A Complete Home Automation Design using IOT

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ABSTRACT

With the advancement of automation technology, life is getting simpler and easier in all aspects. In today's world automatic systems are being preferred over manual system. With the rapid increase in the number of users of internet over the past decade has made internet a part and parcel of life, and IoT is the latest and emerging internet technology. Internet of things is a growing network of everyday object-from industrial machine to consumer goods that can share information and complete tasks while you are busy with other activities. Wireless home automation system(whas) using IoT is a system that uses computers or mobile devices to control basic home functions and features automatically through internet from anywhere around the world, an automated home is sometimes called a smart home. It is meant to save the electric power and human energy. The home automation system differs from other system by allowing the user to operate the system from anywhere around the world through internet connection.

Keywords: IoT, Home automation system, electric power, network, internet.

I. INTRODUCTION

We are living in the Embedded World. You are surrounded with many embedded products and your daily life largely depends on the proper functioning of these gadgets. Television, Radio, CD player of your living room, Washing Machine or Microwave Oven in your kitchen, Card readers, Access Controllers, Palm devices of your work space enable you to do many of your tasks very effectively. Apart from all these, many controllers embedded in your car take care of car operations between the bumpers and most of the times you tend to ignore all these controllers.In recent days, you are showered with variety of information about these embedded controllers in many places. All kinds of magazines and journals regularly dish out details about latest technologies, new devices; fast applications which make you believe that your basic survival is controlled by these embedded products. Now you can agree to the fact that these embedded products have successfully invaded into our world. You must be wondering about these embedded controllers or systems. What is this Embedded System?

The computer you use to compose your mails, or create a document or analyze the database is known as the standard desktop computer. These desktop computers are manufactured to serve many purposes and applications [1]. You need to install the relevant software to get the required processing facility. So, these desktop computers can do many things. In contrast, embedded controllers carryout a specific work for which they are designed. Most of the time, engineers design these embedded controllers with a specific goal in mind. So these controllers cannot be used in any other place. Theoretically, an embedded controller is a combination of a piece of microprocessor based hardware and the suitable software to undertake a specific task.

These days designers have many choices in microprocessors/microcontrollers. Especially, in 8 bit and 32 bit, the available variety really may overwhelm even an experienced designer. Selecting a right microprocessor may turn out as a most difficult first step and it is getting complicated as new devices continue to pop-up very often. In the 8 bit segment, the most popular and used architecture is Intel's 8031. Market acceptance of this particular family has driven many semiconductor manufacturers to develop something new based on this particular architecture. Even after 25 years of existence, semiconductor manufacturers still come out with some kind of device using this 8031 core.

II. Atmel mega AVR microcontrollers:

Atmel® megaAVR® microcontrollers (MCUs) are the ideal choice for designs that need some extra muscle. For applications requiring large amounts of code, megaAVR devices offer substantial program and data memories with performance up to 20 MIPS. Meanwhile, innovative Atmel picoPower® technology minimizes power consumption. All megaAVR devices offer self-programmability for fast, secure, cost-effective in-circuit upgrades. You can even upgrade the Flash memory while running your application [2-4].

Based on proven, industry-leading technology, the megaAVR family offers our widest selection of devices in terms of memories, pin-counts and peripherals. These include everything from general-purpose devices to models with specialized peripherals like Peripheral Touch Controller (PTC), USB, LCD controllers, as well as CAN, LIN and Power Stage Controllers (PSC). You will easily find the perfect fit for your project in the megaAVR product family. All these devices are supported by the Atmel Studio development platform, which further reduces your time-to-market.

a. Key Features:

- Broad family — The megaAVR family offers our widest selection of devices in terms of memories, pin counts and peripherals, enabling reuse of code and knowledge across projects.
- picoPower technology — Selected megaAVR devices feature ultra-low power consumption and individually selectable low-power sleep modes that make them ideal for battery-powered applications.

