ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)

Volume11 Issue 8 August 2024

Simulation of Various Sensors and Actuators in Iot Embedded Environment for Home Automation Using Tinker CAD

[1] Mugdha Sawalapurkar, [2] Shweta Ghadshi, [3] Manjiri Naik, [4] Ruhi Ambone, [5] Amit K. Nerurkar

[1] [2] [3] [4] student, Department of Computer Engineering Vidyalankar Institute of Technology, Mumbai, India
[5] Faculty, Department of Computer Engineering Vidyalankar Institute of Technology, Mumbai, India
Corresponding Author Email: [1] mugdha.sawalapurkar@vit.edu.in, [2] shweta.ghadshi@vit.edu.in, [3] manjiri.naik@vit.edu.in, [4] ruhi.ambone@vit.edu.in, [5] amit.nerurkar@vit.edu.in

Abstract*— The smart house concept refers to integrating technology and automation for controlling and managing various aspects of the home environment. e.g. lighting to adjust to outer light, speed of fan adjusting according to the outer surroundings, or security such as being notified after possible gas leakage. The use of sensors and internet of things devices is a common means to achieve such automation. There are a lot of advantages e.g. better convenience energy efficiency and security which can be obtained by making your home smarter. There are many benefits including more convenience energy efficiency and better safety that can be achieved through the use of intelligent homes smart sensors can learn what one likes and adjust one's temperature at home saving energy and increasing comfort even when one is not home. Smart security systems can keep watch over your house and notify you if there is any danger such as a gas leakage. This paper focuses on using sensors and actuators to create a smart home environment and how to achieve that through experimentation and integrating artificial intelligence and internet of things technologies can be seen by using tinker cad as a simulation tool. Smart sensors learn what one likes and may adjust temperature in one's home, accordingly, saving energy and increasing comfort of one's home. Also, places can be monitored and alerted to potential threats by smart security systems.

I. INTRODUCTION

The way that people interact with their living and working spaces has been greatly influenced over the past years due to AI's development and Internet of Things. Smart homes and buildings have become a standard that offers seamless control, improved energy efficiency, increased security, and unparalleled convenience. However, the successful integration of these technologies requires a range of sensors and actuators that monitor and control different aspects of the environment.

There is a need for automation main reasons being; energy Efficiency; AI and IoT can help improve energy efficiency in both home and office environments. For example, sensors can optimize light settings based on external brightness and end up saving energy since the lights would be off when not needed. Secondly, AI and IoT can enhance safety and security in both home and office environments. Smart sensors and alarms can detect and alert users to potential dangers such as a gas leakage.[2]

AI and IoT can improve productivity and efficiency in office environments by automating routine tasks and providing real-time insights and data. IoT-enabled devices can provide real-time monitoring and feedback on various processes and systems. Bringing IoT and AI together makes users' life much easier. For instance, if one puts a hand under an automatic tap within the range of detection, it will detect the movement through an ultrasonic sensor and switch on the tap. In this regard, this research paper seeks to simulate different sensors and actuators for home and office automation with AI and IoT. Instead, they may want to think about how these simulation tools can help them in enhancing and optimizing performance and functionality of these systems. Another problem that is associated with technology involves integrating various sensors or devices as well as ensuring that different systems work seamlessly together. Finally, this paper discusses their benefits including increased productivity rates; enhanced safety levels; lower power usage in particular areas among others.

II. LITERATURE SURVEY

A lot of research has been done over the last couple of years on how IoT and AI can work together in homes and organizations. A review of the literature shows that a lot of work is being done to optimize simulations of different sensors, actuators, etc.

For example, in 2018, Al-Samaraia et al. created a simulation model to integrate AI algorithms, IoT devices, and BIM in smart buildings to optimize energy consumption. As a result, this model succeeded in minimizing energy consumption by as much as 35%. Another successful example is Liu et al.'s 2019 AI simulation model, which integrated IoT, BIM, and HVAC control in office buildings. Their research indicated that this model could decrease energy consumption by 20%.

