less [6] breadboards. Many Arduino-compatible and Arduino-derived boards exist. Some are functionally equivalent to an Arduino and can be used interchangeably. Many enhance the basic Arduino by adding output drivers, often for use in school-level education, to simplify making buggies and small robots. Others are electrically equivalent, but change the form factor, sometimes retaining compatibility with shields, sometimes not. Some variants use different processors, of varying compatibility. Arduino and Arduino-compatible boards use printed circuit expansion boards called shields, which plug into the normally supplied Arduino pin headers. Shields can provide motor controls for 3D printing and other applications, GNSS (satellite navigation), Ethernet, liquid crystal display (LCD), or bread boarding (prototyping). Several shields can also be made do it yourself.

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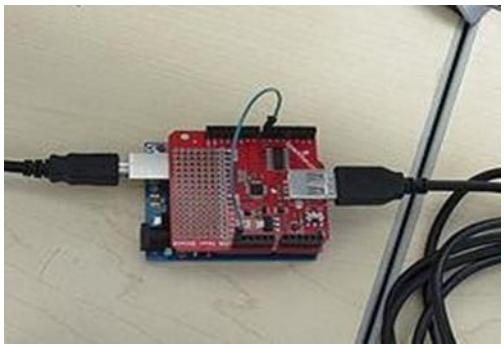
ARDUINO HARDWARE PART



Arduino is open-source hardware. The hardware reference designs are distributed under a Creative Commons Attribution Share-Alike 2.5 license and are available on the Arduino website. Layout and production files for some versions of the hardware are also available. Although the hardware and software designs are freely available under copy left licenses, the developers have requested the name Arduino to be exclusive to the official product and not be used for derived works without permission. The official policy document on use of the Arduino name emphasizes that the project is open to incorporating work by others into the official product. Several Arduino-compatible products commercially released have avoided the project name by using various names ending in -duino. Most Arduino boards consist of an Atmel 8-bit AVR microcontroller (ATmega8, ATmega168, ATmega328, ATmega1280, ATmega2560) with varying amounts of flash memory, pins, and features. The 32-bit Arduino Due, based on the Atmel SAM3X8E was introduced in 2012. The boards use single or double-row pins or female headers that facilitate connections for programming and [7] incorporation into other circuits. These may connect with add-on modules termed shields. Multiple and possibly stacked shields may be individually addressable via an I²C serial bus. Most boards include a 5 V linear regulator and a 16 MHz crystal oscillator or ceramic resonator. Some designs, such as the Lily Pad, run at 8 MHz and dispense with the onboard voltage regulator due to specific form-factor restrictions. Arduino microcontrollers are pre-programmed with a boot loader that simplifies uploading of programs to the on-chip flash memory. The default boot loader of the Arduino UNO is the opti boot boot loader. Boards are loaded with program code via a serial connection to another computer. Some serial Arduino boards contain a level shifter circuit to convert between RS232 logic levels and transistor–transistor logic (TTL) level signals. Current Arduino boards are programmed via Universal Serial Bus (USB), implemented using USB-to-serial adapter chips such as the FTDI FT232. Some boards, such as later-model Uno boards, substitute the [8] FTDI chip with a separate AVR chip containing USB-to-serial firmware, which is reprogrammable via its own ICSP header. Other variants, such as the Arduino Mini and the unofficial Boarduino, use a detachable USB-to-serial adapter board or cable, Bluetooth or other methods. When used with traditional microcontroller tools, instead of the Arduino IDE, standard AVR in-system programming (ISP) programming is used.

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COMMAND CODES

Instruction	Instruction Code										Description	Execution time (fosc= 270 kHz)
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Clear Display	0	0	0	0	0	0	0	0	0	1	Write “20H” to DDRAM and set DDRAM address to “00H” from AC	1.53 ms
Return Home	0	0	0	0	0	0	0	0	1	-	Set DDRAM address to “00H” from AC and return cursor to its original position if shifted. The contents of DDRAM are not changed.	1.53 ms
Entry Mode Set	0	0	0	0	0	0	0	1	I/D	SH	Assign cursor moving direction and enable the shift of entire display.	39 μs
Display ON/ OFF Control	0	0	0	0	0	0	1	D	C	B	Set display(D), cursor(C), and blinking of cursor(B) on/off control bit.	39 μs
Cursor or Display Shift	0	0	0	0	0	1	S/C	R/L	-	-	Set cursor moving and display shift control bit, and the direction, without changing of DDRAM data.	39 μs
Function Set	0	0	0	0	1	DL	N	F	-	-	Set interface data length (DL: 8-bit/4-bit), numbers of display line (N: 2-line/1-line) and, display font type (F:5×11dots/5×8 dots)	39 μs
Set CGRAM Address	0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0	Set CGRAM address in address counter.	39 μs
Set DDRAM Address	0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Set DDRAM address in address counter.	39 μs
Read Busy Flag and Address	0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Whether during internal operation or not can be known by reading BF. The contents of address counter can also be read.	0 μs
Write Data to RAM	1	0	D7	D6	D5	D4	D3	D2	D1	D0	Write data into internal RAM (DDRAM/CGRAM).	43 μs
Read Data from RAM	1	1	D7	D6	D5	D4	D3	D2	D1	D0	Read data from internal RAM (DDRAM/CGRAM).	43 μs

