الجمهورية الجزائرية الديمقراطية الشعبية
وزارة التعليم العالي والبحث العلمي

UNIVERSITÉ BADJI MOKHTAR - ANNABA
BADJI MOKHTAR– ANNABA UNIVERSITY

جامعة باجي مختار – عنابـــــــــة

Faculté : Sciences de L'ingéniorat
Département : Electronique
Domaine : Sciences et Techniques
Filière : Télécommunications
Spécialité : Réseaux et Télécommunications

Mémoire

Présenté en vue de l'obtention du Diplôme de Master

Thème:

Smart home based on speech synthesis for elderly and disabled persons

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Année Universitaire : 2020/2021

ACKNOWLEDGEMENT

First and foremost, praises and thanks to the God, the Almighty, who has granted countless blessing, and knowledge throughout our work so that we have been finally able to accomplish the thesis, and complete the project successfully.

We would like to express our deep and sincere gratitude to our project supervisor, Professor .M.Fezari. For providing invaluable guidance throughout this work. Also for the continuous support for his patience, and immense knowledge. We are thankful for your experience and making sure the project continued to progress towards a finished thesis and a successful prototype.

Our warmest thanks go to the jury members Dr.A.Boulmaiz and Dr.F.Amara, Who agreed to read and rate this work. We show them our deepest respect.

We are extremely grateful to our parents for their love, prayers, caring and sacrifices for educating and preparing us for the future. Regardless of the waves that comes on our way, we recognized that we will always have you by our side. Many thanks; mum as well as dad, for always offering a shoulder to lean on. We could not have done any of this without you, your motivation and momentum.

We would like to extend our gratitude to Tounsi A.Y, Regional Manager of Algeria telecom and director of the maintenance facility, core network D.E.M.R.C. Annaba, His dynamism,vision, sincerity and motivation have deeply inspired us.. He has taught us the methodology to carry out the research and to present this work as clearly as possible. It was a great privilege and honor to work and design the project under his guidance. We are extremely grateful for what he has offered us during the past three month.

An extra thanks to N.Tarfi And Dr.T.Hafs for helping us with the software and operating system of the project.

Finally, we express our gratitude to all the teachers who have gave us a good education, collaborated in our training and knowledge from the first cycle of study until the end of university cycle.

We would not have been able to complete this without you we are immeasurably grateful. Thank you all.

DEDICATION

This project and master thesis is dedicated to God Almighty my creator, my strong pillar, my source of inspiration, wisdom, knowledge and understanding. He has been the source of my strength throughout this period. And to My great teacher and messenger, Mohammed (May Allah bless and grant him), who taught us the purpose of life.

I dedicate my work to my beloved Mom and Dad. A special feeling of gratitude to my loving parents, whose words of encouragement and push for tenacity ring in my ears. You have natured my learning, supported my dreams. Due to the fact that of your genuine love for me, I have become the luckiest person in the world. You made me into who I am today. Thank you so much for all the sacrifices you have made. You are a special present sent out to me by God, a gift I got freely from heaven.

This master thesis is also dedicated to my loved ones and close family: my sister, my brother, my uncles, and my best friends who have supported me throughout the process. I will always appreciate your kind words. And I dedicate this to Tounsi A.Y and his team of core network D.E.M.R.C. Annaba, Lahcene ,Amar ,Lydia ,for being there for me throughout the entire internship period. Quite possibly the most is the kind of you. Most certainly boast and motivation, who have kept me a-float when times were hard.

I would not have been able to complete this thesis without the amazing people for whose help I am immeasurably grateful.

Halis Chaima

I dedicate this master thesis to my beloved parents, My aunt forher love,prayers and continuing support to complete this research work. I Also Dedicate this project to my cousin who has provided information about the software part of the project, my best friend B.Ali rachdi, my brother and my sister for their help and the keen interest shown to complete this work successfully.

Lahmar hocine

Abstract:

Smart home has become a visible concept that attracts the collaboration of various areas of science and engineering. In point of fact the serious social problems of increasingly population aging. Elderly and disabled people can be supported by using smart homes by providing them secure, safe, and controlled environments.

We developed a smart home system that allows the users to monitor the house environment. More particularly, the designed system is based on speech synthesis technology and web page using IOT platform ThingSpeak as to monitor, update, and display the collected data from the connected sensors, which are the house temperature with DHT22 sensor, water level in the tank withHC-SR04sensor. Asecurity system for the door and window, broken glass. In addition, to a unique door security system with RC522 RFID module. Where the caretaker can monitor the entire house environment from the platform, and see the data visualized in graphical and dashboard form.

The major hardware element in our project is a Raspberry Pi 3B credit card sized microcomputer with adapted sensors. The RPI runs a described software system, and analyzes the collected data. Moreover sending the voice alerts, which are the synthesized text messages by eSpeak synthesizer. Providing audio-based security alarm system with the TTS technology will let the elderly person have full control over their house, at detecting abnormal activities.

The test of the smart home prototype shows that the system can perform the corresponding operation well and is more practical.

Keywords: smart home, elderly, speech synthesis, raspberry pi, sensors, webpage.

Résumé :

La maison intelligente est devenue un concept visible qui attire la collaboration de divers domaines de la science et de l'ingénierie. En fait, les graves problèmes sociaux liés au vieillissement croissant de la population. Les personnes âgées et handicapées peuvent être aidées en utilisant des maisons intelligentes en leur fournissant des environnements sûrs, sécurisés et contrôlés.

Nous avons développé un système de maison intelligente qui permet aux utilisateurs de surveiller l'environnement de la maison. Plus particulièrement, le système conçu est basé sur la technologie de synthèse vocale et une page Web utilisant la plate-forme IOT ThingSpeak pour surveiller, mettre à jour et afficher les données collectées à partir des capteurs connectés, qui sont la température de la maison avec le capteur DHT22, le niveau d'eau dans le réservoir avec Capteur HC-SR04. Un système de sécurité pour la porte et la fenêtre, verre brisé. De plus, un système de sécurité de porte unique avec module RFID RC522. Où le gardien peut surveiller l'ensemble de l'environnement de la maison depuis la plate-forme et voir les données visualisées sous forme graphique et de tableau de bord.

L'élément matériel majeur de notre projet est un micro-ordinateur de la taille d'une carte de crédit Raspberry Pi 3B avec des capteurs adaptés. Le RPI exécute un système logiciel décrit et analyse les données collectées. De plus, l'envoi des alertes vocales, qui sont les messages texte synthétisés par le synthétiseur eSpeak. Fournir un système d'alarme de sécurité audio avec la technologie TTS permettra à la personne âgée d'avoir un contrôle total sur sa maison, en détectant les activités anormales.

Le test du prototype de maison intelligente montre que le système peut bien effectuer l'opération correspondante et est plus pratique.

Mots-clés : maison intelligente, personnes âgées, synthèse vocale, raspberry pi, capteurs, page web.

ملخـص:

أصبح المنزل الذكي مفهومًا مرئيًا يجذب التعاون في مختلف مجالات العلوم والهندسة. في الواقع، المشاكل الاجتماعية الخطيرة المتمثلة في زيادة شيخوخة السكان. يمكن دعم كبار السن والمعاقين باستخدام المنازل الذكية من خلال توفير بيئات آمنة وخاضعة للرقابة لهم.

قمنا بتطوير نظام المنزل الذكي الذي يسمح للمستخدمين بمراقبة بيئة المنزل. بشكل أكثر تحديدًا، يعتمد النظام المصمم على تقنية تركيب الكلام وصفحة الويب باستخدام منصة IOT ThingSpeak لمراقبة البيانات المجمعة من المستشعرات المتصلة وتحديثها وعرضها، وهي درجة حرارة المنزل باستخدام مستشعر DHT22، ومستوى الماء في الخزان باستخدام مستشعر HC-SR04. نظام أمان للباب والنافذة زجاج مكسور. بالإضافة إلى نظام أمان فريد للأبواب مع وحدة RC522 RFID. حيث يمكن للقائم بالرعاية مراقبة بيئة المنزل بالكامل من المنصة، ورؤية البيانات في شكل رسوم بيانية ولوحة القيادة

عنصر الأجهزة الرئيسي في مشروعنا هو كمبيوتر صغير بحجم بطاقة الائتمانRaspberry Pi 3B مع أجهزة استشعار ملائمة. يدير RPI نظام برمجي موصوف، ويحلل البيانات التي تم جمعها. علاوة على ذلك، يتم إرسال التنبيهات الصوتية، وهي عبارة عن رسائل نصية مركبة بواسطة آلة النطق eSpeak. إن توفير نظام إنذار أمان صوتي بتقنية TTS سيسمح لكبار السن بالسيطرة الكاملة على منزلهم،في اكتشاف الأنشطة غير العادية.

يوضح اختبار النموذج الأولي للمنزل الذكي أن النظام يمكنه أداء العملية المقابلة بشكل جيد وهو أكثر عملية.

الكلمات الرئيسية: المنزل الذكي، كبار السن، تركيب الكلام،كمبيوتر صغير،أجهزة الاستشعار، صفحة الويب.

LIST OF ACRONYMS:

AC	Alternating Current
ADC	Analog Digital Convertor
AI	Artificial Intelligence
API	Application Programming Interface
ARM	Advanced RISC Machine
CPU	Central Processing Unit
DB	Data Base
DC	Direct Current
DHT	Digital Humidity and Temperature
Flite	Festival lite
GND	Ground
GPIO	General Purpose Input/Output
HAN	Home Area Network
HC-SR	Ultrasonic Distance Sensor
HDMI	High-Definition Multimedia Interfaces
HTML	HyperText Markup Language
HTTP	Hypertexb Transfer Protocol
I2C	Inter-Integrated Circuit
IBM	International Business Machines
IC	Infrared Cam
IoT	Internet of Thing
IP	Internet protocol
ISO	International Organizationfor Standardization
IT	Information Technology
LAMP	Linux Apache MySQL PHP
LAN	Local Area Network
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LPG	Liquid Propane Gas
MCP	MICROCHIP
MQTT	Message Queuing Telemetry Transport
MySQL	"My", the name of co-founder Michael Widenius's daughter, and "SQL", Structured Query Language.
OS	Open Source

PHP	Hypertext Preprocessor
Ppm	Parts Per Million
PWM	Pulse-width modulation
RFID	Pulse-width modulation
RH	Radio Frequency Identification
RPI	Raspberry Pi
SBC	Single board computer
SD	Secure Digital
SMS	Short Message System
SNS	social network service
SPI	Serial Peripheral Interface
SPI-Py	Serial Peripheral Interface-Python
SQL	Structure Query Language
SSH	Secure Shell
TTL	Time to live
TTS	Text-to-Speech
UART	Universal Asynchronous Receiver Transmitter
Wi-Fi	Wireless Fidelity

SUMMARY

Chapter2:Design and Methodology of the smart home

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General Introduction

Introduction

Automation and computerization are becoming increasingly significant in all industries now. A home with cutting-edge automated devices should simplify rather than complicate our lives. The purpose of most technological advancements is to safeguard people and give them with the required comfort.

As a result, including intelligent technology into a home infrastructure simply makes our lives easier and saves us time and money in the long run. The simplicity of the smart home system can be useful to disabled people and the elderly because of their physical limitation to do tasks in the house. From a security perspective, the smart home system can help them because it is convenient [1] [2].

The elderly persons constitute a significant and growing portion of the global population. Statistics reveal that the percentage of persons aged 65 and over is steadily increasing due to a variety of factors, including decreased birth rates and women's fertility. According to the Algerian National Office Of Statistics [3], the percentage of the total population of persons over the age of 65 has increased and is expected to increase further, Population ages 65 years and above as a share of total population. In 2020, population aged 65 years and above for Algeria was 6.7 %. Population aged 65 years and above of Algeria increased from 3.6 % in 1971 to 6.7 % in 2020 growing at an average annual rate of 1.32%. Moreover, the number reached 2.7 million out of a population of 35.5 million Algerians and it will reach 20 percent in 2030.

On the other hand, in 2011, it was stated that 35% of adults aged 65 and up had some type of disability [4].Some of them require assistance in order to achieve critical personal requirements. Frail older persons prefer to live independently and manage their own affairs in their own homes, which promotes sense of competence and reduces depression risk. In reality, living at home with monitoring devices and intelligent equipment is less expensive and more helpful than visiting medical centers and being watched by nurses from an economic standpoint. Smart home systems with remote monitor controls and health-care capabilities, on the other hand, will lower the cost of personal assistance.

Furthermore In the event of any abnormality in the home, a notification system will inform the user through several means, such as voice alarm, SMS to the owner's cell phone, Email notification or a website for notification and monitoring.

The Smart Home or home automation system must overcome four main issues [5].These drawbacks include high ownership costs, inflexibility, poor manageability, and security challenges. Different existing methods for Smart Home and home automation have been applied for both short-range communication (e.g., Bluetooth, Zigbee, etc.) and long-range communication (e.g., internet-connected communication). [6]

The aim of this project is to implement a smart home security and control system that allows elderly individuals with physical problems, especially handicapped and disabled individuals, to get notifications with voice alerts for desired devices and locations in the house. Indeed, the audio alarms of the synthesized messages provide a significant boost in security. The research also examines the concept of the "smart house" and its perceived multi-functional contribution to improving the lives of older people.

Chapter1
Smart home for the elderly persons based on speech synthesis

1.1 Introduction:

Nowadays life automation can play a major role in the life of elderly and disabled persons. The main attraction of any automated system is reducing human labor, efforts, time and errors due to human negligence.

A smart home is a residence that uses internet-connected devices to enable the remote monitoring and management of appliances and systems, such as lighting and heating. Smart home technology, often referred to as home automation or domestics from the Latin "domus" meaning home, provides homeowners security, comfort, convenience and energy efficiency by allowing them to control smart devices, which are useful and possibly even necessary for older people or the one with disabilities. Many smart home devices automate routine processes and adjust to the user's habits. The use of voice synthesis in a smart home provides a significant increase in security, emulating an individual's voice is much more challenging, and need the use of modern communication technology. While the role of the synthesis algorithm is to simulate the action of the vocal tract system. Proper sounds of speech are generated and they represent the input text as a speech signal.

1.2 Purpose Statement:

In order to enhance the self-care ability of persons with disabilities and satisfy people's demand the use of voice synthesis in a smart home system provides a significant increase in security. This project aims at providing voice-based interaction technology, that lets the users have full monitoring over their home environment, at detecting distress situations and at easing the social inclusion of the elderly and frail population. The work also presents the sound and speech synthesis system evaluated thanks to a corpus of data acquired in a real smart home environment.

The project attempt also to implement an intelligent monitoring system, which uses various sensors in the home to identify emergencies by detecting deviations from normal activity pattern.

The detection algorithm works on threshold value if the value of the input is higher than specified threshold, then the system sends a voice alert to the elderly person via the loudspeaker. For the use of this technology, there are many solutions for the speech synthesizers, and Festival or e-speak are one of them. Further, the creation of a web page using IoT platform for monitoring the house environment, the data of the different sensors will be sent to ThingSpeak IoT platform via MQTT protocol that will be displayed in graphs and numbers, where the caretaker will be able to see it and check on the elderly person.

Building this smart home system with Raspberry Pi, a new single board computer with size of credit card. Python is used as the main programming language, which is default. We are also going to provide security, which is an attractive option to homeowner. Moreover, it will be very useful for the ones who cannot perform basic activities efficiently, it will offer raised quality of life for them.

1.3 Smart Home Technology:

Smart home technology [7][8] generally refers to any suite of devices, appliances, or systems that connect into a common network that can be independently and remotely controlled. When your home technology works together in one system, it can also be referred more loosely as a “connected home”. For example, your home's thermostat, lights, audio speakers, TVs, security cameras, locks, appliances, and more are all connected into a common system, which can be controlled from your smart phone or through a mobile touch screen device.