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- High integration — Devices feature on-chip Flash, SRAM, internal EEPROM, SPI, TWI (I^2C), and USART, USB, CAN, and LIN, watchdog timer, a choice of internal or external precision oscillator, and general-purpose I/O pins, simplifying your design and reducing the bill-of-materials.
- Analog functions — Advanced analog capabilities include ADC, DAC, a built-in temperature sensor and internal voltage reference, brown out detector, a fast analog comparator and a programmable analog gain amplifier. This high level of integration allows designs with fewer external analog components.
- Rapid development — megaAVR MCUs speed development with powerful in-system programming and on-chip debug. In addition, in-system programming simplifies production line programming and field upgrades.
- IoT ready — The IoT (Internet of Things) can extend to almost any application—from typical building and home automation to medical and healthcare systems. IoT designs typically require some form of processing power to perform embedded computing tasks and transmit data to the Internet. Increasingly, these devices are battery driven, thus power consumption often becomes the key success factor for a user-friendly IoT-enabled product [5]. megaAVR devices are among the best MCUs in the world when it comes to power consumption, making them a natural choice for IoT applications.
- High Performance, Low Power AVR® 8-Bit Microcontroller
- Advanced RISC Architecture – 135 Powerful Instructions – Most Single Clock Cycle Execution – 32 x 8 General Purpose Working Registers – Fully Static Operation – Up to 16 MIPS Throughput at 16MHz – On-Chip 2-cycle Multiplier
- Non-volatile Program and Data Memories – 16/32KB of In-System Self-Programmable Flash – 1.25/2.5KB Internal SRAM – 512Bytes/1KB Internal EEPROM – Write/Erase Cycles: 10,000 Flash/100,000 EEPROM C(1)°C/ 100 years at 25°– Data retention: 20 years at 85 – Optional Boot Code Section with Independent Lock Bits In-System Programming by On-chip Boot Program True Read-While-Write Operation Parts using external XTAL clock are pre-programed with a default USB bootloader – Programming Lock for Software Security
- JTAG (IEEE® std. 1149.1 compliant) Interface – Boundary-scan Capabilities According to the JTAG Standard – Extensive On-chip Debug Support – Programming of Flash, EEPROM, Fuses, and Lock Bits through the JTAG Interface

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- USB 2.0 Full-speed/Low Speed Device Module with Interrupt on Transfer Completion – Complies fully with Universal Serial Bus Specification Rev 2.0 – Supports data transfer rates up to 12Mbit/s and 1.5Mbit/s – Endpoint 0 for Control Transfers: up to 64-bytes – Six Programmable Endpoints with IN or Out Directions and with Bulk, Interrupt or Isochronous Transfers – Configurable Endpoints size up to 256 bytes in double bank mode – Fully independent 832 bytes USB DPRAM for endpoint memory allocation – Suspend/Resume Interrupts – CPU Reset possible on USB Bus Reset detection – 48MHz from PLL for Full-speed Bus Operation – USB Bus Connection/Disconnection on Microcontroller Request – Crystal-less operation for Low Speed mode
- Peripheral Features – On-chip PLL for USB and High Speed Timer: 32 up to 96MHz operation – One 8-bit Timer/Counter with Separate Prescaler and Compare Mode