For several additional studies, one of the most intriguing themes was the study of specific sensors / actuators used in smart homes / buildings. For instance, in a study in 2018, the team presented a simulation model for monitoring smart

ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)

Volume11 Issue 8 August 2024

lighting systems based on daylight sensors / occupancy. This was an excellent example of how their strategy improved light efficiency while still maintaining adequate light levels. In a study in 2019, Yu et al. (2019) created a light and weather sensor based smart blind optimization simulation model. Their results showed that the suggested approach could potentially reduce energy consumption by up to 25%.

Some studies focus on the use of simulation tools within a specific domain or application. For example, Goh et al., (2018) developed a simulation model to optimize the control of an indoor vertical farming system using AI and the integration of the Internet of Things (IoT). The results showed that following the recommended strategy can increase crop yields by approximately 35%. Another example is Liu et al. (2018), which describes a simulation model to evaluate intelligent transportation systems using actuators and sensors to optimize traffic flow and reduce congestion by 20%.

However, there are still plenty of problems which need to be solved such as including privacy and security policies, the devices and sensors used in the system need to be compatible and the need of guidelines and rules for the simulation of home automation systems and testing purposes. The review of literature describes how simulation tools are useful for testing different sensors and devices to be used in the home automation system. In summary, simulation tools serve as the best solution for designing and implementing IoT and AI based smart homes/buildings.[6]

III. PROPOSED SYSTEM:

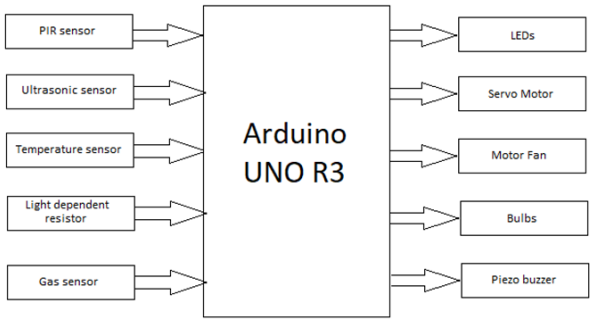


Fig. 1. Block diagram

A home automation system's main goal is to save time, money, and electricity while giving users the power to operate different household equipment using various automation approaches. Home automation with the use of IoT is a practical and dependable solution to address such real-time issues. By setting certain conditions for specific activities, the technology takes care of the rest when those conditions are met, regardless of whether they occur at a predicted or unpredicted time, ensuring the same level of efficiency and the desired outcomes.[2]

The home automation can be achieved by using various sensors which helps to solve many home problems when it comes to safety and efficiency. The proposed system shown in figure 1 gives an basic idea of how different sensors along with few actuators and Arduino Uno can help automate different household appliances.

PIR (Passive Infrared) Sensors sense motions of human body by changes in surrounding temperature. They detect the motion changes in the room and switch on the lights. When the motion is seized, they will switch off the lights. The main work of this sensor is to detect the heat changes in its surroundings.

Ultrasonic sensor is used for object detection and distance measurement. An example of this includes turning lights or taps off or on, trigger security systems, or perform other control functions.

This sensor generates ultrasonic sound waves and measures the distance of the object by measuring the time sound echo takes to return.[1]

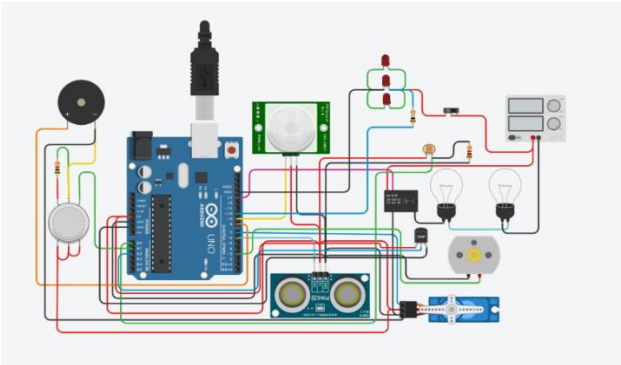
Temperature sensors can be used to detect the temperature at one's home or office and monitor the household appliances which are based on the surrounding temperature conditions conveniently rather than using the switchboards or a remote. An example of this could be regulation of the speed of the fan using a temperature sensor thereby increasing energy efficiency.[3]