Smart home automation allows you to tap into high-tech functionality and luxury that was not possible in the past. Furthermore, home automation, or demotic, is the automation of a home, also known as a smart home. As technology development continues to expand, so will the possibilities for consumer home automation to make life easier and more enjoyable [9] [10].

In home automation, we find three distinct levels presented as next:

- Monitoring
- Control
- Automation

A. Monitoring:

It is the ability to view status of systems and to verify the condition of various devices, such as whether the doors are locked or not, whether the lights are on or off, and the temperature.

B. Control:

It is the ability to change the state of a system, where we can manage the devices since they have sensors. Therefore, we can control the lights thelock of the doors or even the heat as an example we can turn it down no matter where you are even from miles away.

C. Automation:

The ability to change the state of a system automatically in response to an event. Sensors, controllers and actuators are the three main elements of a home automation system

Changes in daylight, temperature or motion sensing can all be monitored by sensors, Home automation systems will then tailor those (and other) to our tastes. We can turn on the heating if the outside temperature falls below a certain temperature.

1.3.1 Smart Home Technologies for Elderly and Disabled People:

Smart homes were advertised as an emerging place for positive aging, in particular with the ability to make household duties easier and safer and enhance communication. Smart houses are newly designed to accommodate individuals with particular needs, including elderly, physically disabled persons and chronic diseases, according to Stefanov, Bien and Bang [11]. Moreover, the actual design of smart houses does not depend on the demands, characteristics and concept of flexibility as such change through time, so that elderly people do not have a single smart house. A variety of appliances were invented to better help and monitor the mental and physical functions of residents, in addition to the generally automatic systems to facilitate domestic work.

The following aspects have been recognized by the Aged and Community Services, which rely on the consumer's health and financial situation: [12]

- Personal alarm through a pendant and a cord pulling in a reactive center.
- Video door entry systems to allow the resident to see who is going and to open the door at the distance.
- Bed and chair occupancy sensors which provide early notice if the resident does not return in a specified time.
- Lighting which may be switched on when the resident leaves bed.
- Medical surveillance, such as pulse, blood pressure and soiling, which may be evaluated and information properly provided on-site.
- Increased application of robotics to support the entire house.

1.3.2 The Conceptual Framework of Smart Home:

A modern home with electronically controlled security and amenities is referred to as a "smart home" in general. The integration of home-based technology and services for a higher quality of life is termed as smart home technology [13]. Smart houses, in general, are outfitted with sophisticated automatic systems that perform a variety of pre-programmed functions and chores, such as lighting, temperature management, multi-media, window and door operations, and so on. Ambient intelligence is a term used to describe a modern environment that is sensitive to and adaptable to modern human and social demands [14]The implementation of smart home technologies is intended to improve everyone's comfort at home by automating domestic duties, improving communication, and increasing security [11]. Users of smart homes can improve their ability to communicate with their domestic environment, execute chores, and participate in activities that were previously difficult or impossible [15]. Because being "smart" can imply various characteristics of a highly advanced modern home, such as being automatic, compact, innovative, convenient, self-adjusting, responsive, or functional, the concept "smart home" is subject to various definitions and interpretations in a digitally enhanced living environment.

A conceptual framework of intelligent houses was developed based on an assessment of appropriate literature with the aim of creating a sound background for further discussion (Figure1).

This proposed framework suggests that intelligent houses can be identified or described as having five key characteristics:

- automation: capacity to adjust or perform automatic functions;
- Multi-functionality: capacity to perform several tasks or to generate different results;
- adaptability: ability to adapt (or adapt) to meet users' needs;
- interactivity: ability to interact or enable user-to-user interaction;
- Efficiency: the ability, timesaving, cost-saving and convenient performance of functions.

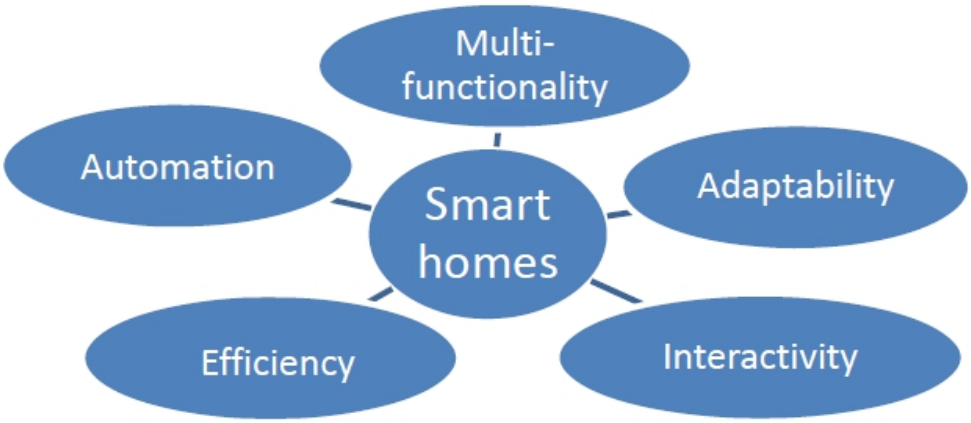

Fig.1.Conceptual framework of smart homes

1.4 Developing a smart home based on TTS technology :

1.4.1 Smart homes and Healthcare for the Elderly:

A smart home system can create a human-centered intelligent environment that is sensitive also adaptive, and is able to respond to human needs, habits, or even gestures and emotions. Which makes it easy and suitable candidate for taking care of the elderly .But also putting in mind that the two main tasks of this disabled persons smart home environment is to follow the daily activities and also the detection of all the abnormal activities.

The key factors for ambient intelligence in smart homes is to include detecting anomalies such as the falling of things or the old person itself, robbery and the detection of a fire at home.[16]

Furthermore, obtaining information, which are related to different daily activities for example the falls are one of the most concerned topics due to their risks like strokes or even the possibility of leading to death in this case it is necessary to trigger emergency help especially for elderly or people who lives alone. By developing different types of sensors and putting them all together such as sound sensors, vision, distance and infrared cameras or even smart wearable devices [17] .

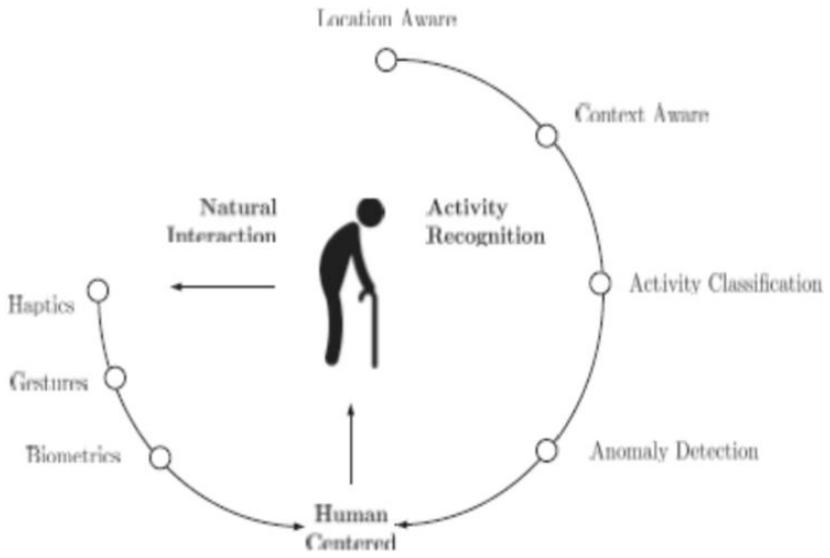

Fig.2.The key factors for ambient intelligence in smart homes (from [16])

As shown in fig.2.Two of the most important objectives in constructing a smart home environment for the elderly and disabled persons are to (a) identify regular everyday activities and (b) detect abnormal activities.

1.5 Smart Home Protocol and home automation system for elderly and disabled persons :

The home automation protocol is the way of communication between devices. A bit like a language, but suitable for smart home products and appliances.

Wi-Fi, Zwave, ZigBee, Thread, Bluetooth are all wireless protocols found on home networks. Although many devices such as Z-Wave use wireless communications [18], other

companies choose to use wired protocols for wired communications. With the help of the smart home protocol, the smart home system will speak to us when monitoring the different devices such as smart lights, thermostats, switches and home assistants. At that point, we will be able to configure automation remotely or control gadgets. As a result, the system of the smart home will be more secure [19].

Some related work to different types and systems of smart home are presented on the table below

Tab.1. Type of Smart Home System

System	Type of system	Year
Bluetooth [20]	Android-based Home Door Lock's Application via Bluetooth for Disabled People	2014
LAN [21]	Smart Home based using several devices via Wireless Data Exchange on LAN	2004
ZigBee [22]	Configurable ZigBee-based Control System for People with Multiple Disabilities in Smart Homes	2016
Wifi [23]	Integration of home networking in a smart environment dedicated to people with disabilities	2004

1.5.1 Home Networking:

Everything from thermostats to lighting systems to doorbells and major appliances in our smart home system are connecting to the Internet and this is the reason why we need to build a home network [24].

A home network, also known as a home area network (HAN), is a form of computer network that facilitates communication among devices within the close vicinity of a home. While the main reason is to improve the quality of life in the home in a number of ways, including automating routine activities, increasing personal productivity, and enhancing security [25].

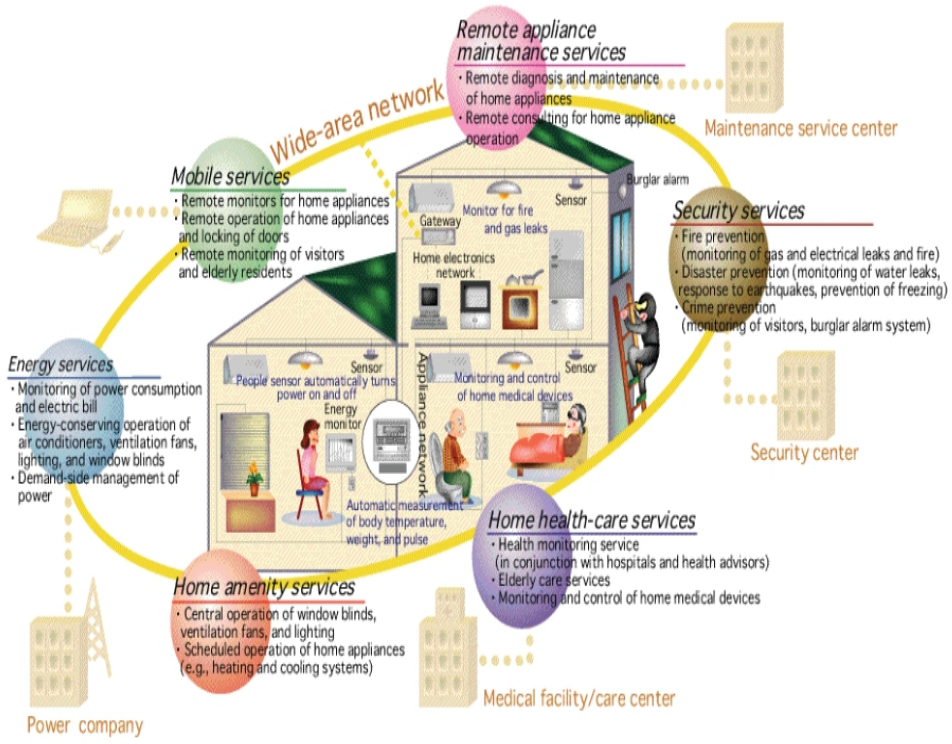

Fig.3.An illustration of the range and scope of potential smart home services [26].

This figure shows many of the services that can be provided for a variety of activities inside a home [26]. An appliance can be defined as smart when it is 'an appliance whose data is available to all Concerned at all times throughout its life cycle' [27].In fact, smart Appliances often use emerging technologies and communications methods [28]to enable various services for both consumer and producer. Here we define smart homes as those having characteristics such as central control of home appliances, networking ability, interaction with users through intelligent interfaces and so on. When considering natural interaction with users, one of the most user-friendly methods would be vocal interaction.

1.5.2 Controlled Appliances:

Smart homes involve different areas of electronics, architecture, computing, and communications. A smart home achieves a complete and total control of unlimited number of appliances[29].it allows multiple levels of security by implementing gas, smoke, and fire sensors connected to sirens, and by using intrusion detectors and automatic motion detectors outside homes that differentiate pets from intruders[30] [31].

It employs glass breaking detectors, surveillance and camera systems as well as monitoring home structure systems for detecting vibrations and earthquakes using 3D accelerometer sensors. In addition, Smart home appliances [10] can minimize or even prevent damage to property. For example, the installation of a smart thermostat allows us to not only comfortably control the temperature but also warn us in advance about freezing pipes in the event of a heating system failure. A smart moisture detector can detect a water leak and warn you about it before it ruins your floor or floods the neighbors downstairs. A device like a smart smoke detector or carbon dioxide detector could one day save your home from a fire and you from death[30] [31].

Furthermore, smart homes can be configured by scheduling tasks for automatic control settings in order to accomplish more rational use of energy. In the end, the functionality with biometric sensors allows **elderly** and **disabled people** to be virtually monitored by International Journal of Smart Home dedicated health progress programs. The appropriate biometric devices measure the irregular heart rhythms, respiration rate, blood pressure, and skin temperature; notify medication periods and doctors meetings, and alerts hospital in case of emergency [32] .or the people who are in charge of that old and disabled person.

Finally, intelligent houses are of great importance because they are water and powerful savings systems, since their powerful consumption can be administered by smart meters, temperature auto control, and battery supervising levels. Moreover, it can be supported by solar tracking and wind green energy systems to reduce the pollution injection [33] [34].

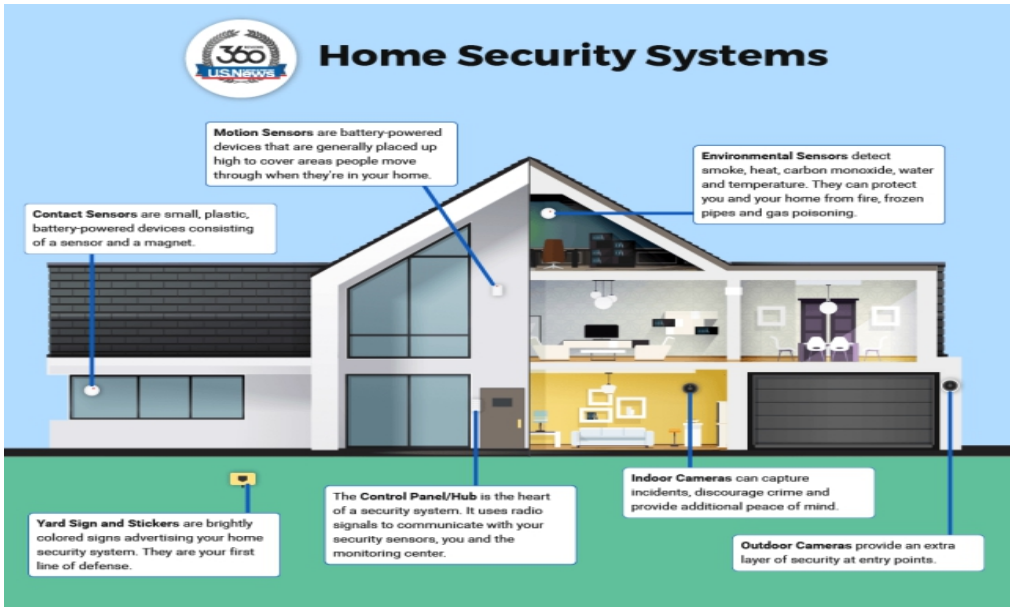

Fig.4.How does home security system works

1.6 Speech and Communication:

Speech is the primary means of communication between people. For reasons ranging from technological curiosity about the mechanisms for mechanical realization of human speech capabilities, to the desire to automate simple tasks inherently requiring human-machine interactions, research in automatic speech recognition (and speech synthesis) by machine has attracted a great deal of attention over the past five decades.