* “-“: don’t care

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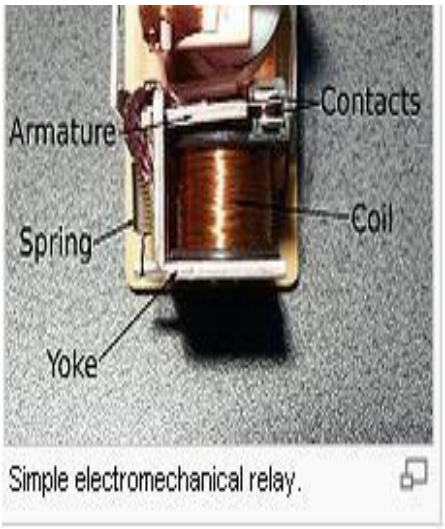
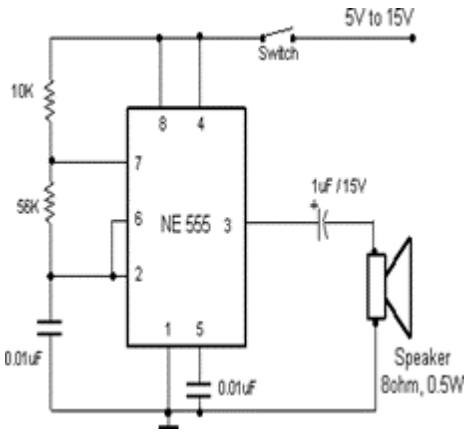
BASIC DESIGN AND OPERATION



Simple electromechanical relay.

A simple electromagnetic relay consists of a coil of wire wrapped around a soft iron core, an iron yoke which provides a low reluctance path for magnetic flux, a movable iron armature, and one or more sets of contacts (there are two in the relay pictured). The armature is hinged to the yoke and mechanically linked to one or more sets of moving contacts. It is held in place by a spring so that when the relay is de-energized there is an air gap in the magnetic circuit. In this condition, one of the two sets of contacts in the relay pictured is closed, and the other set is open. Other relays may have more or fewer sets of contacts depending on their function. The relay in the picture also has a [6] wire connecting the armature to the yoke. This ensures continuity of the circuit between the moving contacts on the armature, and the circuit track on the printed circuit board (PCB) via the yoke, which is soldered to the PCB.

Internal Circuit in Buzzer



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INTER FACING UNIT

Interfacing unit consists of RS-232 and MAX-232RS-232 Serial communication is basically the transmission or reception of a data one bit at a time. Today's computer generally addresses data in bits or some multi thereof. A byte contains 8bits.A bit is basically either logical 1or 0. Every character on this page is actually expressed internally as one bit. The serial port is used convert each byte to a stream of ones and zeros to bytes. The serial port contains a electronic chip called a Universal Asynchronous Receiver/Transmitter (UART) that actually does the conversions.

Introduction:

The official name of the EIA/TIA-232-E standard is "Interface between Data Terminal Equipment and Data Circuit-Termination Equipment Employing Serial Binary Data Interchange. The standard is simply concerned with serial data communication between a host system (Data Terminal Equipment, or DTE) and a peripheral system (Data Circuit-Terminating Equipment, or DCE).

Input Level (min)	±3V
Output Current	500mA (Note that the driver ICs normally used in PCs are limited to 10mA)
Impedance	5kΩ (Internal)
Bus Architecture	Point-to-Point

Mechanical characteristics of RS232:

The third area covered by RS-232 is the mechanical interface. Specifically, RS-232 specifies a 25-pin connector as the minimum connector size [7] that can accommodate all the signals defined in the functional portion of the standard. The pin assignment for this connector is shown in Figure. The connector for DCE equipment is male for the connector housing and female for the connection pins. Likewise, the DTE connector is a female housing with male connection pins. Although RS-232 specifies a 25-position connector, this connector is often not used. Most applications do not require all the defined signals, so a 25-pin connector is larger than necessary. Consequently, other connector types are commonly used. Perhaps the most popular connector is the 9-position DB9S connector, also illustrated in Figure. This 9-position connector provides, for example, the means to transmit and receive the necessary signals for modem applications.