III. Node MCU Arduino core:

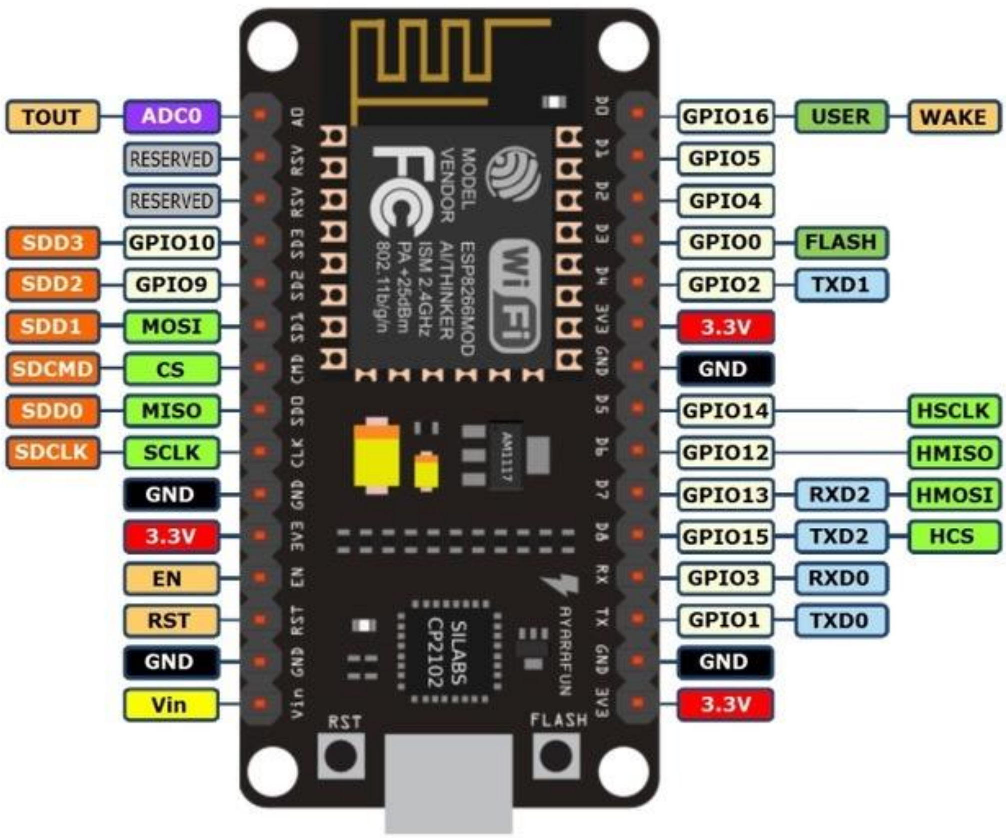

Fig 1. Node MCU module

NodeMCU is an open source IoT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module.[6][7] The term "NodeMCU" by default refers to the firmware rather than the development kits. The firmware uses the Lua scripting language. It is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266. It uses many open source projects, such as lua-cjson, and spiffs.

As Arduino.cc began developing new MCU boards based on non-AVR processors like the ARM/SAM MCU and used in the Arduino Due, they needed to modify the Arduino IDE so that it would be relatively easy to change the IDE to support alternate tool chains to allow Arduino C/C++ to be compiled down to these new processors. They did this with the introduction of the Board Manager and the SAM Core [6]. A "core" is the collection of software components required by the Board Manager and the Arduino IDE to compile an Arduino C/C++ source file down to the target MCU's machine language. Some creative ESP8266 enthusiasts have developed an Arduino core for the ESP8266 WiFi SoC that is available at the GitHub ESP8266 Core webpage. This is what is popularly called the "ESP8266 Core for the Arduino IDE" and it has become one of the leading software development platforms for the various ESP8266 based modules and development boards, including NodeMCUs.

IV. Internet of Things:

The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction [7]. A thing, in the Internet of Things, can be a person with a heart monitor implant, a farm animal with a biochip transponder, an automobile that has built-in sensors to alert the driver when tire pressure is low -- or any other natural or man-made object that can be assigned an IP address and provided with the ability to transfer data over a network.