1.6.1 Text to Speech (speech synthesis):

Speech synthesis is the artificial production of human speech. A computer system used for this purpose is called a speech computer or speech synthesizer, and can be implemented in software or hardware products. A text-to-speech (TTS) system converts normal language text into speech; other systems render symbolic linguistic representations like phonetic transcriptions into speech [35].

Synthesized speech can be created by concatenating pieces of recorded speech that are stored in a database. Systems differ in the size of the stored speech units; a system that

stores phones or diphones provides the largest output range, but may lack clarity. For specific usage domains, the storage of entire words or sentences allows for high-quality output. Alternatively, a synthesizer can incorporate a model of the vocal tract and other human voice characteristics to create a completely "synthetic" voice output At a higher level [36], most of the speech synthesis convert sentences or a set of input characters into speech or audio signal. The process involves generating spectrogram for the given characters and then constructing them into waveforms.

1.6.2 Speech and Voice Synthesis System:

The most important qualities of a speech synthesis system are naturalness and intelligibility. Naturalness refers to how closely the output resembles human voice, while intelligibility refers to how easily the output is comprehended. The perfect speech synthesizer is natural sounding and understandable. Speech synthesis devices usually strive to achieve the best of all worlds.

Concatenative synthesis and formant synthesis are the two main methods for creating synthetic speech waveforms. Each technology has advantages and disadvantages, and the desired applications of a synthesis method would usually dictate which approach is used [37].

The quality of a speech synthesizer is judged by its similarity to the human voice and by its ability to be understood clearly. An intelligible text-to-speech program allows people with visual impairments or reading disabilities to listen to written words on a home computer. Many computer operating systems have included speech synthesizers since the early 1990s [38].

A text-to-speech system (or "engine") is composed of two parts: a front-end and a back-end.

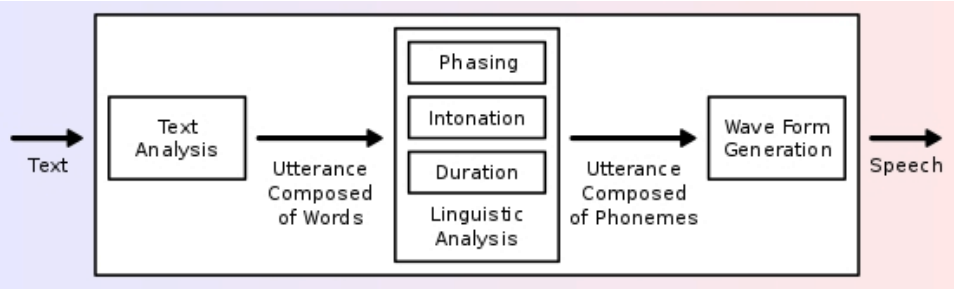

Fig.5.Overview of a typical TTS system

The front-end has two major tasks. First, it converts raw text containing symbols like numbers and abbreviations into the equivalent of written-out words. This process is often called text normalization, pre-processing, or tokenization. The front-end then assigns phonetic transcriptions to each word, and divides and marks the text into prosodic units, like phrases, clauses, and sentences. The process of assigning phonetic transcriptions to words is called text-to-phoneme or grapheme-to-phoneme conversion. Phonetic transcriptions and prosody information together make up the symbolic linguistic representation that is output by the front-end.

The back-end often referred to as the synthesizer then converts the symbolic linguistic representation into sound. In certain systems, this part includes the computation of the target prosody (pitch contour, phoneme durations) [39] .Which is then applied to the speech output.

1.6.3 History of Speech Synthesis:

Some people attempted to create computers that could mimic human speech long before electronic signal processing was invented. Pope Silvester II (d. 1003 AD), Albertus Magnus (1198–1280), and Roger Bacon (1214–1294) were all mentioned in early legends about the presence of "Brazen Heads."

About two hundred years ago, the first attempts to create synthetic speech were made. Professor Christian Kratzenstein of St. Petersburg, Russia, demonstrated the neural distinctions between five long vowels (/a/, /e/, /i/, /o/, and /u/) and created apparatus to manufacture them artificially in 1779.He built acoustic resonators that resembled the human vocal tract and triggered them with vibrating reeds, as in musical instruments.

A few years later in Vienna1791 Wolfgang von Kempelen presented his "Acoustic-Mechanical Speech Machine", capable of producing single sounds and certain sound combinations [40].

Inspired by Wheat stone's speaking system, Alexander Graham Bell and his father built a similar machine in the late 1800s. Bell has conducted several dubious studies on his terrier. He had his dog growl between his thighs, and then manipulated his vocal tract with his hands to make speech-like sounds.

Until the 1960s, researchers and experimented with mechanical and semi-electrical analogs of the vocal system, but with little success. Popular scientists like Herman von Helmholtz and Charles Wheatstone conducted mechanical and semi-electrical experiment [40] [41].

1.6.4 Speech Synthesis in Artificial Intelligence:

Text-to-speech processing and speech synthesis are two of the most cutting-edge advances enabled by artificial intelligence. Beyond simply allowing a person to enter text to be recited by a robot, voice computing allows for the creation of unique synthetic voices[42].

These voices enable people to regain lost voices, converse with computers in increasingly realistic ways, and convert any amount of language text into natural-sounding speech.
John McCarthy (Dartmouth College), Claude Shannon (Bell Telephone Laboratories), Nathaniel Rochester (IBM), and Marvin Minsky (Harvard University) first coined the term "Artificial Intelligence" in a proposal to the Rockefeller Foundation in 1955. Artificial intelligence can be described as human intelligence shown by machines also Artificial intelligence (AI) has affected nearly every area of life and the world since its inception. Speech synthesis is one example of a system that uses AI to make it easier for its users.

1.6.5 Applications and Uses of Speech Synthesis:

Speech synthesis is used in a wide range of applications. It is important to note, however, that this device was initially intended to assist people with disabilities (particularly the visually

impaired) in their everyday lives. For example due to his extreme condition, Stephen Hawking used a TTS to get along and communicate with others around him [43].

Since then, many instances of use had been advanced extra or much less near the authentic distinctive feature of TTS .From low-quality talking calculators to advanced 3D applications including talking heads, communication aids have evolved. The mode of implementation is mostly determined by the program being used. Unrestricted vocabulary is not needed in some situations, such as announcing or alert systems, and the best results are normally obtained with some basic messaging scheme. Any funds can also be saved with proper execution. In the other hand, certain systems, such as reading devices for the blind or e-mail readers, necessitate an infinite vocabulary, necessitating the use of a TTS scheme.

Furthermore, the application field of synthetic speech is rapidly evolving, and the efficiency of TTS systems is gradually improving. Speech synthesis devices are now getting more inexpensive for average users, making them more desirable for daily use. Better availability of TTS systems, for example, can improve employment opportunities for people who have communication difficulties.

A. Educational Applications:

Synthesized voice can also be used in a variety of educational settings. A computer equipped with a speech synthesizer can provide instruction 24 hours a day, 365 days a year. It can be programmed to perform specific tasks such as spelling and pronunciation instruction for various languages. It is also compatible with immersive educational software [44].

B. Applications for Telecommunications and Multimedia:

The newest applications in speech synthesis are in the area of multimedia-mail messages can be listened to over a regular phone line using synthetic voice. Synthesized voice can also be used in mobile phones to read out brief text messages (SMS). An automatic speech recognition system is also needed for fully immersive multimedia applications. While automated recognition of

fluent speech is still a long way off, the efficiency of current systems is high enough that it can be used to issue command and control instructions [44].

C. Other Applications:

In theory, speech synthesis can be used in any form of human-machine interaction. Synthesized voice, for example, can be used in alert and alarm systems to provide more precise information about the current situation. Using speech instead of warning lights or buzzers allows you to hit the warning signal from a nearby room, for example a speech synthesizer can also be used to receive certain desktop messages from the device, e.g. to operate the printer or to send-mails.

The vast area of IoT is another sector that implements speech synthesis in embedded or cloud systems and continues to revolutionize uses. Indeed, in an ever-expanding world, intelligent systems are constantly being outfitted with TTS, on the one side to enhance the user experience and, on the other, to improve usability and the intelligence of the interfaces. Household appliances (also known as "appliances" in English) are a good example of how speech is gradually being integrated into consumer goods and robotics [44][43].

1.7 Choosing and Integrating Speech Synthesis:

In order to select the appropriate speech synthesis (text-to-speech), various criteria must into account. These parameters are the following: the language spoken, the type of speaker, the quality of the voice and the provider. With this information, it will be easier to choose the appropriate solution that meets your needs and constraints. In fact, not all companies that offer TTS have equal ranks. Therefore, it is very important to find these partners before you start. The type of voice is an important criterion for the proposed user experience. There has to be a coherence between the voice interface and his part of inspiration. On the convergence front, speech synthesis systems are often focused on cloud, embedded, or mixed (also known as "on-premise") concepts.

1.7.1 Classification and Construction of Speech Synthesis Systems:

Text-to speech systems' functioning is based on the fact that the entered text is automatically converted into speech. The input constitutes written text in a digitalized form, and the output is a synthetic speech.

The TTS method performs two fundamental stages in order to synthesize speech: [45]

1. Textual analysis (description of linguistic rules in the text)
2. Speech synthesis (creation of speech sounds corresponding to the input text using the principles of the text's linguistic description)

1.7.2 Concatenative Speech Synthesis:

Concatenative speech synthesis concatenates (combines) individual units (phonemes, diphones, triphones, micro-segments, syllables) into a speech. [46] in general, it provides the most natural-sounding synthesized voice. Differences between natural variations in speech and the design of the artificial techniques for segmenting the waveforms, on the other hand, can result in audible glitches in the output. Concatenative synthesis is classified into three main subtypes [47].

- Domain-Specific synthesis:

Domain-specific synthesis combines previously documented words and phrases to form full utterances. It is used in systems where the system's text output is restricted to a specific domain, such as transit service updates or weather forecasts. The technology is easy to apply and has been used commercially for a long time in devices such as talking clocks and calculators [48].

- Diphone Synthesis:

It makes use of a speech database that contains all of the diphones of a given language – one registered sample for each diphone (meaning the transition between two adjacent letters). The number of di-phones for each language can vary greatly. As an example, Spanish has approximately 800 diphones and German has approximately 2500 diphones [49].

- Unit-selection synthesis (also known as corpus-based speech synthesis) :

The largest distinction between unit-choice synthesis and diphone synthesis is the duration of speech segments. [50] Unit-choice synthesis database continues complete phrases and phrases. Therefore, it is regularly large than the diphone database. This reasons that the gadget makes use of a massive quantity of reminiscence whilst having a low critical processing unit utilization. Unit-selection synthesis, which has properly prepared corpora in its section database, is the most efficient and common method of concatenate synthesis. It comprises registered voice units of varying lengths. An utterance is generated using the Cost Function.

This function lists all of the possible ways to produce a given set of expressions. The cost function's value is made up of the goal cost and the join cost. The target cost quantifies how well a given unit suits the target sequence's linguistic specification. The join cost determines the most cost-effective way to combine neighboring units. The synthesis efficiency is affected by the weighted elements of the goal cost, as well as cost optimization [50].

1.8 The Reason why Text-to-Speech essential for Voice Recognition:

Today, we are all familiar with the voices of Siri, Alexa, and Google Assistant. As true ambassadors of “voice,” these assistants have all been directly fitted with voice synthesis in order to adapt to the customer. This is not a trivial matter, it is precisely a matter of fortifying the human-machine relationship through a conversational reciprocal connection. As in a normal dialogue between two or more humans, the recipient speaks to the assistant, and the latter responds. This element is more critical than we realize.

In reality, the acceptance process is typically complicated, particularly when there is a break in use, as with any invention. The easiest way to achieve support for voice assistants was to introduce new features that encourage their use while still improving the user interface as much as possible by humanizing the technology. These synthesized voices then made it possible to give an identity to the various assistant. Allowing them to be distinguished, but still seen as distinct individuals in their own right [43]

1.8.1 Advantages and Disadvantages of Speech Synthesis:

A. Advantages:

Speech synthesis devices are conveniently adaptable to express anything the customer wants them to say. Changes of prescription or medication regimen, for example, are not a challenge for a medication alert device that employs a robotic voice. [51] In comparison, a device that uses human speech can require new data to be recorded. Furthermore, Typical Speech Synthesis systems provide a variety of accents and voices, while systems that use pre-recorded human voices can provide only one or two.

B. Disadvantages:

Despite significant advancements, Speech Synthesis can still sound artificial. In addition, the approaches to Speech Synthesis that produce the most natural speech require significant resources in terms of data storage and processing capacity [51].

1.8.2 Speech Synthesis and Voice Recognition in Smart Home:

A smart home built on Microsoft voice synthesis and speech recognition technologies is proposed to improve the self-care potential of people with disabilities and to meet people's need for intelligent control home appliances. Primarily, a home security system with voice interactions aims to protect your property and those inside it from burglary, home intrusion, fire, and other environmental disasters such as burst pipes. Professional monitoring where you will be aware of the problem [52].

Having a smart home system that gives voice alerts and monitor the devices, one can control the home security system and receive voice notifications and voice alerts as an example when someone unlocks the door without any key. The residents are given an opportunity to protect and keep track of what is going on by receiving the voice alerts with the TTS technique .Also Smart home voice based control systems allow home residents to wirelessly control any electrical appliances that can be configured to operate virtually.

1.8.3 Literature Survey:

Based on the literature study, in this section, we present some of the existing works based on home automation so as voice interactions and their main contributions in table 2.

The following information was retrieved whilst searching existing- or possible smart home services while some of them are implemented by voice control the results present different smart home service techniques.

Tab.2.Some of the existing works based on home automation

Reference	***Title***	***Technology used***	***Result***
[53] 2015	Voice Recognition Based Home Automation System for Paralyzed People	Arduino, Voice recognition module V3, Microphone	This system is used for paralyzed people for controlling bed and buzzers.
[54] 2015	Smart Home Automation System for Elderly, and Handicapped People using XBee	Microcontroller, Wireless Communication; XBee	It consists of remote control supported by command buttons and provided by alert LEDs and a LCD for showing messages. The unique master board toggles the ON/OFF switches of the appliances by means of relays. The remote control and its base are communicating with RF signals realized by XBee transceivers.
[55] 2016	Home Automation System Using Android Application.	ATmega328P, Various sensors like LM35, MQ5, DHT11.	It helps in automation such as sensing humidity, temperature and LPG gas leakages.
[56] 2020	Mobile Voice Recognition Based for Smart Home Automation Control	Android OS, Raspberry pi	It will be possible to run any system from any place using a single voice command the system validate specific voice that belongs to the system owner, accessibility where the system can be used by people that have disabilities as(blinded, deaf, dumb).

1.9 Conclusion:

Home automation systems gradually become a major control system field. In particular, with their propensity to standardize their procedures, the implementation of these systems steadily expanded. Indeed, the capacity to collaborate, communicate and perform with high degrees of harmony in devices of diverse types and from different manufacturers is a significant factor.

Speech synthesis in sustainable houses is particularly advantageous for the disabled people, allowing for previously unachievable lifestyles. The use of speech synthesis technologies could have enormous advantages such as providing a safe, secure and comfortable place to live in. because this system of home automation allows the elderly to receive continuous voice alarms and information about the home appliances ,By allowing them to live independently and actively. Intelligent houses can also monitor and control the home environment by evaluating users' behavioral and daily lives. This is why more elderly have voice interfaces. They are also familiarizing themselves with computer technologies and the synthesized

Moreover, sophisticated processes and various given solutions aim at lowering Smart Home prices, simplifying, managing the integrated system easily, and achieving permanent levels of safety.