Similarly, a LDR (Light Dependent Resistor) sensor can be adjusted to detect a particular amount of light intensity in its surroundings. As a result, when the light intensity outside is high, the lights will be turned off, and when the intensity decreases below a specific value, the sensor will detect it, and the lights will be turned on.

Gas leaks are a significant concern in many industries, and their gaseous nature makes them difficult to detect in time to prevent accidents. By setting a specific gas density and triggering the buzzer when the gas concentration exceeds the limit, small household mishaps and tragic accidents can be avoided.

By automating various daily tasks, the implementation of automation can simplify many activities while also preventing numerous accidents or mishaps. Home automation is the ideal solution for individuals who are always short on time in today's technology-driven world, as it makes everyday tasks easy, convenient, and safe.[4]

IV. IMPLEMENTATION & RESULT



ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)

Volume11 Issue 8 August 2024

Fig. 2. Circuit diagram

Figure 1 and the circuit diagram in figure 2 illustrate the block diagram of a home automation system using different sensors. The paper proposes the use of Tinker cad for the development of home automation system that can regulate a variety of household devices. Tinker cad is a web-based tool for 3D modelling as well as to build circuits, enabling users to produce 3D objects and gain basic skills in coding and electronic circuitry via a range of shapes and electronic components. The system operates using sensors and various actuators to command household appliances. The data gathered by these sensors is processed, and further actions are taken accordingly.

The system incorporates Arduino Uno with five sensors such as ultrasonic distance sensor, Passive Infrared (PIR) sensor, photoresistor, temperature sensor (TMP36) and gas sensor each being connected to actuators such as DC motor, servo motor, LED, piezo buzzer and light bulbs. Working of these sensors is given as follows:

A. Gas sensor

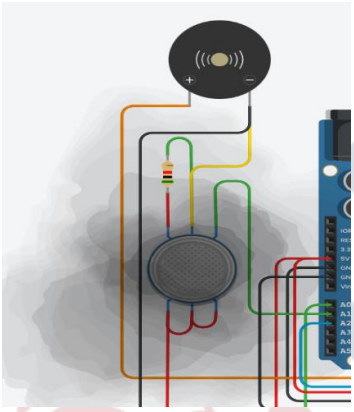


Fig. 3. Gas sensor and buzzer

A gas sensor is a gadget that, frequently as part of a safety system, detects the presence of gases in a space. Figure 2 depicts how a gas sensor operates. The Arduino UNO microcontroller, which is connected to the sensor, reads the gas level from the sensor and turns on an alarm device such a buzzer when the gas level rises above a predetermined threshold. A buzzer is a loud, continuous-sounding audio signalling device. Buzzers are frequently employed in many different contexts, such as alarms, timers, and other warning systems. Piezo buzzers are utilised in this instance as an auditory alarm to notify consumers of the presence of gas or smoke.[1] [2]

