Smart Home System (use style: paper title)

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*Abstract*—This paper introduces Smart Home System that includes four main components which are Smart Lamp, Smart Heating and Cooling, Smart Fire Alarm and lastly Smart Door Lock. Source of the image and type of image also will be explained in this paper to make the reader more understand about our Smart Home System works . This article contains a few images and table to make the explanation more understandable. *Do Not Use Symbols, Special Characters, Footnotes, or Math in Paper Title or Abstract*. (*Abstract*)

Keywords—component, formatting, style, styling, insert (key words)

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## Smart Light System

The main crucial point in building a Smart lighting system is to allow us controlling lights inside and outside house. Lights can be controlled or can be configured to automatically shut off when there is nobody in a room and switch on when a person walks into the room. Moreover, it can also be managed via a smartphone app or smart hub.

Typically , the smart bulbs is needed for these system to be wirelessly connected to some sort of gateway device or to your home network. Alternatively, some smart lighting systems work by plugging an existing light into a so-called smart plug.

For example, connect the gateway device to a system remote control or a smartphone app and use that remote control or app to send the necessary commands to all connected bulbs. Individual bulbs or groups of bulbs can be turned on or off, or, in some instances, you can dim the lights. For that matter, you can use the system’s smartphone app and the Internet to control the lighting in your house while you’re away. Beyond simple on/off operation, some smart LED lights can be configured to output a specific brightness or color. Switch the colours and brightness what the user prefer in certain environment, can provide better utilizitaion of technology in changing user mood plus helping in stress level. This lets us provide different levels and types of lighting for different tasks.[1]

### 1) Pros and Cons Smart Lighting System

Smart Lighting System surely have plus and minus in implementation in real situation. Here the advantages of using smart lamp:

* Save cost on electric bills

Since we manage to control it automatically , so easier  
 to turn off lamp when there is no person in   
 a room. Hence, reduce the electric consumption.

* More energy efficiency

Optimising energy and not wasting it are main target for   
 all technology companies nowadays.Therefore, using   
 smart bulbs increase energy efficiency due to   
 controlling the system by our own.

* Can manually and automatically controlled by user

Providing more options or alternatives for the user  
 makes the smart bulb

* Better utilization

Ease the user performance with auto-controlled system,  
 brightness and colour modification.

The disadvantages of using smart lamp:

* Possiblity access by unauthorized user
* Not provide stable efficiency if WLAN connection is not strong
* Only reliable in urban areas

### 2) Motion detector

A key element in any smart home, motion detectors enable your system to react to you and your visitors as you move about your house.

The X10 wireless motion detector is a beautiful thing in the world of home automation. It’s small, inexpensive, and incredibly useful when it comes to creating a smart home. Nothing does a better job of impressing your friends than the lights coming on automatically when you enter a room and turning off after you’ve left. And that’s just the tip of the iceberg for what you can do with these beauties.



Figure 1-8. An X10 motion detector[2]

Motion detectors use passive infrared (PIR) to sense when something around them is moving. They see the world in terms of temperature, and they detect motion by watching for moving patterns of warmth. When you walk into a room, you might feel like a living, breathing being; but to a PIR detector, you’re just a moving blob of body heat. Don’t take it personally; it treats everyone the same way.

### 3) Positioning Motion detector

Now that you’ve configured the motion detector, you’ll need to mount it on the wall. For best results, position it so that movement occurs across its field of view. It’s looking for a moving object, and a person walking toward the motion detector won’t set it off as quickly as someone walking past it will.