Due to the number of elderly and disabled persons, we need to increase health care system with more places in Hospitals or special houses for elderly persons. Some of them can afford the presence of the nurse at home, but that will cost a lot of money. Our project is to design a system at home that can help the elderly person by assuring the security and monitoring through IT. The proposed solution is based on a SBC RPI and a set of sensors that can be selected and added depending on the situation, and the house environment. Where the speech synthesis technology is for the voice alerts heard by the homeowner. In addition, to a web page accessed by the caretaker or consultant to take precautionary action in case any abnormality is detected using IoT platform.

Chapter2
Design and Methodology of the smart home

2.1 Introduction:

Smart home technology promises tremendous benefits for an elderly person living alone. From a security perspective, the Smart homes will notify the resident while monitoring the house environment.

In this chapter, we consider doing the methodology of the smart home system. The architecture of our system is built over raspberry model 3b, and we will be monitoring and controlling many interconnected appliances such as humidity and temperature sensor, gas, smoke and fire detectors, the Ultrasonic Sensor Distance Measuring for the water limit, as well as security systems for the doors and the windows. In addition, to RC522 RFID module to unlock the front door. While the system is able to detect events such as high temperature, gas leakage and fire incidence, and upon detection of any event, it will then send voice alerts to the person inside the house, with the speech synthesis technology TTS.

2.2 System Block Diagram:

Here is a system block diagram of the smart home for elderly persons

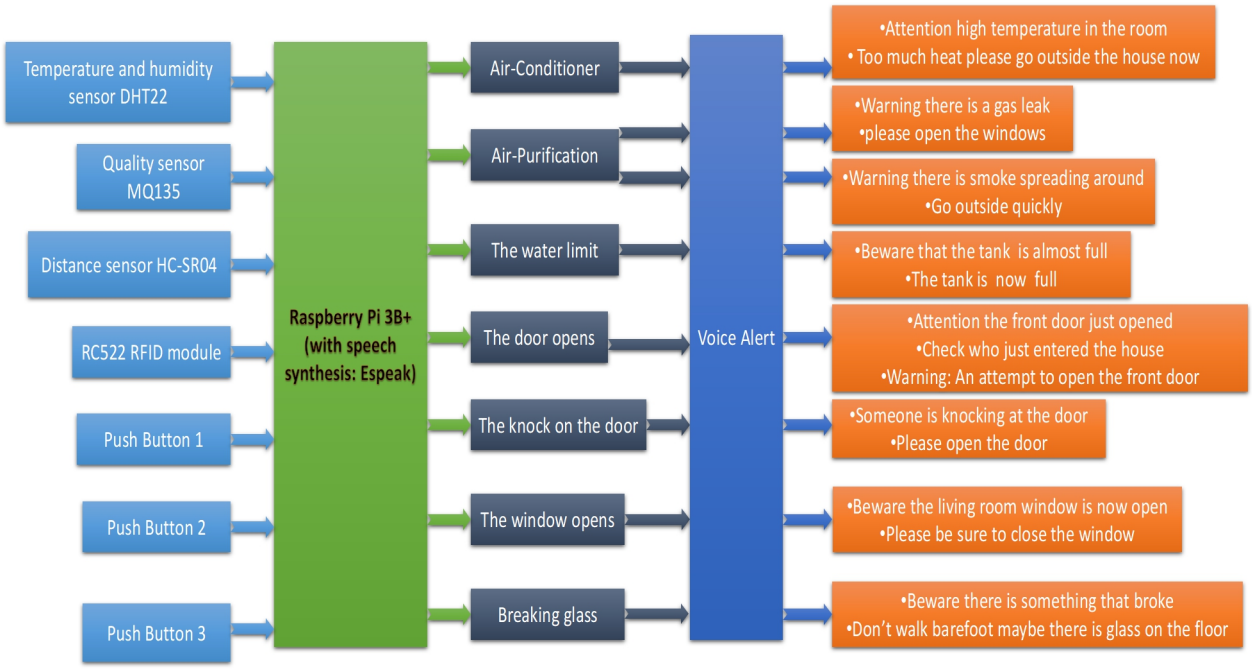

Fig.6. System block diagram

2.3 Main Features of Raspberry Pi:

2.3.1 Presentation of Raspberry Pi:

The Raspberry Pi is a low cost, **credit card sized computer** that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. A capable little device enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. It is capable of doing everything you would expect a desktop computer to do, from browsing the internet and playing high-definition video, to making spreadsheets, word-processing, and playing games.

What's more, the Raspberry Pi has the ability to interact with the outside world, and has been used in a wide array of digital maker projects, from music machines and parent detectors to weather stations and tweeting birdhouses with infra-red cameras [57].

- Raspberry Pi model B:

Raspberry Pi is an ARM based computer credit card in size. It is single "on chip" computing hardware.

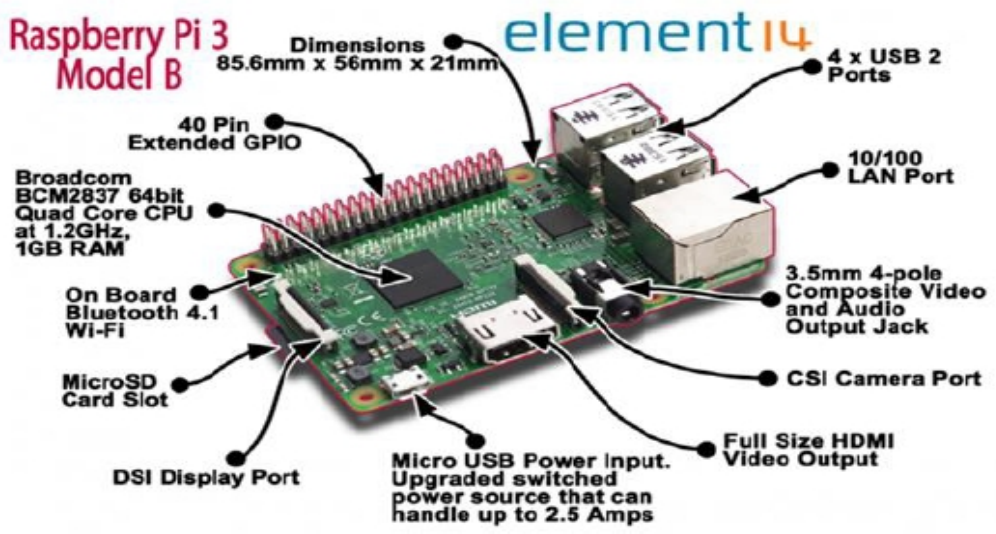

Fig.7. Diagram of Raspberry pi 3B

2.3.2 GPIO Pins:

A powerful feature of the Raspberry Pi is the row of GPIO (general-purpose input/output) pins along the top edge of the board. The GPIO pins allow the Raspberry Pi to control and monitor the outside world by being connected to electronic circuits. The Pi is able to control LEDs, turning them on or off, run motors, and many other things. In addition to that, it can be used to communicate to the CPU the ON/OFF signals received from switches, or the digital readings received from sensors.

There are 40 pins on the Raspberry Pi (26 pins on early models), and they provide various different functions [58].

Fig.8. GPIO Pins and Their Functions

The Raspberry Pi features five different types of pins: [59]

- **GPIO:** These are general-purpose pins that can be used for input or output.
- **3V3:** These pins supply a 3.3 V power source for components. 3.3 V is also the internal voltage that all GPIO pins supply.
- **5V:** These pins supply a 5 V power source, the same as the USB power input that powers the Raspberry Pi. Some components, such as the passive infrared motion sensor, require 5 V.
- **GND:** These pins provide a ground connection for circuits.
- **ADV:** These special-purpose pins are advanced and not covered in this tutorial.

2.4 Interacting with Physical Components:

It is important to determine the Layout of the smart home system because it contributes to the effective construction of the system. Therefore, we will describe the comprehensive components of the entire system and describe the reasons behind the choice of each feature from the architecture.

2.4.1 Temperature Humidity DHT22 sensor:

The DHT22 is made of two parts it is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). The data pin of this sensor is connected to the GPIO pin of Raspberry pi. It is fairly simple to use, but requires careful timing to grab data [60].

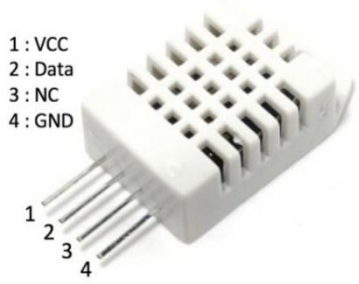

Fig.9. DHT 22 Digital Temperature and Humidity sensor

- Sensor Datasheet:

Tab.3. Humidity performance table

Parameter	Condition	Min	TYP	Max	Unit
Resolution			0.1		%RH
Range		0		99.9	%RH
Accuracy	25°C		±0.2		%RH
Repeatability			±0.3		%RH
Exchange		Completely interchangeable			
Reponse	1/e(63%)		<5		S
Sluggish			<0.3		%RH
Drift	Typical		<0.5		%RH/yπ

Tab.4. Temperature performance table

Parameter	Condition	Min	TYP	Max	Unit
Resolution			0.1		°C
n			16		bit
Accuracy			±0.5	±1	°C
Range	-40			80	°C
Repeat			±0.2		°C
Exchange		Completely interchangeable			
Reponse	1/e(63%)		<10		S
Drift			±0.3		°C/yr

- Circuit Connection:

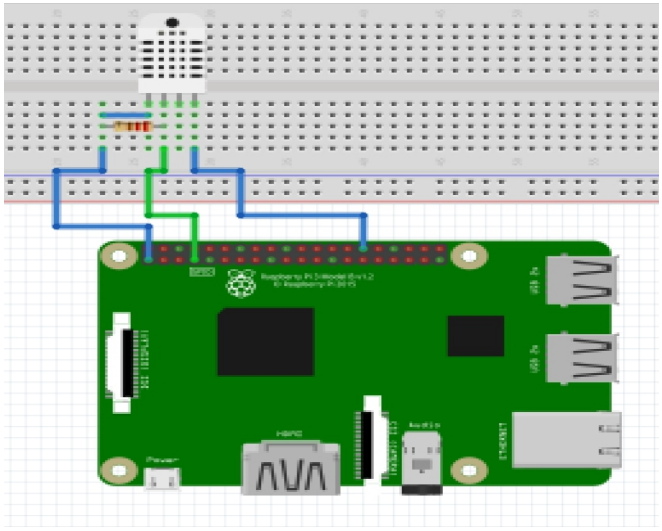

Fig.10.Breadboard of the Dht22 sensor

- DHT22 System Architecture:

Raspberry Pi is connected to the DHT22 to sense temperature and humidity. Sensor data from the DHT22 is decoded using Ad fruit's DHT22 Python library [61], and converted to user readable format for both the temperature and humidity, i.e., temperature in 0C and humidity in percentage%. The value of the sensor data is then compared with the threshold value that we have specified in the Python program. Two temperature thresholds have been specified one for

maximum positive temperature value and another for maximum negative temperature value. If the temperature exceeds these thresholds, then the system gives a speech synthesis, which is the voice, alert and by using Raspberry Pi as means to send the alert to the person inside the house.

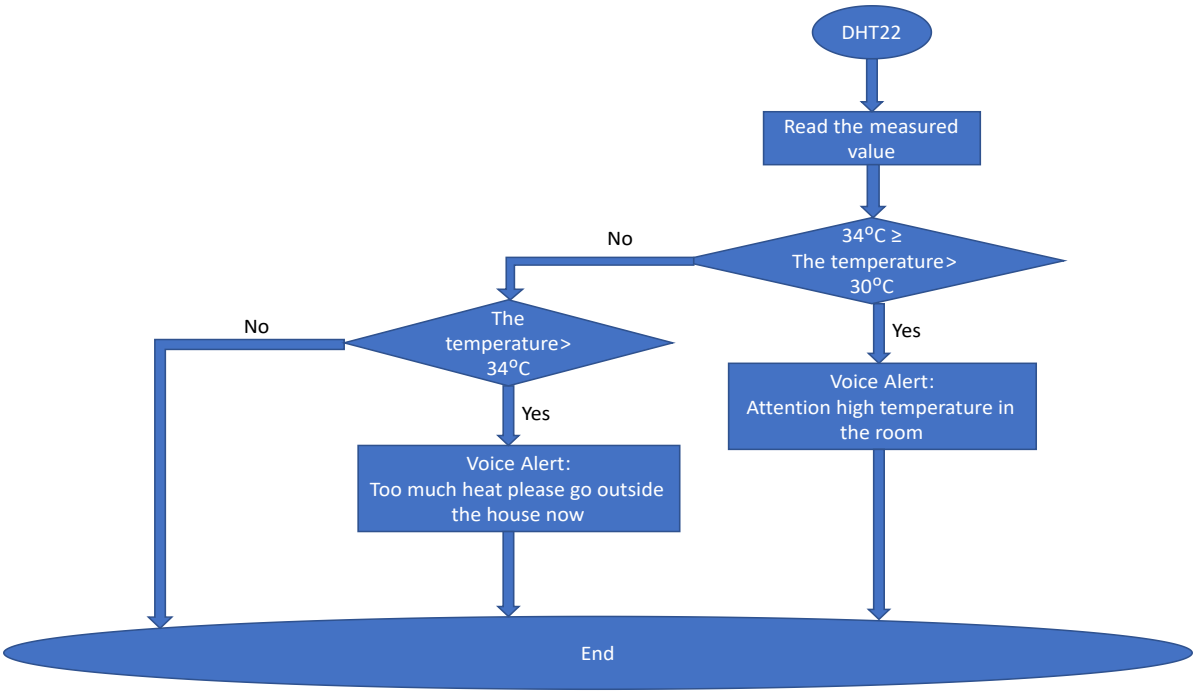

Fig.11. DHT22 sensor operating flowchart

2.4.2 Distance sensor HC-SR04:

The HC-SR04 sensor [62] uses ultrasound to determine the distance to an object. It offers an excellent non-contact detection range, with high precision and stable measurements .the HC-SR04 Ultrasonic distance sensor consists of two ultrasonic transducers. The one acts as a transmitter that converts electrical signal into 40 KHz ultrasonic sound pulses. The receiver listens for the transmitted pulses. If it receives them, it produces an output pulse whose width can be used to determine the distance the pulse travelled.

The sensor is small, easy to use in any robotics project and offers excellent non-contact range detection between 2 cm to 400 cm with an accuracy of 3mm.Since it operates on 5 volts.