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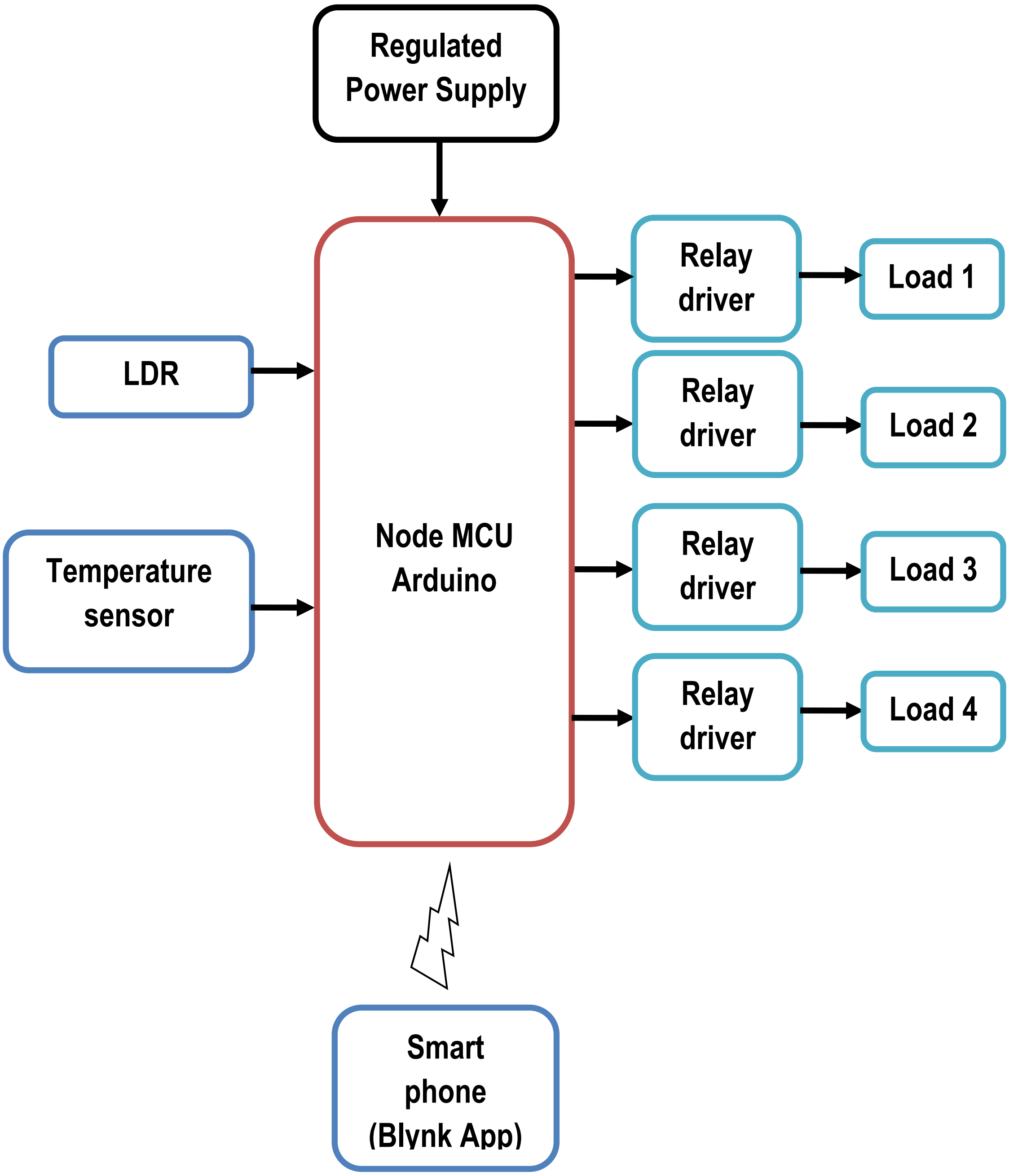

Figure 2. Proposed hardware architecture

IoT has evolved from the convergence of wireless technologies, micro-electromechanical systems (MEMS), microservices and the internet. The convergence has helped tear down the silo walls between operational technology (OT) and information technology (IT), allowing unstructured machine-generated data to be analyzed for insights that will drive improvements. The Internet of things (stylised Internet of Things or IoT) is the internetworking of physical devices, vehicles (also referred to as "connected devices" and "smart devices"), buildings, and other items—embedded with electronics, software, sensors, actuators, and network

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connectivity that enable these objects to collect and exchange data. In 2013 the Global Standards Initiative on Internet of Things (IoT-GSI) defined the IoT as "the infrastructure of the information society." The IoT allows objects to be sensed and/or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, smart homes, intelligent transportation and smart cities. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure. Experts estimate that the IoT will consist of almost 50 billion objects by 2020 [8-9].