The detector’s field of view is cone-shaped and extends out about 30 feet. If you expect people will be passing close to the detector, mount it at about chest or waist height to put more mass in the field of view. You also might want to turn it sideways, as shown in Figure 1-8, so that the widest part of the field is oriented vertically rather than horizontally.[2]

### 4) Class Diagram Of Smart Light System



Firstly, class diagram is designed to classify the main components in Smart Light System that will be included in Smart Home System. As figure shown above, there are 4 main components which are motion sensor, light, light sensor and person. Every classes has it owns operations except for person class. For class Light, it has 2 attributes which are different colours for lamps and its brightness. Two operations wich are ON and OFF functions are in class Light. Relation class Light with class Motion Sensor and class Light Sensor are

### 5) Sequence Diagram Smart Light System



Sequence Diagram of Smart Light System is identified as figure . The purpose of this sequence diagram to clearly show the interaction of main domain that happened in Smart Light System. Here is simple explanation how the system should work in proper sequence. At the beginning, motion sensor detects the human signals in the environment, then Smart Home System which the main controller check the status signal and switch on or off the lamps. If there is human signal, the lamps will automatically swittch on and vice versa. After that, the system will check the lighting environment which will be detected by light sensor to control the brightness of lamp. Lastly, it will display the final result.

### 6) State Machine Diagram of Smart Light System



As figure shown above, there are 3 main situations how Smart Light works:

* Initialize state
* NoMotionDetected state
* MotionDetected state

First initiliaze state. The system will start the system at first stage. Then, it will enter either NoMotionDetected state or MotionDetected state. We can clearly see in both state have same substate. It means that in both state, the system always detects light environment to make sure the proper brightness of light will be displayed to the user whether there is human signal or not in a room. The system will stay in the loop of NoMotionDetected state or MotionDetected state, unless there is some system failures which require to restart the system.

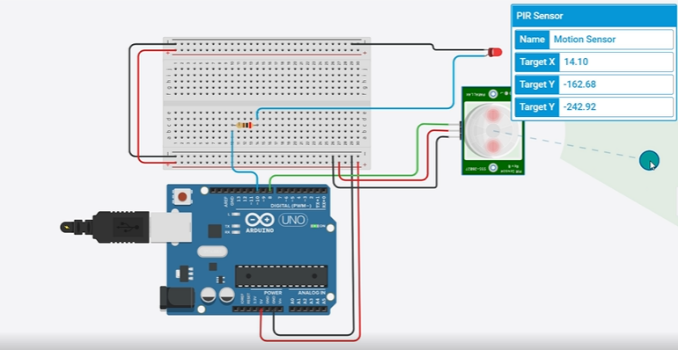
### 7) Simulation Smart Light System

In this simulation part, not all details will be included but only the main function of smart light with motion detector will be explained. There is 2 main parts of simulation:

* The lamp turn off when there is no motion by PIR Sensor.( Figure 1.3)
* The lamp turn on when there is motion detected PIR Sensor. ( Figure 1.4)

Diagram

Description automatically generated



## Smart Door Lock

### Introduction

### The main idea of Smart Home Technology is to introduce networking devices and equipment in the house for better quality living. A smart home allows the entire home to be automated and therefore provides comfortable living as well as added benefits for disabled individuals. All the existing door locking systems are old-fashioned ways of accessing the system with either a traditional key or some means of RFID (Radio-Frequency Identification) chips [3]. For example, with a traditional lock, a friend or a guest cannot be allowed to get to the place if the doors are locked when the owner is unavailable. Or if the keys are lost, either a locksmith has to be found or the lock should be broken [6]. This is where the smart door locking system comes to the scene. Security is a primary concern for every individual where humans cannot find ways to provide security to their confidential belongings manually. Instead, humans find an alternative solution that provides reliable and automized security. This paper describes a security system that can control the home door lock. The safety enhancements in the system should not only improve the robustness of the system but also not complicate the system accessibility, in other words, it should provide the ease of access. Users can access the door lock once the user credentials are verified with the database.

### Pros

* **Convenience**

When using smart door lock you do not need to carry a key. You do need to be not afraid of losing or forgetting somewhere. You will not have to sit outside the door to wait for the mechanic to break the door lock. Smart door lock opens / closes automatically, can be activated via smartphone or biometric reader.