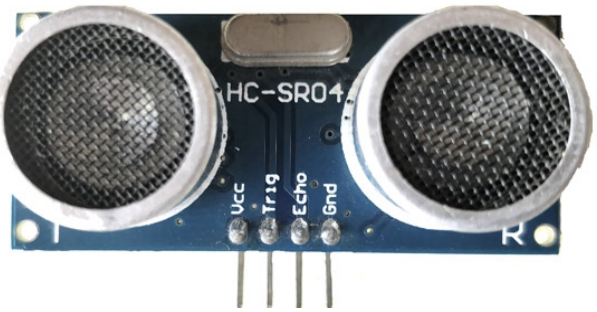

Fig.12. Ultrasonic Sensor HC SR04

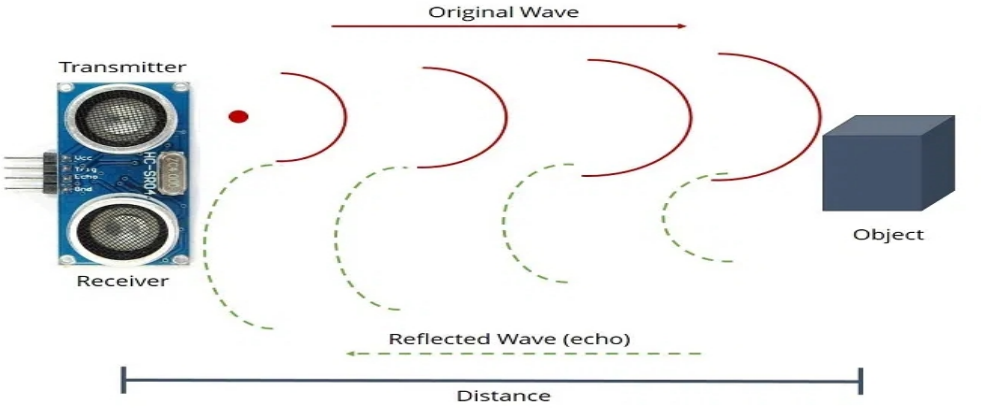

Fig.13. Ultrasonic Sensor HC SR04 and how does it work [63]

Where: Distance = Speed x Time/2

Speed = 300 m/s

The pulse indicates the time it took for the signal to be sent out and reflected back so to get the distance, we need to divide in half

- Sensor Datasheet:

Tab.5. HC-SR04 Sensor Datasheet table

Electrical parameters	HC-SR04 Ultrasonic Module
Operating voltage	DC-5v
Operating Current	15mA
Operating Frequency	40KHZ
Farthest Range	4m
Nearest Range	2cm
Measuring Angle	15 Degree
Input Trigger Signal	10 us TTL pulse
Output Echo Signal	Output TTL level signal , proportional with range
Dimensions	45*20*15mm

- Circuit Connection:

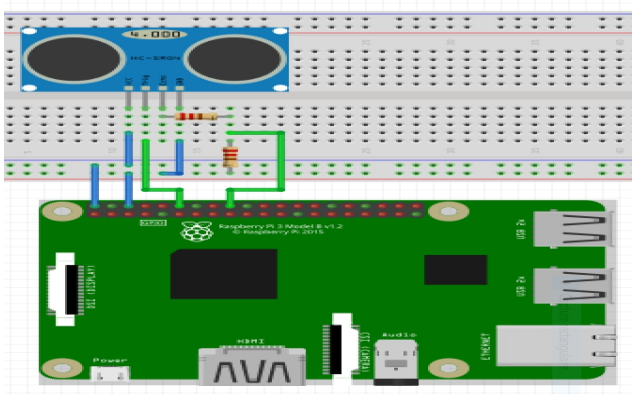

Fig.14.Breadboard of the HC-SR04

- HC-SR04 Ultrasonic Sensor System architecture :

The ultrasonic sensor uses sonar to determine the distance to an object. Once The transmitter (trig pin) sends a signal: a high-frequency sound. The signal finds an object that is the water level, and it is reflected so that the transmitter (echo pin) receives it. While two distance thresholds have been specified one for maximum positive distance value and another for maximum negative distance value. If the distance exceeds the maximum negative value, then the system will give a speech synthesis which is the voice alert and by using Raspberry Pi as means to send the alert to

the person inside the house so that he knows that the pelvis is almost full . The sensor determine again the distance of the water to send the second voice alert for the person to inform him that the tank is now full.

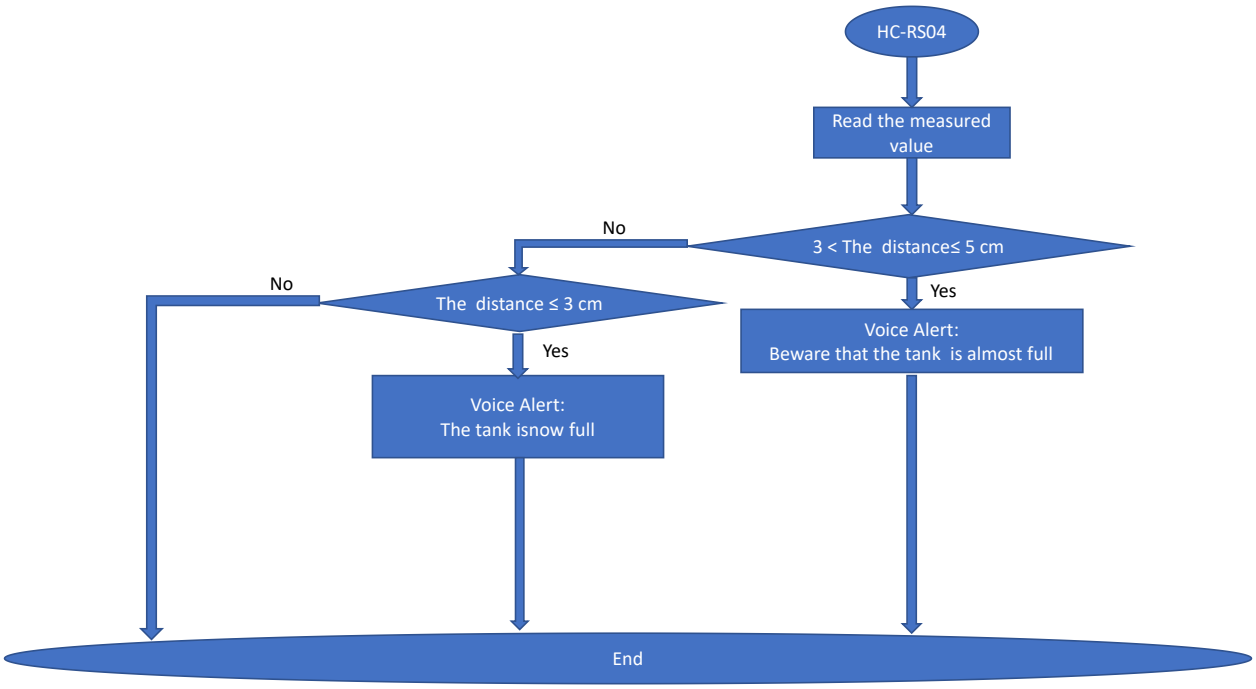

Fig.15. HC-SR04 sensor operating flowchart

2.4.3 Door Security system with RC522 RFID module:

The RC522 RFID module based on MFRC522 IC from NXP semiconductors, [64]it is shipped with a RFID card and key fob tag having 1KB memory. It is commonly used in attendance systems and other person/object identification applications.

The RC522 RFID Reader module is designed to create a 13.56MHz electromagnetic field that it uses to communicate with the RFID tags (ISO 14443A standard tags). The reader can communicate with a microcontroller over a 4-pin Serial Peripheral Interface (SPI) with a maximum data rate of 10Mbps. It also supports communication over I2C and UART protocols.

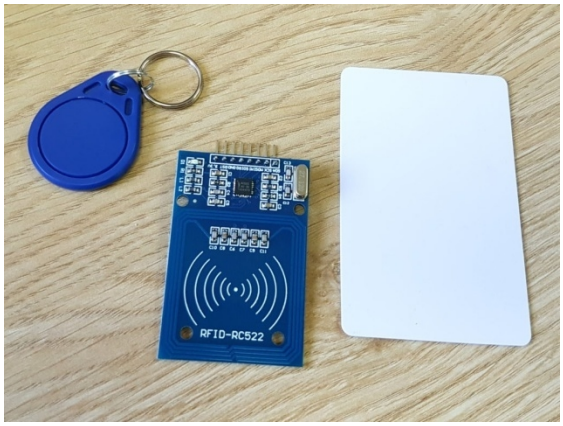

Fig.16. RC522 RFID sensor

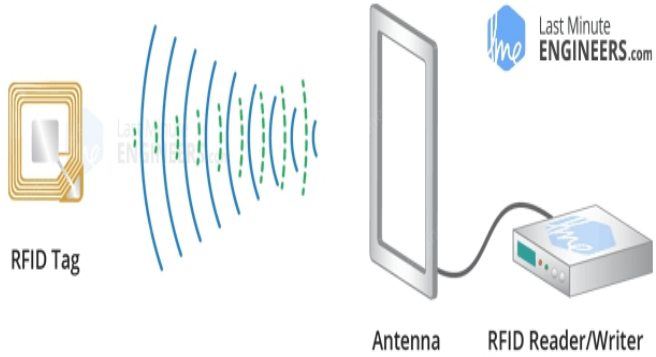

Fig.17. RFID technology and how does it work [64]

- Sensor Datasheet:

Tab.6. RC522 RFID Module Datasheet

Frequency Range	**13.56 MHz ISM Band**
Host Interface	SPI / I2C / UART
Operating Supply Voltage	2.5 V to 3.3 V
Max. Operating Current	13-26mA
Min. Current(Power down)	10µA
Logic Inputs	5V Tolerant
Read Range	5 cm

- Circuit Connection:

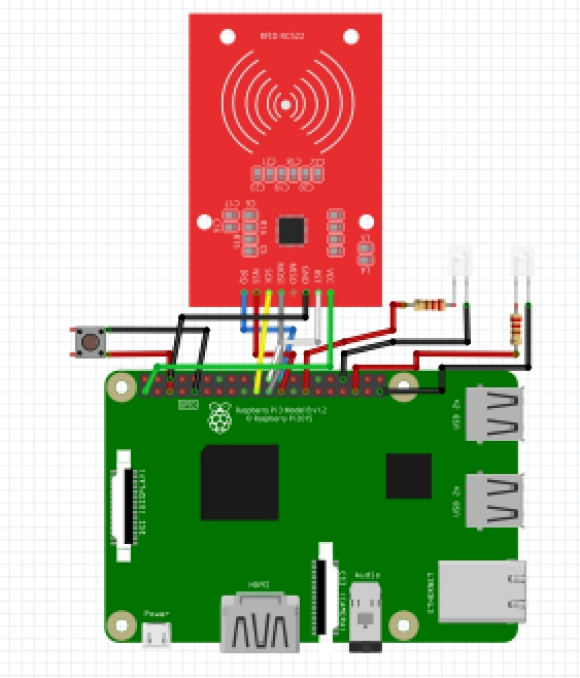

Fig.18. Breadboard of RFID RC22 Module

- RC522 RFID Module System architecture :

RC522 RFID module will be connected to our Raspberry Pi to read MIFARE tag and card [65]. This is potentially a great feature to include in a security system for our lock door where we need to identify a person without them knocking on the door or ringing the bell .The contactless tags can be carried on a key ring and the cards fit nicely in a wallet. Both of them will be hidden inside the door to give them a unique ID that can be read by the Pi.

Once the person with the card presses the button and then swipes the tag into the card reader. The door automatically unlocks, and the white led is on. This will call the function of the speech synthesis, when the espeak synthesizer sends the voice alert to inform the person inside the house that the front door just opened, the system will wait 1s to send the second voice alert telling the person to check who entered the house. In case the tag is not authorized by the smart home security system when swiping it into the car reader, he will activate the alarm where the red light in and the espeak synthesizer sends the warning message an attempt is made to open the front door. Each of the tags and the RFID cards has a unique code (UID) which it is read using a Python script.

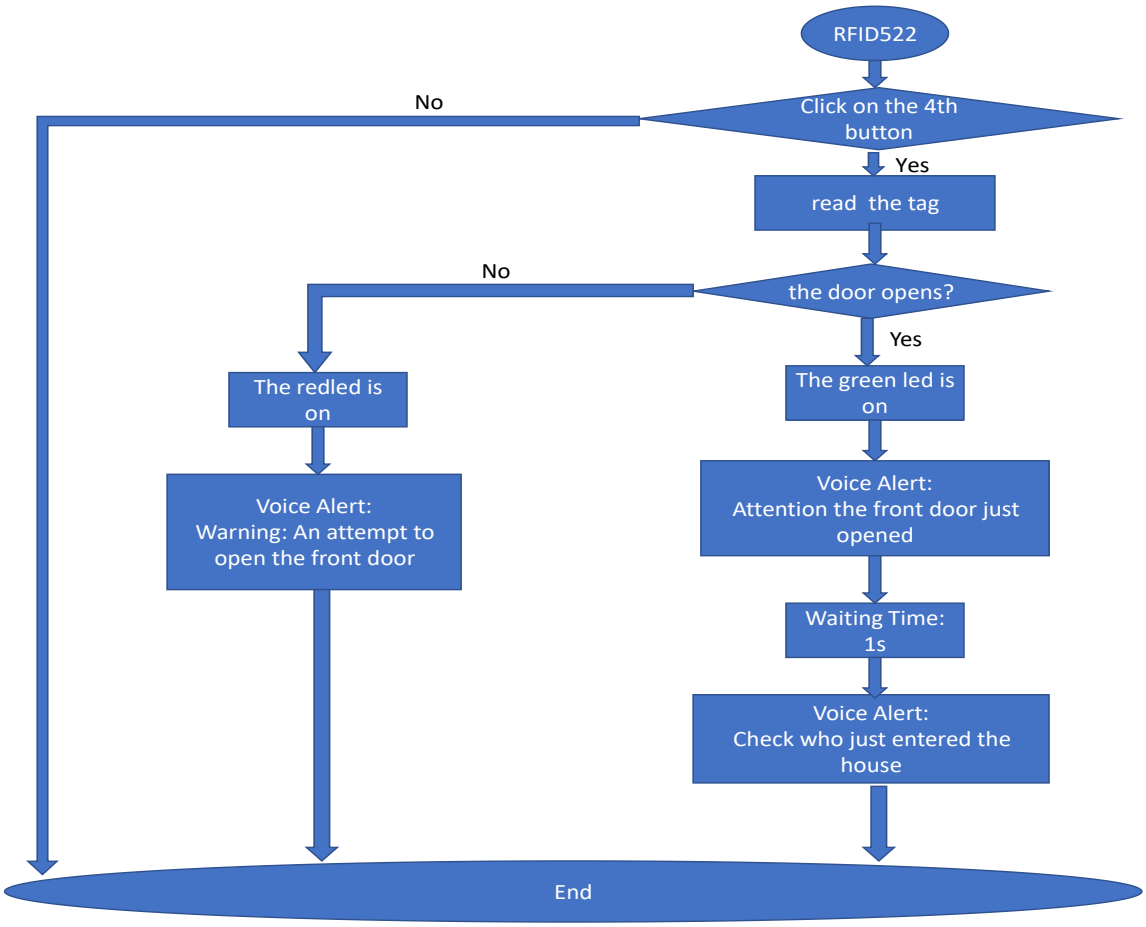

Fig.19. RC522 sensor operating flowchart

2.4.4 Gas Sensor:

Gas sensor [66] is one that comes handy in applications where we have to detect the variation in the concentration of toxic gases in order to maintain the system safe and avoid/caution any unexpected threats. There are various gas sensors to detect gases like oxygen, Carbon Dioxide, Nitrogen, methane etc. They can also be commonly found in devices that are used to detect the leakage of the harmful gases, monitor the air quality in industries and smart homes etc.