B. Ultrasonic sensor

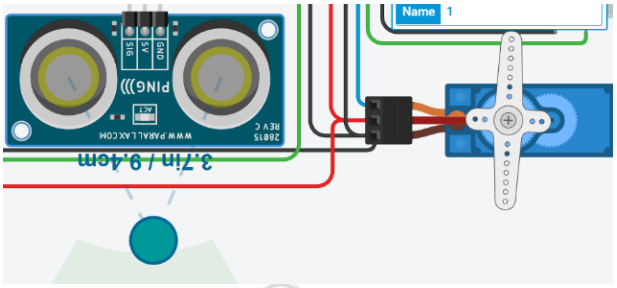


Fig. 4. Ultrasonic sensor detecting motion

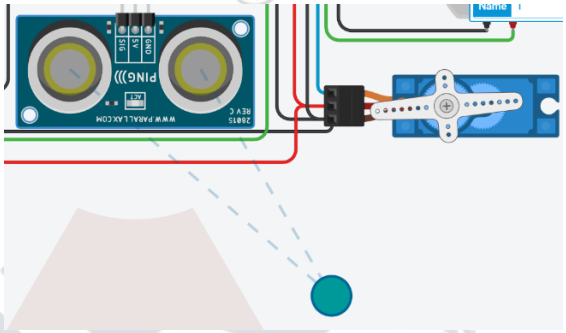


Fig. 5. Ultrasonic sensor not detecting motion

The ultrasonic sensor works by sending out ultrasonic waves, which are then picked up by ultrasonic receivers and used to calculate the distances between things, including people. The ultrasonic sensor acts as a source of information regarding the presence of things, specifically humans, in front of the water tap in the automatic system seen in Figures 4 and 5. The water tap will open when anything, like a hand, gets close enough to it. To explain, when someone uses the washbasin to wash their hands or perform an ablution, their hand will block the ultrasonic waves that are released, allowing the ultrasonic sensor to determine how far away their hand is from the tap. The microcontroller then makes a decision based on the obtained distance whether to open or close water tap.

C. Light Dependent Resistor (Photoresistor)

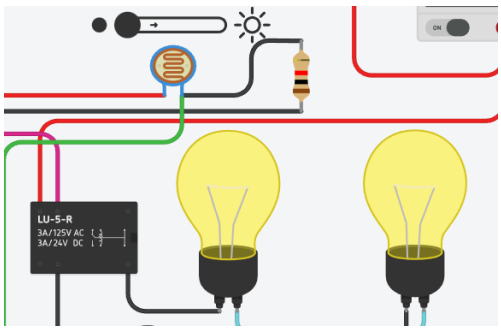


Fig. 6. Bulbs ON

ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)

Volume11 Issue 8 August 2024

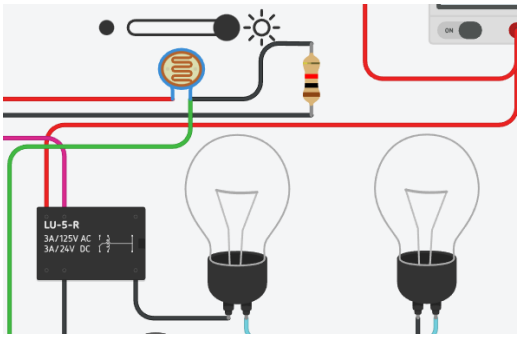


Fig. 7. Bulbs OFF

Light Dependent Resistor, commonly known as LDR, is a component that exhibits a change in resistance based on the intensity of light it is exposed to. This makes it a suitable choice for use in light sensing circuits. Similar to a resistor, LDR has no polarity.

The figure shows a circuit that typically comprises a photoresistor and a 1kΩ in-line resistor. When light is present, the photoresistor's resistance decreases, whereas in its absence, the resistance increases. As a result, the LDR generates an analogue output that corresponds to the light's intensity. It has a threshold value ranging from 0 to 1023. The bulbs connected to the LDR are turned on when the resistance of LDR is increased and they are turned off when the resistance is decreased i.e. the external light is present. LDR gets sends the signal to the Arduino and Arduino Uno turns the bulb on. The implementation of LDR sensor is shown in figure 6 and 7.[6]