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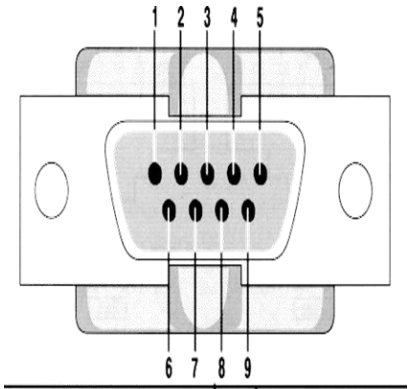
Pin diagram:



Pin	Signal	Pin	Signal
1	Data Carrier Detect	6	Data Set Ready
2	Received Data	7	Request to Send
3	Transmitted Data	8	Clear to Send
4	Data Terminal Ready	9	Ring Indicator
5	Signal Ground		

	RS-232
Cabling	Single-ended
Number of Devices	1 transmit, 1 receive
Communication Mode	Full duplex
Distance (max)	50 feet at 19.2kbps
Data Rate (max)	1Mbps
Signaling	Unbalanced
Mark (data 1)	-5V (min) -15V (max)
Space (data 0)	5V (min) 15V (max)

Table RS-232 specification

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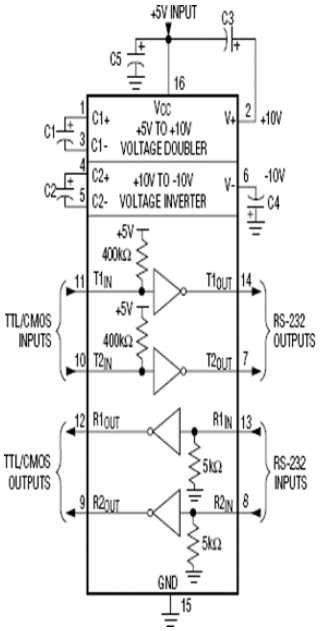

MAX-232:

The MAX-232 converts from RS-232 voltage levels to TTL voltage levels, and vice versa. One advantage of MAX-232 chip is that it uses +5v power source which is same as the source voltage for microcontroller, with no need for the dual power supplies that are common in many older systems .Since the RS-232 is not compatible with microprocessor and microcontrollers we need a line driver (voltage converter) to convert the RS-232's signals to TTL voltage level that will be acceptable to microcontrollers' TxD and RxD pins. Pin diagram:

MAX-232 Block Diagram

The MAX-232 has two sets of line drivers for transferring and receiving data, as shown in above figure. The line drivers used for TxD are called T1 and T2, while the line drivers for RxD are designated as R1 and R2. MAX-232 requires four capacitors ranging from 1-22 microfarads.

VOLAGE REGULATOR

Voltage regulator ICs are available with fixed (typically 5, 12 and 15V) or variable output voltages. The maximum current they can pass also rates them. Negative voltage regulators are available, mainly for use in dual supplies. Most regulators include some automatic protection from excessive current (over load protection) and overheating (thermal protection). Many of fixed voltage regulator ICs has 3 leads. They include a hole for attaching a heat sink if necessary

CONCLUSION

This project defines an environmental monitoring system for real-time monitoring of temperature and humidity of the surrounding environment. The data which is collected or

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sensed is passed to cloud by wi-fi where we can see data and graphical analysis. An Android application is developed for the client who can monitor the environment of the area where the hardware is placed an executed using a smartphone. The designed application is used as basic home automation system where the observed values of temperature and humidity can be used to operate some action and control the devices through the mobile application.

Future scope

1. Enhanced automation refers to systems that use user behavior to predict and automatically change lighting and temperature in homes.

2. Smart Grid Integration: Managing renewable energy sources and integrating with smart grids to optimize energy utilization.

3. Advanced Security: Enhanced home security with safe data processing and threat detection powered by AI.

4. Interoperability: A more integrated smart home experience through smooth integration with other IoT devices.

5. Sustainability: Minimizing environmental effect through the use of eco-friendly and energy-efficient technologies.

Homes will become more intelligent, safe, and energy-efficient thanks to these developments.

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