Fig.20. Gas Sensor

➢ Sensor Datasheet:

Table.7. MQ135 sensor Datasheet table

Model No			**MQ135**
Sensor Type			Semiconducteur
Standard Encapsulation			Bakelite (Black Bakelite)
Detcetion Gas			Ammonia , suinde ,Benze steam
Cencentration			10-10000ppm (Ammenia,Benze,hydrogen)
Circuit	Loop voltage	V0	≤24V DC
	Heater voltage	Vh	5.0V ±0.2 V AC or DC
	Load resistance	Rl	Adjustable
Character	Heater Resistance	Rh	310 ±30 (Room Tem)
	Heater consumption	Ph	900mW
	Sensing Resistance	Rs	2K 20K (in100 ppm NH3)
	Sensitivity	S	Rs(in Air)/Rs(100ppm)NH3 ≥6
	Slop	a	≤0.6(K/K NH3)
Condition	Tem . humidity		20°C ±2°C, 65% ±5%RH
	Standard test circuit		Vc:5.0V ±0.1V Vh:5.0V ±0.1V
	Preheat Time		Over 48 Hours

- Circuit Connection:

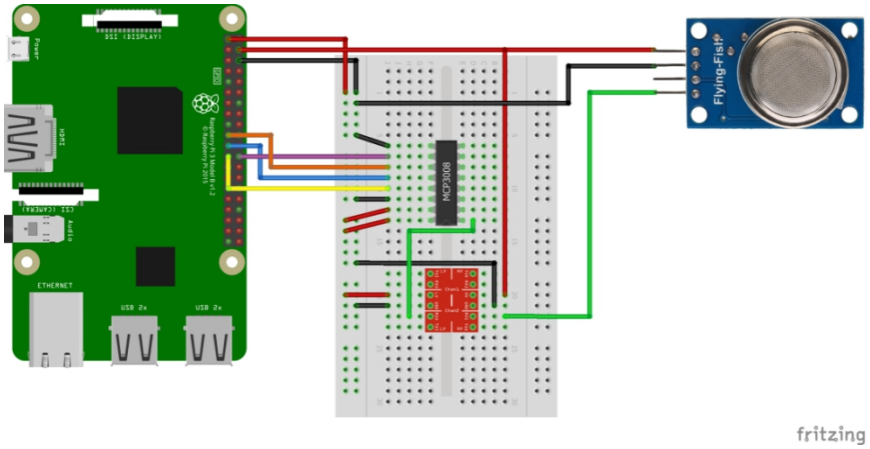

Fig.21.Breadboard of MQ135 sensor

As only the digital signal can be processed by raspberry pi, we added an analog digital converter (ADC) to process the analog signal from MQ135 sensor. We used MCP3008 as ADC chip it is a low cost 8-channel 10-bit analog to digital converter. We also used converter logic levels 3.3 a 5V.

Fig.21. shows how to make the connection of the GPIO of Raspberry towards the sensor.

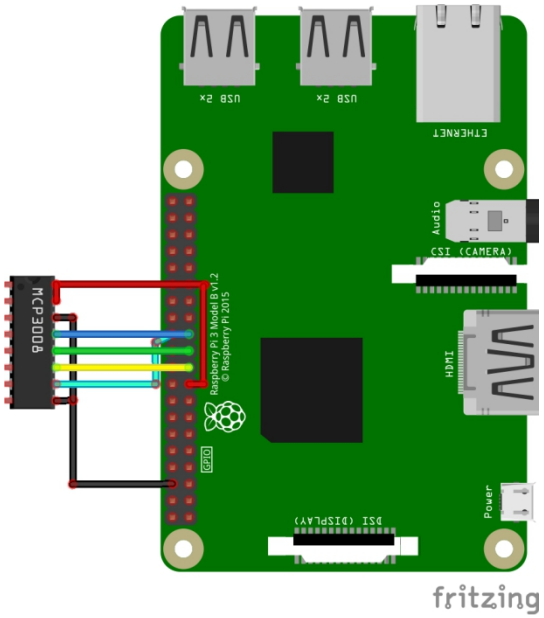

Fig.22.Breadboard of MCP3008

- Gas sensor MQ135 System architecture

The MQ-135 gas sensor detects the air quality value by detecting polluting gases co and smoke. In addition, compares the values, when air enters the sensor, it is energized by a small heater, which allows its electrical resistance to be measured. This is done by passing a low level of electricity across a small gap of energized air. The more contaminated the air is, the less resistance it has and the better it will conduct electricity. The output of the sensor is therefore an analogue voltage that goes up and down according to how contaminated the air is. The more contaminants, the lower the potential difference (voltage) across the sensor [67]. So when it compares the air quality values ,the system sends the first voice alert and then it waits 5s if it's still detects high values of polluting gases and gas leaking the second voice alert will be sent for the person to go outside or to open the windows. Furthermore, the sensor will continue the detection of polluting gases every 2us High sensitivity and fast response time enable fast measurement.

In our project, we ended up not using the MQ-135 gas sensor because it got burned when we were testing it for smoke detection.

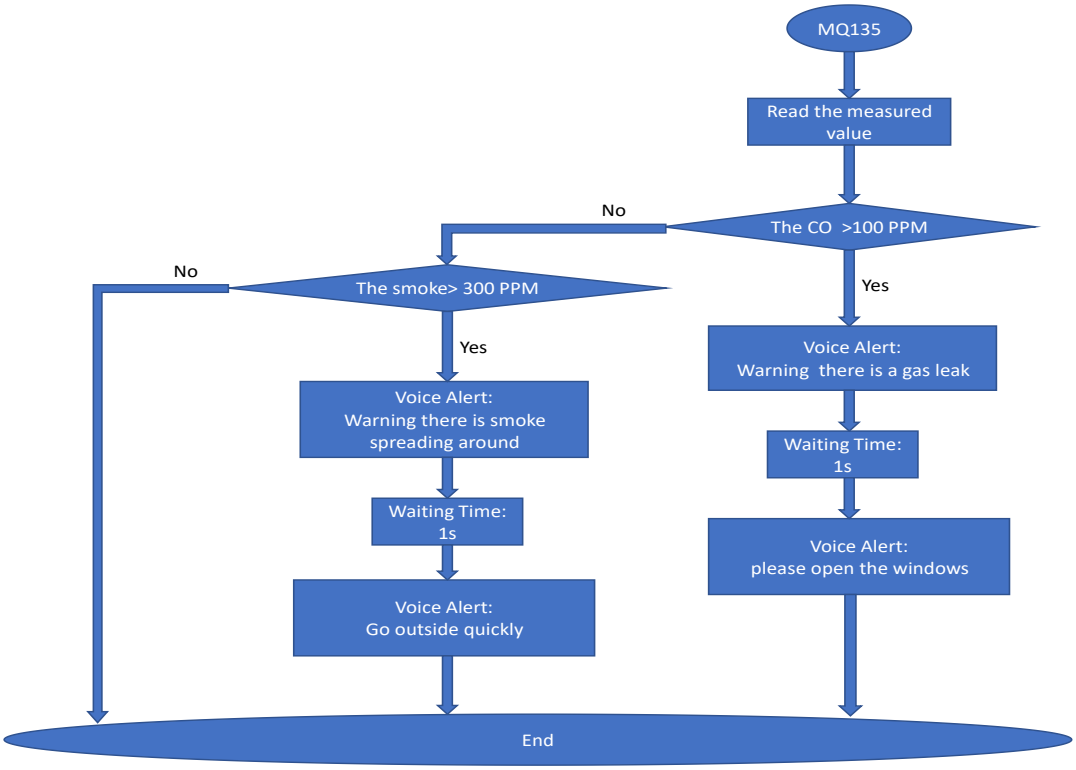

Fig.23. MQ135 sensor operating flowchart

2.4.5 Buzzer as the sound of Glass breaking:

An electromagnetic or piezoelectric component transforms electrical energy into vibration, therefore into sound. There are two types of Buzzer:

- The active buzzer, which can receive a direct voltage. It is different from the passive buzzer, because the electronics are not visible on the underside of the buzzer. In addition, the active Buzzer often has a label on the top.
- The passive buzzer, which operates with an alternating voltage, the frequency of which is generally between 500 Hz and 5 kHz. This will therefore work on a PWM pin. We can easily recognize it because on the underside (that of the pins) we can see the electronic components.

Fig.24. A buzzer

- Circuit Connection:

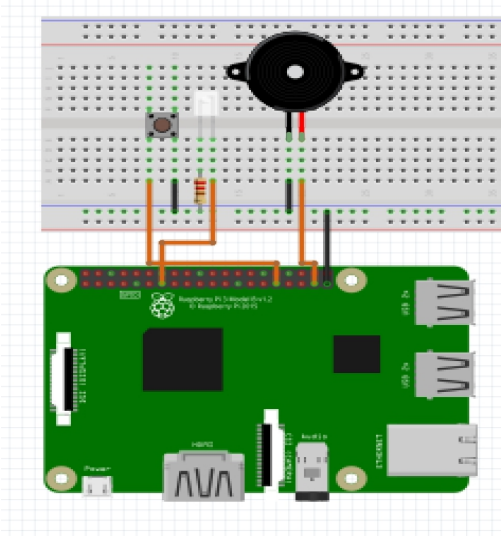

Fig.25. Breadboard of buzzer

2.4.6 Buttons to emulate window and door opening:

We are going to connect a tactile button to the Raspberry Pi.[59] A tactile button is an electronic switch that, when pressed, closes a circuit. When a circuit is closed, the Raspberry Pi will register an **ON** signal. We are going to this ON signal to trigger different actions.

- Circuit Connection:

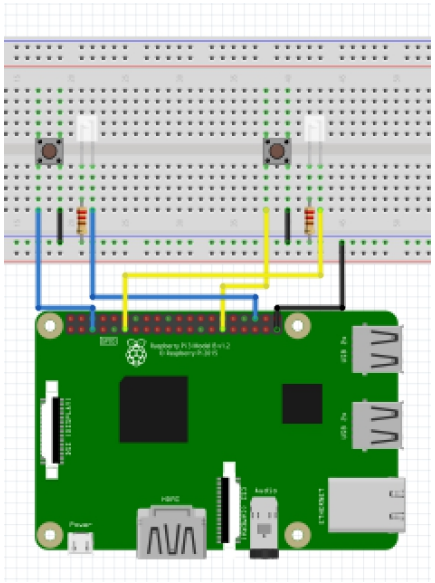

Fig.26.Breadboard of the tactile button and Leds

- Buttons System architecture

In this project, we will use a tactile button to run different Python functions based on the state of the button. In our case, it will be used as a knocking sensor, for window security system and as a glass-breaking sensor. We will Create an instance of the Button class and pass the pin number as a parameter. Next, we define functions that will be called for the different button events that are available on a Button instance like pressing the button or holding it. Once we press the first key, the system will send voice alarm with the red LED ON. It will take five seconds to send the second voice alert.

The second button that will call the function of the window security system, by sending another voice alert with a red LED on and waits another five seconds to send the second voice alert. Finally, pressing the third button the red led is on and the buzzer is sounded, the system will call the function of the glass break sensor and we will get the TTS voice alert beware there

is something that broke. The system will repeat the same monitoring whenever we press one of those three buttons.

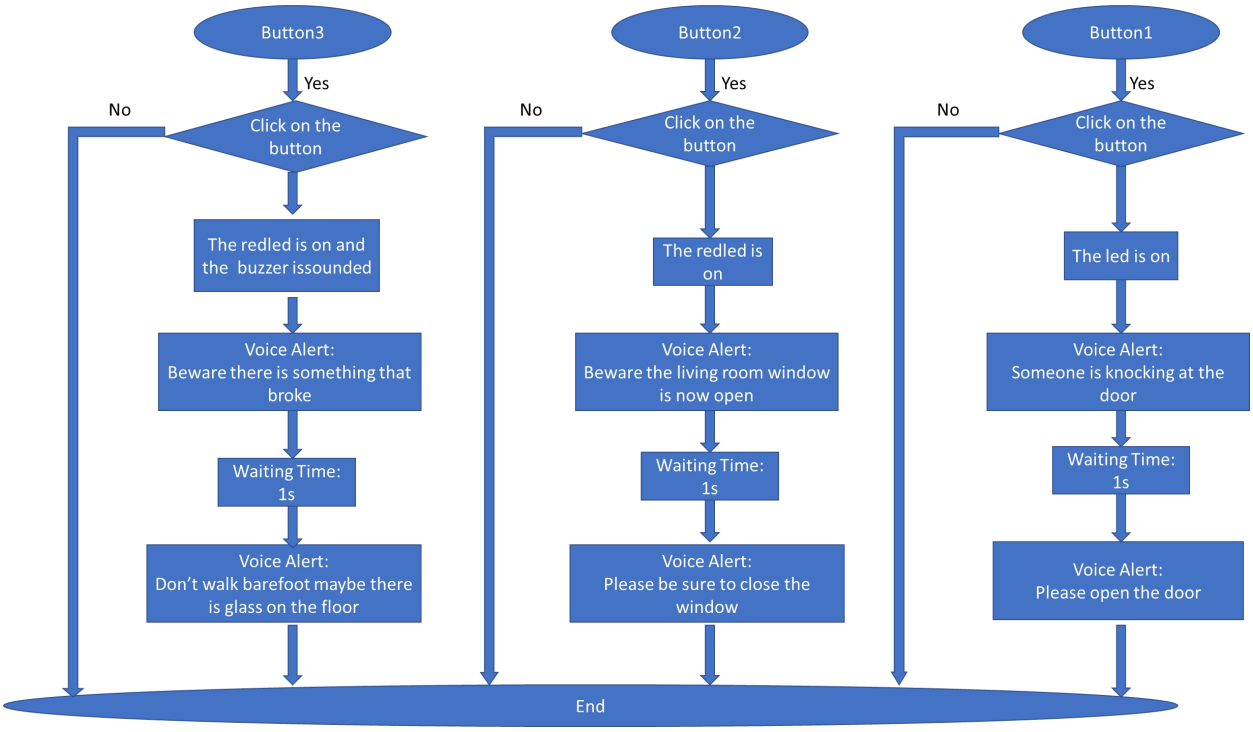

Fig.27. Buttons operating flowchart

2.4.7 Optional Hardware:

We can use a whole range of additional hardware with the Raspberry Pi to extend its capabilities.

- Case

It is nice to have a case for the Raspberry Pi to keep its components from being damaged during normal use. When selecting a case, make sure that you purchase the correct type for your model of the Raspberry Pi.

- Speakers

We are using speakers so that we will be able to hear the home automation system speaking when giving us the different warnings and voice alerts when monitoring the smart home from the Raspberry Pi .These can be any standard speakers that have a 3.5 mm jack. We can connect the speakers to the Raspberry Pi using the AV jack on the side of the board.

2.5 Software Design of the Smart Home System:

2.5.1 Raspberry Pi OS:

Raspberry Pi OS [68] (formerly Raspbian) is a Debian-based operating system for Raspberry Pi. Since 2015, it has been officially provided by the Raspberry Pi Foundation, as the primary operating system for the Raspberry Pi family of compact single-board computers. [69]The first version of Raspbian was created by Mike Thompson and Peter Green as an independent project. The initial build was completed in June 2012. [70][71]

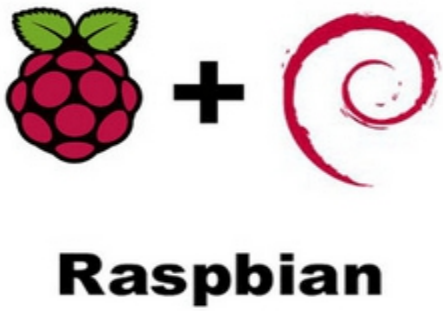

Fig.28.The Raspberry PI OS

2.5.2 Programming Language:

"Python is the language of choice for one of the most popular microcontrollers on the market, the Raspberry Pi," said Covey. Moreover, Python language is used to develop the code for our speech synthesis based Home automation system. It is a high level programming language widely used for raspberry pi. In addition, Python has been making home automation possible for many years now.

2.5.3 Running Python on the Raspberry Pi:

One of the best things about working with Python on the Raspberry Pi is that Python is a first-class citizen on the platform. The Raspberry Pi Foundation specifically selected Python as the main language because of its power, versatility, and ease of use. Python comes preinstalled on Raspbian, so we will be ready to start from the get-go.[59]

We have many different options for writing Python on the Raspberry Pi. In our project we will be editing remotely over **SSH.**

2.5.4 Creating a python-projects Directory:

Before we start building our speech synthesis on smart home project with Python on the Raspberry Pi, it is a good idea to set up a dedicated directory for our code. The Raspberry Pi has a full file system with many different directories. Having a reserved place for our Python code will help keep everything organized and easy to find.
Therefore, we will be creating a directory called python-project where we can store Python code for our project over SSH.