D. PIR sensor with LEDs

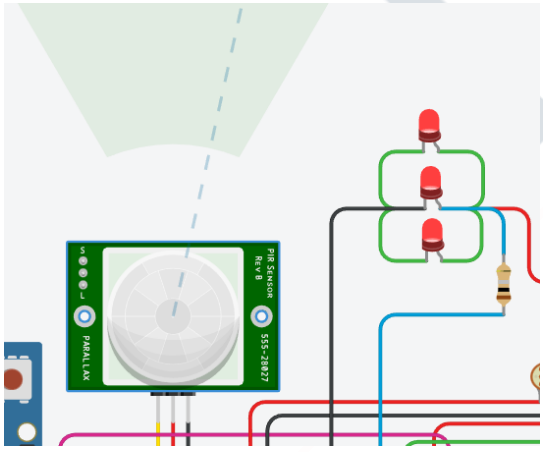


Fig. 8. Lights ON when PIR detects motion

The figure 8 shows Passive Infrared, or PIR sensor, which refers to the technology utilized within a device that passively senses levels of infrared light, as opposed to an infrared camera which actively emits infrared light to capture its reflection. The IR detector within the PIR device is enhanced by a white dome lens, which broadens its field of vision. By default, the sensor reports a LOW signal, while simultaneously detecting the ambient infrared light levels. When there is a change in these levels, indicating movement, the sensor triggers a HIGH signal for a specific duration. PIR sensor, when senses anything in its close proximity triggers the signal and this signal is sent to the Arduino Uno and LEDs are tuned on and they are turned off otherwise.

E. Temperature sensor with DC motor

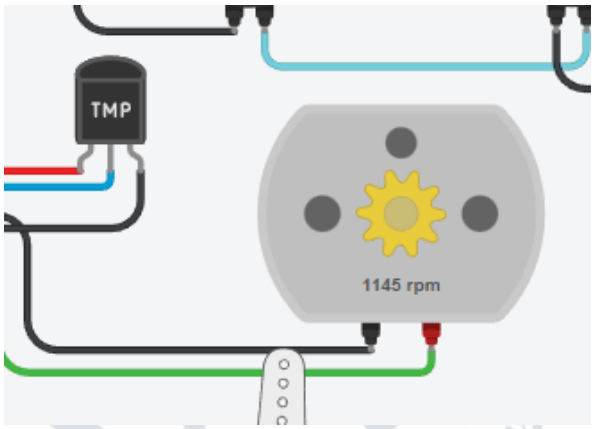


Fig. 9. Speed of the fan at room temperature (Minimum speed [SR1])

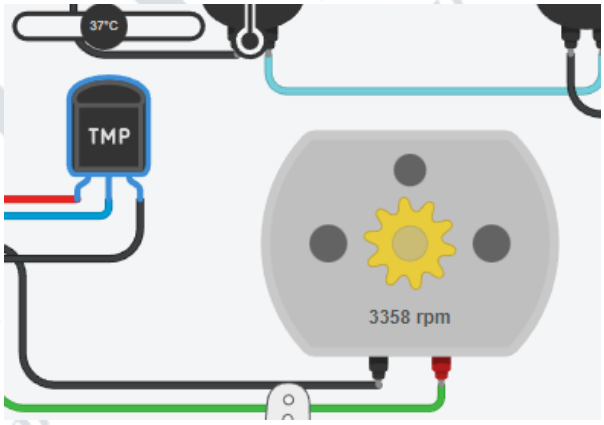


Fig. 10. Speed of the fan when temperature is increased

The temperature sensor TMP36 and an Arduino UNO R3 compatible temperature-based fan speed controller are shown in the above illustration. A DC motor used to depict an electric fan is controlled dynamically and effectively by the Arduino microcontroller dependent on the situation.

Above is an illustration of the circuit diagram for the temperature-based fan speed control and monitoring using Arduino and TMP36. The output voltage of the TMP36, a high-precision integrated circuit, is proportional to the Celsius (Centigrade) temperature. This temperature sensor measures the temperature, changes it to an electrical signal in the analogue range, and finally converts it to a digital value. Therefore, the fan is controlled using the sensed values. The fan starts to operate when the temperature goes above 20°C.When the temperature is between 20°C and 25°C, the fan speed is at a minimum, and when the temperature exceeds 45°C, the speed is maximum. The fan speed is adjusted using a low-frequency pulse-width modulation (PWM) signal, which varies the duty cycle.

ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)

Volume11 Issue 8 August 2024

V. RESULT

Through this paper we can see that various day to day activities have become simplified if proper implementation using the tinker-cad tool has been done. The software-based implementation can be transformed into a working model by effective use of Arduino, motors and the other major components of the project. The major sensors used in the proposed paper like PIR Sensor, Ultrasonic sensor, LDR, temperature sensor and the buzzer system are commonly used in the major hardware systems generated now a days. In industry these are used as basic primitive systems for major projects development. Our motive to learn something new and find solutions to the common problems which we face in daily life is achieved by making some advancements in the existing systems. Hence, we are able to create a system which tries to reduce human efforts for in particular aspects.[7]

VI. CONCLUSION

To make our homes a bit more convenient and safer for anyone has always been a prime concern & with such a huge advancement in technological world with each passing day, one can surely use and implement some technological concepts. System proposed in this paper, i.e., simulation of various sensors and Actuators in Automating Home environment, is a precise and compact idea of how it can be practically implemented. Also, such automated systems are no less than a boon for specially abled or visually impaired persons and will reduce their hardships to some extent. The simultaneous implementation of sensors through a simulation gives us an abstract idea of how this system is scalable and convenient for installation in home and office environments enhancing our definitions of comfort and convenience and making it a lot more secure. The problem of gas leakage has been reduced by implementation gas sensors as mentioned in this paper. Using a buzzer, it has become easier for people to identify the problem so as to take immediate action on it. [1] [7]. It is a human tendency to seek convenience even in the simplest jobs such as opening a tap. With the use of ultrasonic sensor, this paper has implemented touchless taps which eventually reduce the possible spread of germs present on them. Appropriate brightness of the lights of one's home is necessary. By the use of LDRs, this paper demonstrates how the lights could increase or decrease their brightness depending upon the amount of light present outside. This is fitting seeing how the lights would adjust automatically. PIR sensors which sense motion, in this paper, are used to sense the motion of a person. So, when one would enter the room or concerned area, the lights would spontaneously be turned on and in the absence of motion, they would turn of. Benefit and comfort have effectuated the use of temperature sensors for speed regulation of a fan. The speed of the fan increases or decreases depending upon the changes in the temperature inside the room. [5]

REFERENCES

[1] S. Jamadagni, P. Sankpal, S. Patil, N. Chougule and S. Gurav, "Gas Leakage and Fire Detection using Raspberry Pi," in 2019 3rd International Conference on Computing Methodologies and Communication (ICCMC), 2019.

[2] A. Agape and M. Postolache, "Internet-enabled Access Control System using a Mobile Application," in 2018 22nd International Conference on System Theory, Control and Computing (ICSTCC), 2018.

[3] Caril Martinez, Leonardo Eras and Federico Dominguez "The Smart Doorbell: A proof-of-concept Implementation of a Bluetooth Mesh Network "in 2018 IEEE Third Ecuador Technical Chapters Meeting

[4] Amit Nerurkar "IoT based Approach for Automatic Irrigation System and Securing the Farm" INDIACom-2019; IEEE Conference ID: 46181

[5] Amit Nerurkar "Comparative Analysis of Biometric Systems" INDIACom-2019; IEEE Conference ID: 46181

[6] Sanjay Thakare, Ambikesh Kumar Gupta, Shilpi Sharma, "Secure Reliable Multimodel Biometric Fingerprint and Face Recognition", International Conference on Computer Communication and Informatics (ICCCI), 2017

[7] S.Z. Li, Juwei Lu, "Generalizing Capacity of face database for face recognition", IEEE International Conference on Automic Face and Gesture Recognition, 1998

[8] Amit K. Nerurkar, G. T. Thampi "Intelligent Process Automation for Detecting Unauthorized Entry by Actors in IoT Imbedded Enterprise Setting" IEMIS 2022 Springer Series Emerging Technologies in Data Mining and Information Security