* **Fast opening / closing times**

With normal mechanical locks you will have to take a few minutes to open the door. You also take that much time to close the door. But the smart lock will save you a lot of time. This type of lock only takes about 3- 5s to unlock and you just need to close the door, the latch will close itself.

* **High safety and security**

Smart lock is very structured consisting of 5 latches instead of 2 latches like normal faculties. Keyhole is replaced by biometric reader or a smartphone detection unit so there will be no phenomenon break. Moreover, when there is a strong action or a raid phenomenon, the door lock will emit an alarm sound so the safety is greatly enhanced.

### Preferences for Smart Lock

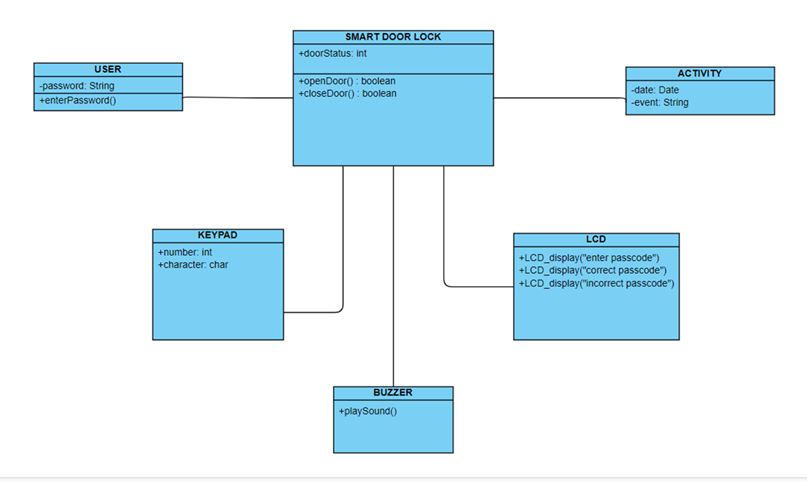
Everyone has a smart smartphone these days. The incorporation of smart door technologies with additional capabilities such as scanning biometrics, password keypad, card swipe, and other functionalities allows owners to clearly believe that those who have been allowed to do so are the only ones who can go through the door.

The convergence with other home appliances such as Amazon Alexa, Apple HomeKit, Google Home IFTTT and Nest is an explanation why people choose to get smart door locks over conventional ones. Your house or workplace is bound to be safer from intruders with a combination of sound-detecting software and sophisticated locking systems, and you will certainly know when an unknown party has gained entry to your home.

Bluetooth and Wi-Fi features are the best smart locks, so connectivity with your smart home systems will run seamlessly. When a door is opened, you will automatically receive a security warning or notification, particularly if you have set that at around that time you were not expecting any visitors or family members to come home.

### Components

Smart digital door lock is a system to monitor and control several devices in the home. Our smart digital door lock system operates over wireless sensor network. It is a network of sensor nodes with digital door lock as sink node as shown in Fig. 1. The smart door lock system can be divided into five parts: keypad, LCD, activity, user and the buzzer.



1. Figure above shows the class diagram for the Smart Door Lock System.

### Simulation

I will explain about state diagram for smart door lock. The first step or initialize step is that the user need to put their password. Next, it will go to the another state based on their guards. When the user enter wrong password, the state will go into false state where the door will remain locked, the lcd will display wrong password and loud sound will play. On other hand when the user enter right password, the state will go into true state where the door will unlocked and lcd will display correct password.



1. Figure above shows the state diagram for the Smart Door Lock System.





## Smart Home Fire Alarm System

Fires almost always occur in homes in consequence of carelessness and changes in environmental conditions. That is why fire safety is one of the major concerns for a safe home environment. In recent years, fire detection has become a very big issue, as it has caused severe damage including the loss of human lives. Sometimes, these incidents are more destructive when the fire spreads to the surroundings [2]. In the present circumstances, fires can get out of control because people intend to save money rather than installing proper fire alarm systems.