The Internet of Things (IoT) is the network of everyday objects — physical things embedded with electronics, software, sensors, and connectivity enabling data exchange. Basically, a little networked computer is attached to a thing, allowing information exchange to and from that thing. Be it lightbulbs, toasters, refrigerators, flower pots, watches, fans, planes, trains, automobiles, or anything else around you, a little networked computer can be combined with it to accept input (esp. object control) or to gather and generate informational output (typically object status or other sensory data). This means computers will be permeating everything around us — ubiquitous embedded computing devices, uniquely identifiable, interconnected across the Internet. Because of low-cost, networkable micro-controller modules, the Internet of Things is really starting to take off.

ESP 8266:

ESP8266 (presently ESP8266EX) is a chip with which manufacturers are making wirelessly networkable micro-controller modules. More specifically, ESP8266 is a system-on-a-chip (SoC) with capabilities for 2.4 GHz Wi-Fi (802.11 b/g/n, supporting WPA/WPA2), general-purpose input/output (16 GPIO), Inter-Integrated Circuit (I^2C), analog-to-digital conversion (10-bit ADC), Serial Peripheral Interface (SPI), I^2S interfaces with DMA (sharing pins with GPIO), UART (on dedicated pins, plus a transmit-only UART can be enabled on GPIO2), and pulse-width modulation (PWM). It employs a 32-bit RISC CPU based on the Tensilica Xtensa LX106 running at 80 MHz (or overclocked to 160 MHz) [10]. It has a 64 KB boot ROM, 64 KB instruction RAM and 96 KB data RAM. External flash memory can be accessed through SPI.

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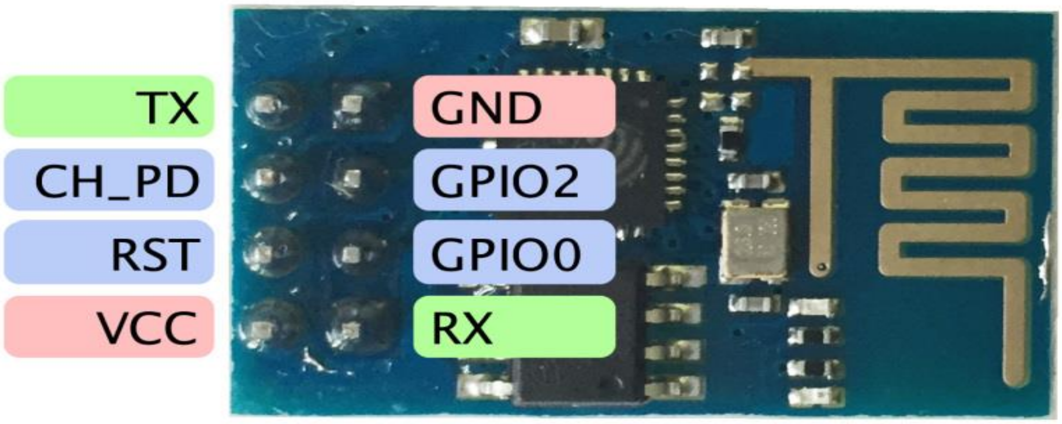

Figure 3: ESP 8266

Various vendors have consequently created a multitude of modules containing the ESP8266 chip at their cores. Some of these modules have specific identifiers, including monikers such as "Wi07c" and "ESP-01" through "ESP-13"; while other modules might be ill-labeled and merely referred to by a general description — e.g., "ESP8266 Wireless Transceiver." ESP8266-based modules have demonstrated themselves as a capable, low-cost, networkable foundation for facilitating end-point IoT developments. Espressif's official module is presently the ESP-WROOM-02. The AI-Thinker modules are succinctly labeled ESP-01 through ESP-13. NodeMCU boards extend upon the AI-Thinker modules. Olimex, Adafruit, Sparkfun, WeMos, ESPert (ESPresso) all make various modules as well.

a. **Light Dependent Resistor**:

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 [11].