2.6 Conclusion:

The Raspberry Pi is a powerful little beast and an excellent foundation for constructing low-cost, yet highly competent, embedded systems. The interfaces built into its GPIO connection make it easy to bolt on modules using basic low-cost circuits and a little of setup to create extremely useful and versatile systems. However, the raspberry pi cannot read the measured values of two sensors at the same time that is why the monitoring of the smart home system will be by detecting and reading sensors one by one.

After proposing the home automation system that controls the various sensors and the door plus windows security system in addition to providing the voice alarms, we move on to the next chapter in which we will describe the realization and implementation of our proposed system and the prototype of the smart home. In addition to the creation of a web page using thingSpeak IoT platform to monitor the house environment and the elderly person.

Chapter3
Implementation and realization of the smart home

3.1 Introduction:

The speech synthesis in a smart home for elderly and disabled people using Raspberry Pi is proposed for the benefit of security and the easy use of devices by homeowner. This chapter includes the settings and configuration of the raspberry pi and the interactions with the physical components.

We are designing and implementing a smart home prototype that is intended in particular to elderly and disable people .The system will allow us to remotely monitor the state of the house and control various sensors. The realized prototype of our home automation will be designed to control six home appliances: Home temperature and humidity, the sound of broken things in the kitchen, the air quality, the window lock and the indication of water level in the tank and finally. The entrance lock door with RFID tag and card.

Further, we are creating our own web page for the house monitoring and the visualization of the sensors Data in the IOT platform ThingSpeak.

3.2 Setting up the Raspberry Pi:

3.2.1 Installing up the Raspberry Pi OS:

The operating system for the Raspberry Pi is stored on the micro SD card; we will need to install the operating system on it. In this section, we will look at how to install **Raspbian**, the officially supported Raspberry Pi operating system, which is based on Debian Linux.

We downloaded the latest version of OS Raspbian stretch zip file. [72] And extracted it. Then we downloaded the win disk 32 manager. In addition, we connected SD card (we formatted the SD card after connecting to pc). Moreover, we did connect raspberry pi to our laptop and give LAN connection in order to know the IP address of the raspberry pi by installing IP scanner.

3.2.2 Editing Remotely Over SSH:

Often we will not want to spend the time hooking up a monitor, keyboard, and mouse to write Python on the Raspberry Pi. Luckily, Raspbian allows us to connect to the Raspberry Pi

remotely over SSH. In this section, we enable and used SSH to program Python on the Raspberry Pi.

➢ Enabling SSH:

Before we can connect to the Raspberry Pi over SSH, we will need to enable SSH access inside the Raspberry Pi Preferences area. There are two methods to activate SSH.

The first one is to create an SSH file without extension in the boot partition, for this operation we use our pc and the bootable SD card without using raspberry pi and the hardware. [59] The second method uses the raspberry pi and the tools to enable SSH; and we used this method in our project.

We Activated the SSH server on our Raspberry Pi: after we put the bootable SD card with the Raspbian OS in the raspberry pi and plug in their tools (the screen, the mouse and the keyboard) then we switched on, after displaying the Raspbian graphical interface, we activated SSH by enabling it and going to the following file path :

Raspberry Pi Icon → Preferences → Raspberry Pi

Once the configuration appeared, we selected the Interfaces tab and then enabled the SSH option and changed SSH to "Active". We confirmed by clicking on OK.

Fig.29. Activation SSH server

➢ After that, we installed the SSH client on the computer: we chose the putty software. Before using this software we must verify the IP address of our raspberry pi. We launched the software, and we put the IP address of the raspberry and clicked on Open.

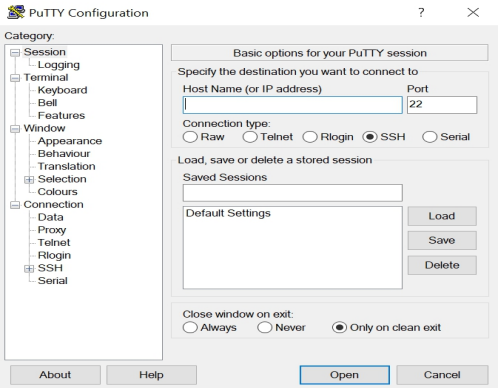

Fig.30. SSH client

3.3 Speech Synthesis on the Raspberry Pi:

In this part we will be showing how to have our Pi use the free software packages eSpeak , Festival and its derivative Flite to output voice.

3.3.1 Introduction:

Text-to-speech (TTS)[73] [74] is a type of speech synthesis program that is used to produce a spoken sound version of the text, such as a paper file or web page, TTS can simplify the interpretation of computer display material by a visually disabled individual or to increase the understanding of a text message. Otherwise, it can be used to make your robot speak or in blind stick projects to speak out the written instructions like street name, building name, etc.

There are many free and paid Text-to-Speech synthesizers such as Cepstral and eSpeak. Therefore, to choose the suitable one for our smart home system we are going to compare different open-source TTS synthesizers by installing them on Raspberry Pi to see which one is more accurate and gives us the best clear sound. We are using TTS to build a speaking smart home based on Raspberry Pi.

3.3.2 Open Source Text-to-Speech Synthesizers:

- Festival Text-to-Speech
- Flite Text-to-Speech
- eSpeak Text-to-Speech

3.3.2.1 Festival:

Festival is an open-source Text-to-Speech tool. It is developed by the Centre for Speech Technology Research in the UK, offers a framework for building speech synthesis systems. It offers full text to speech through a number APIs: from shell level, via a command interpreter. Festival is multi-lingual (currently British English, American English, and Spanish. Other groups work to release new languages for the system. Festival is in the package manager for the Raspberry Pi making it very easy to install.

- We Used the below command to install Festival:

```
sudo apt-get install festival -y
```

- We Tested the Festival with some command line examples:

```
echo "Hello World!" | festival --tts
```

- We heard the Pi utter Hello World over HDMI and the headphones too. We also adjusted the volume, because we could not hear it at first. It worked fine and produces a voice like a rough sounding robot. However, for our project it was not good enough. In addition, The Festival command line argument --tts tells the program to treat the input as text to speech.

3.3.2.2 Flite:

Flite ((festival-lite) is a small, fast open source text to speech synthesis engine developed at CMU and primarily designed for small embedded machines and/or large servers.

Flite is designed as an alternative text to speech synthesis engine to Festival for voices built using the FestVox suite [75] of voice building tools.

3.3.2.3 eSpeak Text-to-Speech:

eSpeak [76] is a compact open-source software speech synthesizer for English and other languages like Linux and Windows. It is a modern and easy-to-use TTS package compared to other open-source packages available. It sounds clearer but does wail a little. Overall, it is a good all-rounder with great customization options.

We used the below command to install eSpeak:

```
sudo apt-get install espeak
```

- Then we tested eSpeak with:

```
espeak “attention high temperature”
```

- We modified espeak by changing the voice, volume, speed, accent, and delay between words.
- We did also tested eSpeak with English female voice, emphasis on capitals (-k), speaking slowly (-s) in low volume (-a) using direct text:

```
espeak  -ven+f2 –k5 –s150 –a 100  –g10 “ Warning ,High temperature”
```

- It sounded clearer than Festival, and Flite but does wait a little, which makes it good all-rounder with great customization options.

3.3.3 Results and Review:

Listed above are the 3 open-source text-to-speech synthesizers As to which TTS application to recommend, we ended up choosing and going for eSpeak because it uses a formant synthesis method, providing many spoken languages in a small size. It is also very accurate and easy to understand. eSpeak has the best quality sound it is easy and has good customization options. While with Flite the speech has a very metallic, non-human sound (more than the other engines). Moreover, it doesn't support too much languages, for Festival the sound quality is not good it creates a voice like a gritty robot. That’s why we’re going to work with eSpeak synthesizer.

3.4 Operating Algorithm:

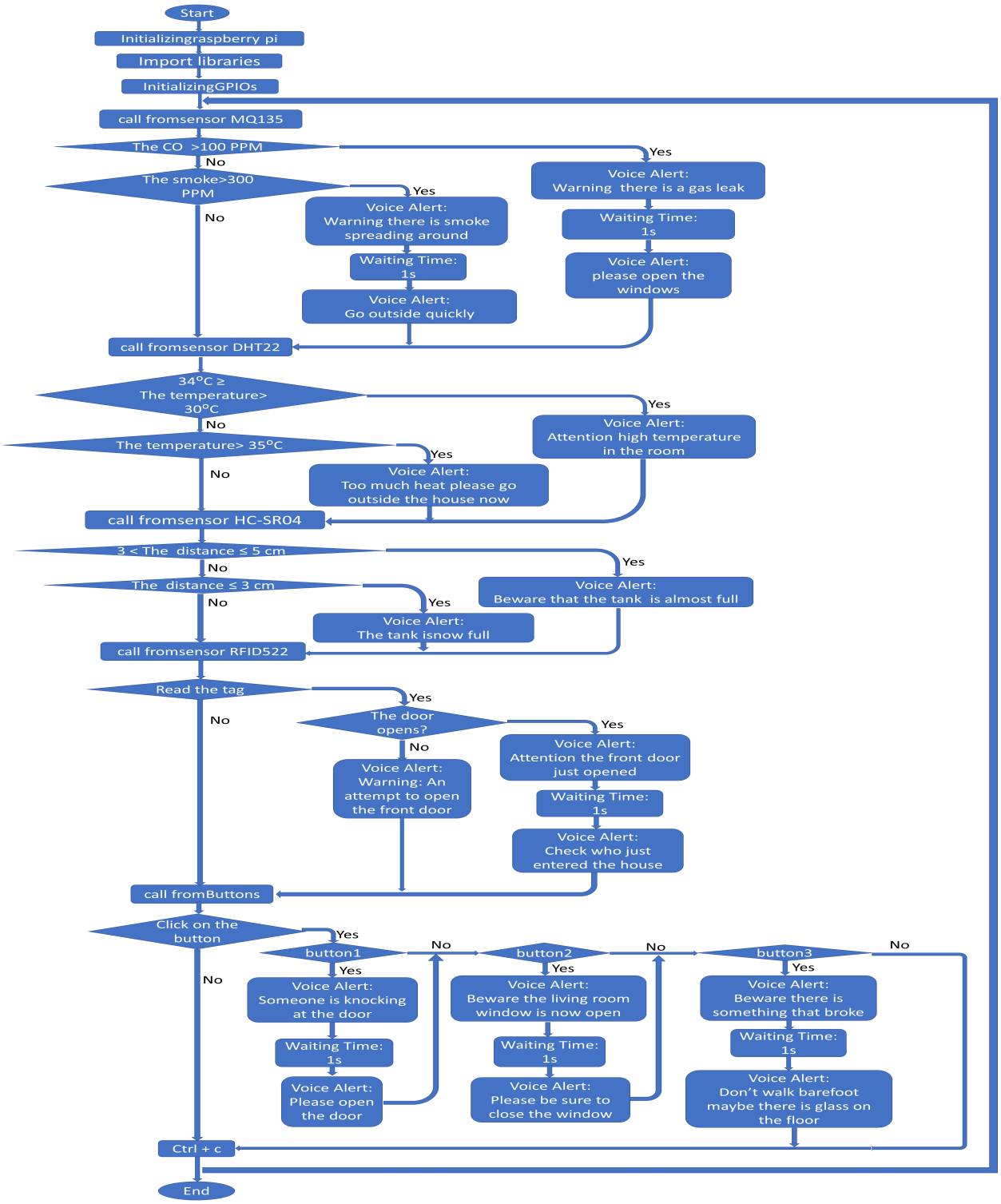

Fig.31. Principal Diagram

3.5 Integration with Python and Interacting with physical components:

We are already running the latest Raspian distribution we will need to install these two packages to run the Circuit Python examples

```
sudo apt-get update
```

```
sudo apt-get install python3-dev python3-pip
```

3.5.1 Interacting with physical components:

In this section, we will interact with our different physical components using Python on the Raspberry Pi

A. Temperature and Humidity measuring with DHT22 sensor :

DHT22 sensor is used to measure the temperature in our smart home. A Python script is written for the sensed data and the temperature is represented in the form of degree Celsius

- Installing the Circuit Python-DHT Library

We will need to install a library to communicate with the DHT sensor. Since we are using Adafruit Blinka (Circuit Python), we can install Circuit Python libraries straight to our small Linux board. In this case, we are going to install the Circuit Python_DHT library. This library works with both the DHT22 and DHT11 sensors.

We run the following command to install the Adafruit_DHTlibrary:

```
sudo python3 –m pip install –upgrade pip setup tools wheel
```

```
sudo pip3 install Adafruit_DHT
```

- Test and Result of the python script :

```
pi@pi:~ $ cd project
pi@pi:~/project $ sudo python temperature.py
Temp=33.4*C  Humidity=99.9%
Attention high temperature in the room
Too much heat please go outside the house now
pi@pi:~/project $
```

Fig.32.Test of the temperature and humidity sensor

B. Door security system with RFID module for unlocking the front door :

Radio Frequency Identify the people who wish to enter the house with radio frequency waves in order to send data, with no visual orientation or physical contact between the tag and the reader. (RFID)

- Enable SPI :

In order to interact with Pi, RC522 uses the SPI interface. The SPI interface must be activated. From the terminal or “Raspberry Pi Configuration», we enable SPI under the “Interfacing Options” section.

- Install SPI Supporting Libraries

We installed the spidev library using:

```
sudo apt-get install python-spidev python3-spidev
```

- Download RC522 Python Library

Finally, [77] we downloaded a library that helps talk to the RC522 module over the SPI inter face. It relies on the SPI-Py library installed in the previous step.

- Test and Result of the python script :

```
pi@pi:~ $ cd project
pi@pi:~/project $ sudo python RFIDRead.py
Attention the front door just opened
Check who just entered the house
pi@pi:~/project $ sudo python RFIDRead.py
Warning: An attempt to open the front door
pi@pi:~/project $
```

Fig.33.Test of key security system for the front door

C. Indication of water level in the tank using ultrasonic sensor HC- RS04:

The Ultrasonic sensor module is placed at the top of bucket (water tank), this sensor module will read the distance between itself and the water surface and it will tell the level of water. If the distance is less than or equal to 5 cm then espeak synthesizer will send the voice alert that the tank is almost full and when the distance is less than 3 cm espeak synthesizer will send the second text to speech which the voice alert the tank is now full .