Study shows that, in the United States, fire is the fourth largest accidental killer behind motor vehicle accidents, falls, and drownings. It is also the disaster that families are mostly likely to experience. Over 80 percent of all fire deaths occur where people sleep, such as in homes or hotels. Most fires occur when people are likely to be less alert such as between midnight and morning. Approximately three-quarters of all fire fatalities occur in residential dwellings. On average in the United States, fires kill nearly 5,500 Americans each year. Over 30,000 people are injured in fires annually and someone dies in a fire every 40 minutes. Most often, victims are children or the elderly. Approximately 1,300 senior citizens die in fires annually. Each year, fire causes over $2 billion worth of damage to homes [1].

Protecting your family from fire requires advance planning for what to do if fire strikes. This includes the use of protective devices, usually smoke alarms, to provide early warning of fire, especially at night when they are most vulnerable.

Early detection of a fire event is an effective way to save lives and reduce property damage. To escape a fiery place and to extinguish the fire source, the fire must be detected at its initial stage. The installation of a fire alarm system is the most convenient way to detect a fire early and avoid losses. A fire alarm system includes components operating together to detect and alarm people by visual and audio methods when smoke, fire, or other dangers are occurred [2]. It also can notify the fire department and control all the fire alarm devices in the area.

Smoke detectors save lives and can help minimize property damage, but what happens when the alarm goes off when nobody is home? [3] In accordance to this problem, we have come out with Smart Fire Alarm System with Automatic Water sprinkler that has been developed to solve the slow response issue of fire accidents. The system reads the heat and smoke data using IoT, analyses these data, and then quickly triggers the automatic water sprinkler. The inputs provide readings for the system to analyse, such as sensors and Wi-Fi module that works as a transmitter for the sensor readings. Temperature and gas sensors are inputs [5]. The readings from the inputs are displayed on the LCD.

Outputs like LED and Buzzer indicate a fire. The water system is supplied with a 12V water pump powered by Arduino and Controlled by a 5V relay. The sprinkler head is the outer of the water output. The alarm is also wired into the fire and smoke detectors and the sprinkler system. The alarm system itself is fault tolerant, has its own internal backup power supply, and is encased in a fireproof box [4] On account of this, our study's importance is to provide a low-cost fire alarm system considering the affordability, effectiveness, and responsiveness.



1. Figure above shows the class diagram for the Smart Fire Alarm System.

As we can see, there are seven main components connected to the main Smart Home System and the components are:

* Smoke detector
* Heater (which also includes temperature sensor)
* Water sprinkler
* Screen (LCD)
* Window
* Sound system
* Door

All of the stated components will respond or react correspondingly to the surroundings and perform their respective functions based on the situation. The concept is simple, a fire alarm system that tells us that there is a fire nearby is great, but the ones that tells us that there is a fire and reacts upon the fire in immediate effect is undoubtedly even better.

We know that each component of a smart home system is designed to be used in a specific location. In the following parts, we will explore more on the components detail, discover how smoke detectors work and where they are located.



1. Figure above shows the state diagram for the Smart Fire Alarm System.

House combustion is one of the main concerns for builders, designers, and property residents. Singular sensors were used for a long time in the event of detection of a fire, but these sensors cannot measure the amount of fire to alert the emergency response units. To address this problem, as stated earlier, this study also aims to implement a smart fire detection system that would not only detect the fire using integrated sensors but also alert property owners, emergency services, and local fire department stations to protect lives and valuable assets simultaneously [5].

The proposed model in this paper employs different integrated detectors, such as heat and smoke detector. The signals from those detectors go through the system algorithm to check the fire's potentiality and then broadcast the predicted result to various parties using Global System for Mobile Communications (GSM) modem associated with the system. To get real-life data without putting human lives in danger, an IoT technology has been implemented to provide the fire department with the necessary data making this system more reliable. The experimental results showed the superiority of our model in terms of affordability, effectiveness, and responsiveness as the system uses the Ubidots platform, which makes the data exchange faster and reliable [5].