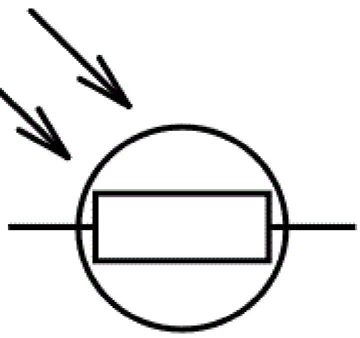

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Figure 4. LDR operation

A light dependent resistor works on the principle of photo conductivity. Photo conductivity is an optical phenomenon in which the materials conductivity is increased when light is absorbed by the material. When light falls i.e. when the photons fall on the device, the electrons in the valence band of the semiconductor material are excited to the conduction band. These photons in the incident light should have energy greater than the band gap of the semiconductor material to make the electrons jump from the valence band to the conduction band. Hence when light having enough energy strikes on the device, more and more electrons are excited to the conduction band which results in large number of charge carriers. The result of this process is more and more current starts flowing through the device when the circuit is closed and hence it is said that the resistance of the device has been decreased. LDR's have low cost and simple structure. They are often used as light sensors. They are used when there is a need to detect absences or presences of light like in a camera light meter. Used in street lamps, alarm clock, burglar alarm circuits, light intensity meters, for counting the packages moving on a conveyor belt, etc.

b. Temperature sensor:

LM35 is a precision IC temperature sensor with its output proportional to the temperature (in ^{o}C). 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 ^{o}C 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 ^{o}C rise/fall in ambient temperature, *i.e.,* its scale factor is 0.01V/ ^{o}C.

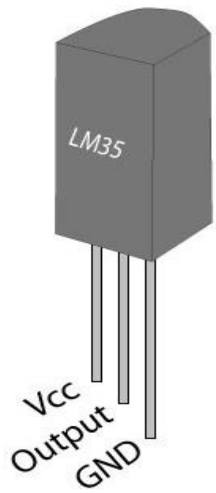

Figure 5. LM35 Temperature sensor

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.

c. Relay:

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

The heart of a relay is an electromagnet (a coil of wire that becomes a temporary magnet when electricity flows through it). You can think of a relay as a kind of electric lever: switch it on with a tiny current and it switches on ("leverages") another appliance using a much bigger current. Why is that useful? As the name suggests, many sensors are incredibly *sensitive* pieces of electronic equipment and produce only small electric currents. But often we need them to drive bigger pieces of apparatus that use bigger currents. Relays bridge the gap, making it possible for small currents to activate larger ones. That means relays can work either as switches (turning things on and off) or as amplifiers (converting small currents into larger ones).

Here are two simple animations illustrating how relays use one circuit to switch on a second circuit.

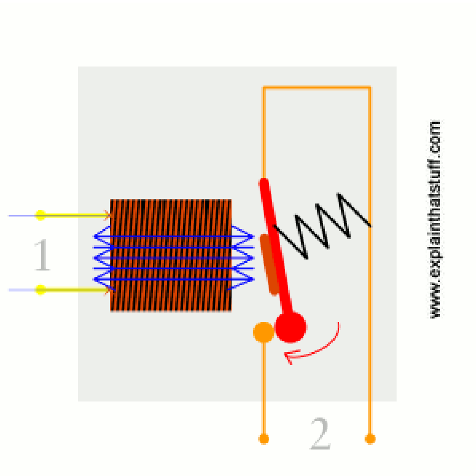

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Figure 6. Relay

When power flows through the first circuit (1), it activates the electromagnet (brown), generating a magnetic field (blue) that attracts a contact (red) and activates the second circuit (2). When the power is switched off, a spring pulls the contact back up to its original position, switching the second circuit off again.

V. Arduino Software

Arduino is a prototype platform (open-source) based on an easy-to-use hardware and software. It consists of a circuit board, which can be programed (referred to as a microcontroller) and a ready-made software called Arduino IDE (Integrated Development Environment), which is used to write and upload the computer code to the physical board.

The key features are:

- Arduino boards are able to read analog or digital input signals from different sensors and turn it into an output such as activating a motor, turning LED on/off, connect to the cloud and many other actions.
- You can control your board functions by sending a set of instructions to the microcontroller on the board via Arduino IDE (referred to as uploading software).
- Unlike most previous programmable circuit boards, Arduino does not need an extra piece of hardware (called a programmer) in order to load a new code onto the board. You can simply use a USB cable.
- Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program.
- Finally, Arduino provides a standard form factor that breaks the functions of the micro-controller into a more accessible package.

Experimental setup

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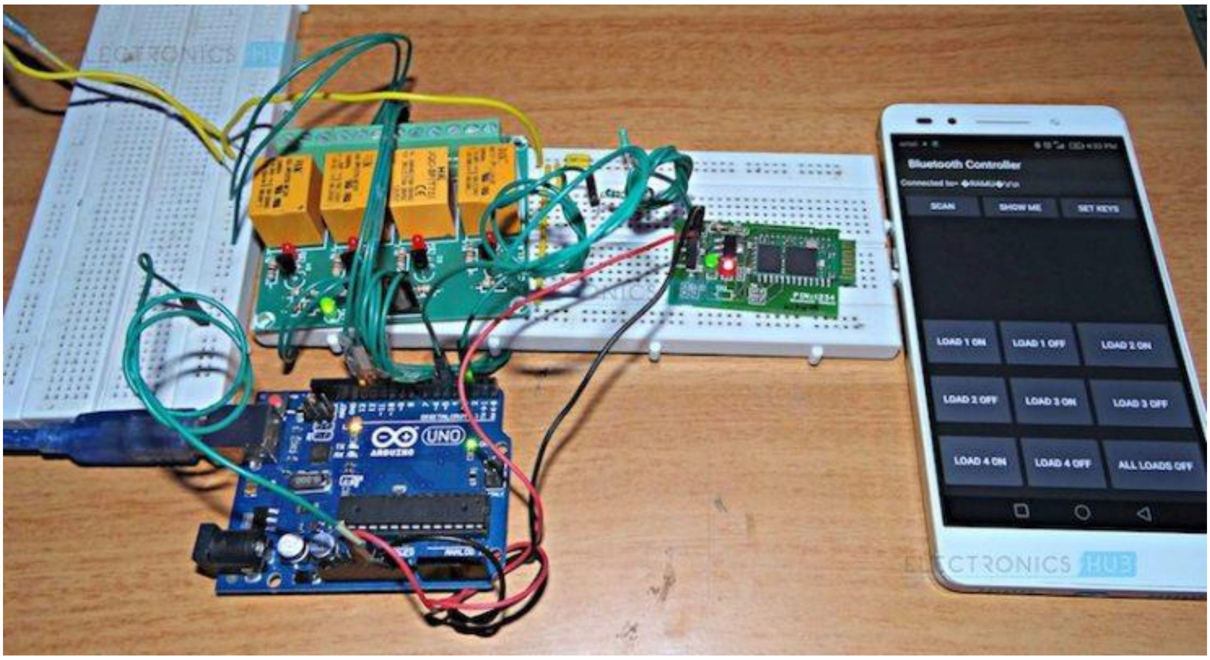

Figure 7. IOT Home automation setup

A model is built for the home automation system and is as shown in the figure 7. Light 1 will turn on automatically when light sensor detects the darkness. A cooler/Fan will turn on when the room temperature exceeds the set threshold and in turn reduces the room temperature**.**

CONCLUSION

The IoT based home automation has been successfully designed and tested. It has been developed by integrating features of all the hardware components used. Presence of every module has been reasoned out and placed carefully thus contributing to the best working of the unit. Secondly, using highly advanced IC's and with the help of growing technology the project has been successfully implemented.

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Biography

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