Location and material requirements consideration when designing a smart fire alarm system are:

* For all new home construction, fire alarm sensors must be powered by the home AC power electrical wiring. Although this overcomes the problem of neglecting to replace batteries on a periodic basis, there remains the problem of power outages that would also disable a fire warning sensor that uses the home wiring as a power source [6].
* For homes built prior to 1979, battery-powered smoke alarms are permissible. In newer dwellings, alarms must be powered by the electrical wiring. The problem with battery units is that people often neglect battery replacement. On the other hand, what good are wired-in smoke alarms if we have an electrical fire accompanied by a power outage? The safest arrangement, therefore, is to install wired-in alarms equipped with battery backup. Batteries feed the system as a back-up source while the primary Alternating Current (AC) source function [6].
* As to smoke alarm placement, requirements also vary according to the age of the dwelling. In older homes, most municipalities require alarms in the locations of within a close proximity to all bedroom entrances, on each storey of a multilevel home, and in basements. The latest standards, enacted in 1993, require that there be an additional alarm in each bedroom. Another practical location, although not required, is the garage [6].

Next, we will go deeper on the explanation behind the state machine diagram given in figure 2. Furthermore, the basic implementation of the smart fire alarm is realised by using the Tinkercad platform to take a glimpse on how the smart fire alarm really works in respective situations and conditions. To ease our understandings on the functionalities and responds of this system, we will use the approach with the help of illustration using some diagrams and pictures which we will explain later.

Based on the state machine diagram in figure 2, we can see that there are two state which are Initial State and Burning State. The transition between the states only depends on the analogue value of the sensor. If the analogue value exceeds the sensor’s threshold value, it will go to the burning state where the action of opening the window and door, turning off the heater to reduce the surrounding temperature, turning on the water sprinkler and notify the fire department nearby. The other features of the system will be explained more afterwards using some snaps of photos during the simulation on Tinkercad.

Subsequently, the implementation of the circuit below does not really imply all the detailed components that were supposed to be in the system itself, but rather an adaptation of a simple circuit sample aims for a clearer interpretation of the system implementation.



1. Figure above shows the example simple circuit for the Smart Fire Alarm System when no burning is detected.

Notice that when there is no fire or burning detected in any area of the smart home, the LCD screen displays “All Clear” and the green LED is turned on meanwhilst the red LED and the buzzer stayed turn off.



1. Figure above shows the example simple circuit for the Smart Fire Alarm System when there is fire detected.

Meanwhile, when there is fire or burning detected in any area of the smart home, the LCD screen will be displaying “Evacuate” and the green LED will turn off. Subsequently, the red LED will turn on and the buzzer will play sound to indicate there is emergency or wake the home owner up in case that the inhabitants are sleeping, since most fire deaths occur where people sleep such as between midnight and morning. This aims to warn the home owner or person living at the home that there is a fire and take particular act or precaution.

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## Smart Heating and Cooling System

### Introduction

A traditional temperature sensor has one job, which is its job is to adjust the temperature in your house or apartment, whether it is high temperature or low temperature. That is also job one for a smart temperature sensor, although a smart temperature sensor will give the function in a much different way. Before we get too far into this and explain more details about it, know that you can use a smart temperature sensor just as you do a traditional one. That is, you can set the temperature on your own house that you like, but this time, smart home system will help you to achieve the required temperature. The smart home system with the help of the temperature sensor will communicates with your heater or air conditioner to run until the required temperature is reached. In addition, it means that we do not bother to find or use remote to change the temperature. This smart heating and cooling system will use the temperature sensor to detect outside temperature and then the air conditioner will respond to the required temperature. In our smart heating and cooling system, if the temperature is above 30 degree, then air conditioner will turn on and heater will turn off. Furthermore, if the temperature is below 10 degree, then vice versa. But air conditioner and heater will remain off if both condition is not reached.



Figure 6 shows that the state diagram of smart heating and cooling system

### Element of Heating and Cooling System

In our smart heating and cooling system, the most important element is temperature sensor. This temperature sensor will work together with smart home system to achieve the required temperature. In addition, the feature also require the home owner elements which contain id,name and age of the home owner. This smart heating and cooling system also have air conditioner and heater. The heater and conditioner only can respond to the temperature detected if smart home system allow them to do so.



Figure 6 show that the elements of smart heating and cooling system

### Benefits of Smart Heating and Cooling System

* It is easy to make change of temperature effortlessly

It is a lot easier to change the temperature without you need to use the remote. An ordinary home that does not require smart heating and cooling system need to change the temperature by themselves in every single situation. Whether it is cold or hot, they need to change it by themselves.

* It can save money and time

Air conditioner and heater cost a lot of money when it is turn on. For example, for our smart heating and cooling system, if the temperature is between 11 to 29 degree Celsius, the air conditioner and heater will turn off itself. Sometimes, we always forget to turn off heater and air conditioner as well even the temperature is not too hot or too cold. We do not also want to waste time of finding the remote since the tempartature will change with help of the smart heating and cooling system.

* It is more convenient

This is very important especially to old folks. Old folks always require decent temperature. They cannot afford too high or too low temperature.

### Simulation of Smart Heating and Cooling System

* Normal Temperature

Green light indicates that the house is in normal temperature which the temperature is between 10 to 30 degree Celsius. Heater and also air conditioner will both turn off.

Figure 7 shows that simulation of smart heating and cooling system during normal temperature

* High Temperature

Red light indicates that the house is in high temperature which the temperature is above 30 degree Celsius. Air conditioner will turn on but heater will turn off.



Figure 8 shows that simulation of smart heating and cooling system during hot temperature.

* Cold Temperature

Blue light indicates that the house is in cold temperature which the temperature is below 10 degree Celsius. Heater will turn on but air conditioner will turn off.

Figure 9 shows that simulation of smart heating and cooling system during cold temperature.

### Scenario Test

##### Summary and Outlook

Smart cities and homes concepts have been hot topics for over a decade. Changing lifestyles and the growing demand on useful and consistent services require a new approach that relies and benefits from ICT advances. Although there are many advantages to smart homes and cities, there still exist many challenges that make their implementation difficult. Some of these challenges are the security of data that transits across many components and interfaces, and the current fragmentation of standards that make it hard for different devices to be interoperable as well as deployed at scale [7].

In addition, there is the challenge of making sense of the amount of data generated by all of the deployed IoT devices. Although these challenges exist, we have started to see a first batch of smart home devices that solve everyday’s optimization issues such as energy efficiency, home security, and home automation. Nevertheless, we still need to overcome the described challenges through standardized and interoperable protocols [7].

This project was a great introduction to the world of microprocessors and a learning experience for all the four of us. We feel the time we spent on this project was substantial and yet has benefits that will reach far beyond what we do in the university. One day we would like to have a system of our own design integrated into our own house and it would be something that we would enjoy creating. For our prototype we expect it to cost roughly one hundred and sixty-eight dollars however there were expenses not included in that such as the breadboard, LEDs and generic buttons for us to explore the basic functionality of the Arduino with. We believe that using a less expensive Arduino and buying some of these items online in bulk could substantially reduce the cost of creating our system. We feel very privileged as undergraduate students to be able to have a project that we can present as something of entirely our own design.

##### Appendix

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##### Affidavit

We (Muhammad Amjad Bin Abdul Malik, Muhammad Farid Bin Shabri, Muhammad Iqbal Bin Mohd. Fauzi, Amirul Hakimi Bin Zaprunnizam) herewith declare that we have composed the present paper and work ourself and without use of any other than the cited sources and aids. Sentences or parts of sentences quoted literally are marked as such; other references with regard to the statement and scope are indicated by full details of the publications concerned. The paper and work in the same or similar form has not been submitted to any examination body and has not been published. This paper was not yet, even in part, used in another examination or as a course performance.

##### References

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