- Test and Result of the python script :

```
pi@pi:~ $ cd project
pi@pi:~/project $ sudo python ultrason.py
Measured Distance = 3.9 cm
Beware that the tank is almost full
pi@pi:~/project $ sudo python ultrason.py
Measured Distance = 2.9 cm
The tank is now full
pi@pi:~/project $
```

Fig.34. test of the water level in the tank

D. The door security system :

- Test and Result of the python script :

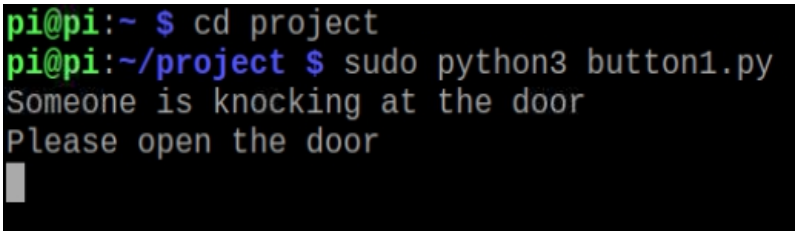

Fig.35. Test of the door security system and warning message heard by the elderly

E. The Window opening:

- Test and Result of the python script :

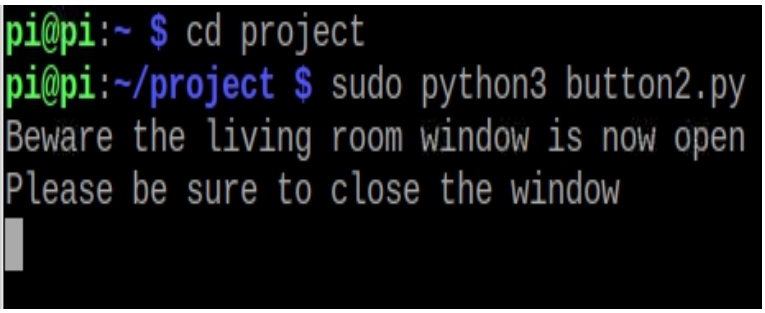

Fig.36. test of the window security system and the warning message heard by the elderly

F. Detection of broken glass in the kitchen using a buzzer :

- Test and Result of the python script :

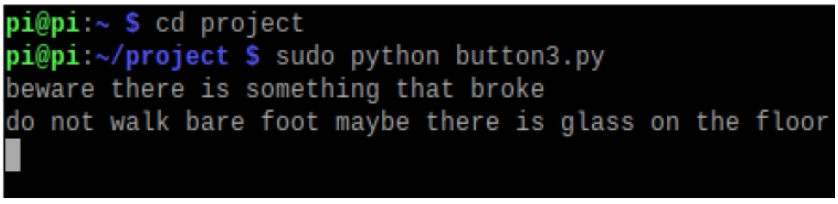

Fig.37.The result of glass breaking detection and the warning message heard by the elderly

3.6 Testing and Implementation:

As illustrated in Fig.38, we propose the implemented system for the smart home automation for the elderly and disabled people with voice alerts and it is fully functional .It enables remote monitoring of the house environment and voice notifications with TTS technology while controlling different devices and data collection in the SD CARD files.

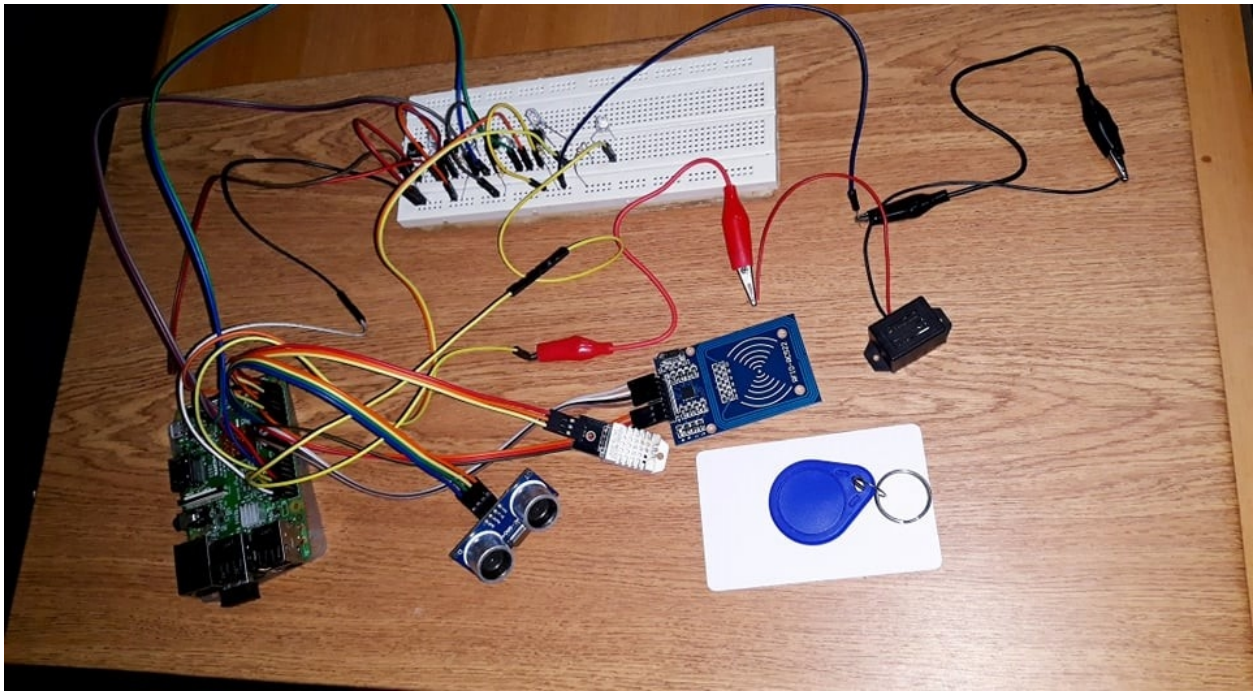

Fig.38.Implemented system for smart home with TTS technology proposed by us

3.6.1 The prototype of the Smart Home for Elderly:

The functionality procedure of the home automation system for the elderly and disabled can be characterized through the following phases. For homeowners to feel secured and comfortable as the only way to open their door is by using registered RFID tag cards in the system using an infrared remote, and they can easily and comfortably know if anyone has entered the house and when the door in opened by the speech synthesis technology that gives them the voice warning. The fig.32. Until fig.37. Illustrates the result of the warning message that was heard as a voice alarm. Moreover hearing the voice alerts when there is high temperature in the house in addition to voice warning for when the ultrasonic sensor detects that the level of water is up and the tank is full.

Finally, when a button particular to a specified appliance is pressed, a warning and LED assigned to this appliance is illumined and a voice alert is heard on the house.

Fig.39. Our Smart Home Prototype from the front side

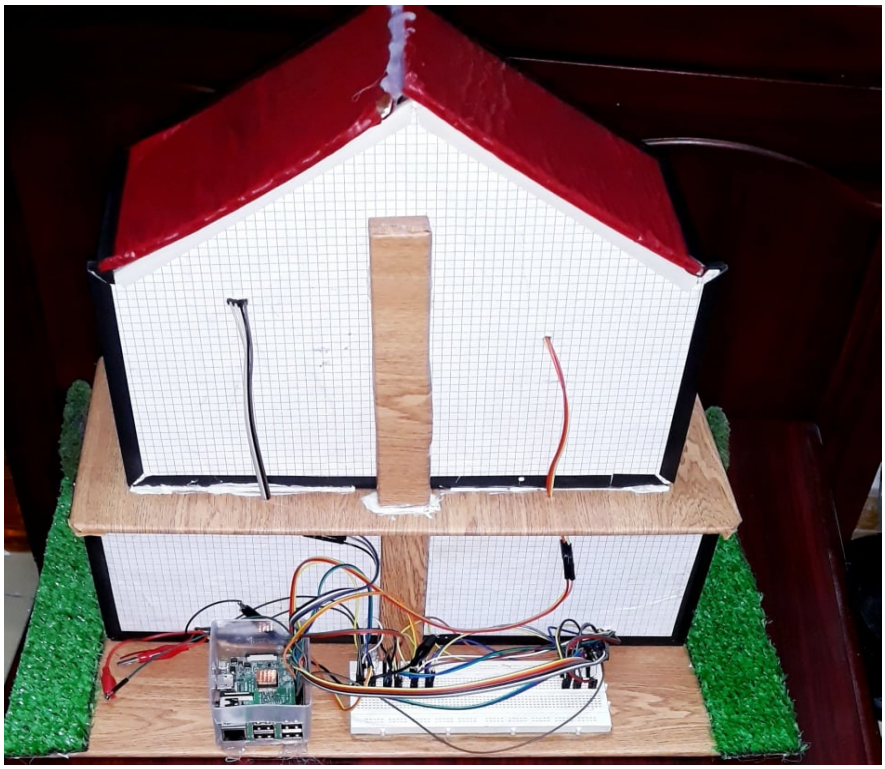

Fig.40. Our Smart Home Prototype from the backside

The entire system was completely built using wooden home prototype where the home appliances are modeled by sensors, buttons and LEDs. The software was tested to ensure that the program code does not include bug errors and does not produce unexpected results. However, the system hardware is realized and implemented and our system design shows that the complete operations are executed correctly.

Table.8. the voice alert messages synthesized by eSpeak synthesizer and heard by the elderly person

Physical components	**Elements**	**Condition**	**Voice alert**
DHT22	Temperature	$34^{O}C \geq$ temperature$> 30^{O}C$	-Attention high temperature in the room
		Temperature $> 34^{O}C$	-Too much heat please go outside the house now
HC-SR04	Distance	5cm $\geq$ distance $>$ 3cm	-Beware that the tank is almost full
		Distance $\leq$ 3cm	-The tank is now full
RFID RC522	Front door	Id == tag	-Attention the front door just opened -Check who just entered the house
		Id == card	-Warning: An attempt to open the front door
Button1	Door knocking	Etat == 0	-Someone is knocking at the door -Please open the door
Button2	Window opening	Etat == 0	-Beware the living room window is now open -Please be sure to close the window
Button3	Glass breaking	Etat == 0	-Beware there is something that broke -Don't walk barefoot maybe there is glass on the floor

Fig.41. the Smart Home Prototype with the speakers on the side for the voice alerts.

3.7 The Web Server:

We proposed a smart monitoring system using LAMP server (Linux Apache MySQL PHP), these systems have the capability to monitor and control a security system from a location away from the house area. Including the notification and graphical representation of the real time sensor data. Moreover, the system will read, and send the sensors gesture information utilizing the web server and Raspberry Pi. In addition, the person who is responsible of the elderly inside the house will be able to visualize the house environment and the sensors information as charts graph or dashboards.

3.7.1 Apache installing:

Apache is a popular web server application you can install on the Raspberry Pi to allow it to serve web pages. On its own, Apache can serve HTML files over HTTP. With additional modules, it can serve dynamic web pages [78]. It is commonly combined with a SQL Database (such as MYSQL or MariaDB) and a server-side programming language (such as PHP) [79].

We Installed Apache2 with the following commands:

- sudo apt install apache2 php libapache2-mod-php php-mysql -y
- sudo /etc/init.d/apache2 restart

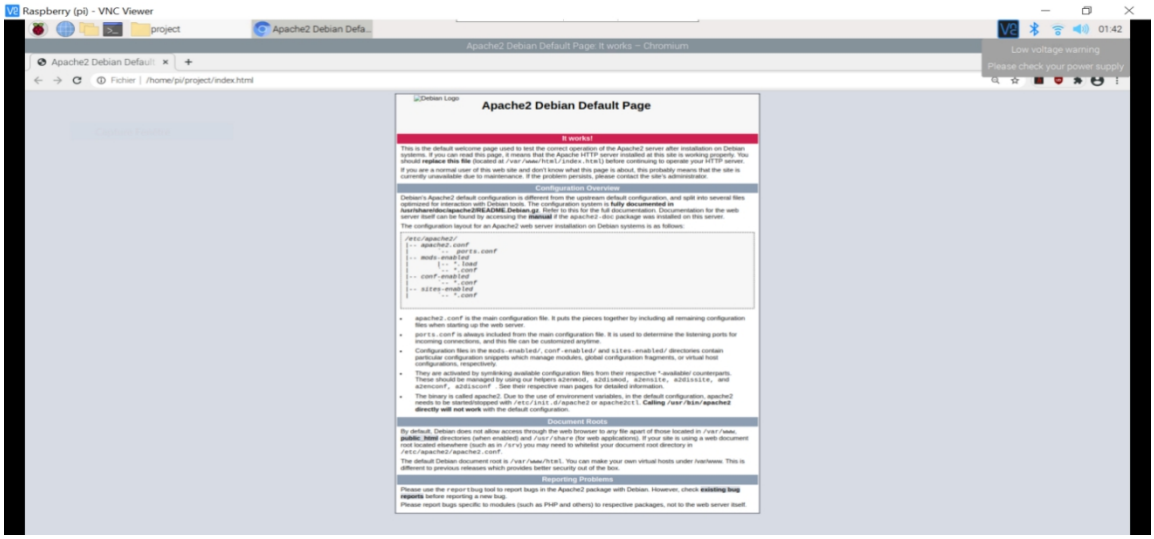

Fig.42.Web Server Test

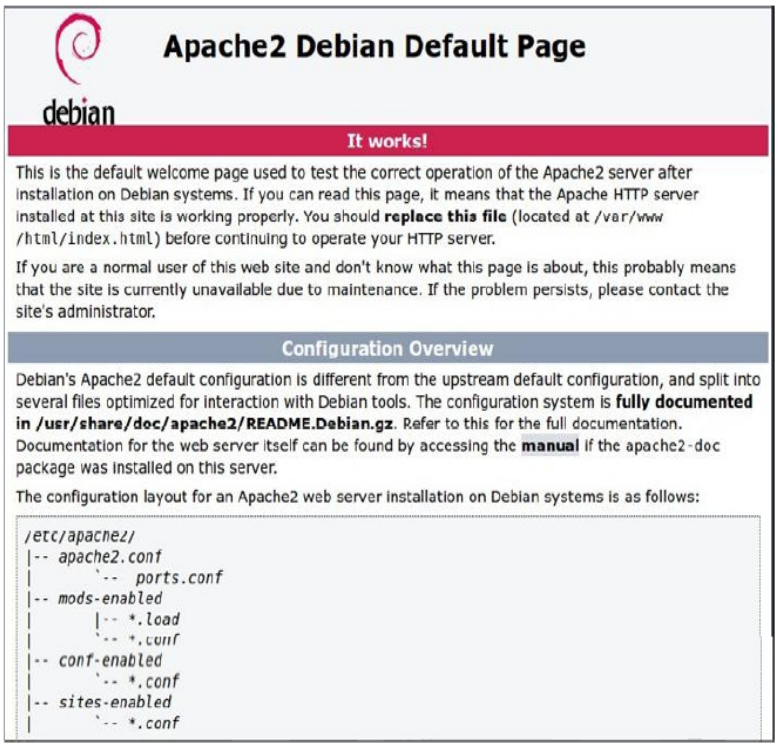

Fig.43.A closer look of the Apache2 Debian Default Page

3.7.2 PHP installing:

(PHP: Hypertext Preprocessor) [80] An extremely popular scripting language that is used to create dynamic Web pages. Combining syntax from the C, Java and Perl languages, PHP code is embedded within HTML pages for server side execution. It is commonly used to extract data out of a database on the Web server and present it on the Web page. Originally known as "Personal Home Page," PHP is supported by all Web servers and widely used with the MySQL database. See MySQL.

- cd /var/www/html/
- sudo chown -R www-data:pi /var/www/html/
- sudo chmod -R 770 /var/www/html/
- cd /home/pi
- sudo apt install phpmyadmin–y

3.7.3 MySQL installing:

MySQL" stands for "Structured Query Language" MySQL, is an open source relational database management system. It is based on the structure query language (SQL), also most commonly found on Web servers. A website that uses MySQL may include Web pages that access information from a database. These pages are often referred to as "dynamic," meaning the content of each page is generated from a database as the page loads. Websites that use dynamic Web pages are often referred to as database -driven websites and they use a Web scripting language like PHP to access information from the database the PHP/MySQL combination has become a popular choice for database-driven websites [81] [82].

We Installed MySQL (MariaDB) using the following commands:

- sudo apt install mariadb-server
- sudomysql_secure_installation

❖ **Data base storage:**

- sudo mysql -u root -p

- create database DHT22;
- use DHT22;
- create user 'rms'@'localhost' identified by 'soundsysteme';
- grant all privileges on DHT22.* to 'rms'@'localhost';
- flush privileges;
- quit
- sudo service mysql restart
- sudomysql -u rms -p
- use DHT22;
- create table temphumi (dateetheure DATETIME, temp DOUBLE, humi DOUBLE);
- quit
- sudo /etc/init.d/mysql restart
- cd /home/pi
- nano dht22.py
- sudo python dht22.py
- sudomysql -u rms -p
- use DHT22;
- select * from temphumi;

```
MariaDB [DHT22]> select * from temphumi;
+---------------------+------+------+
| dateetheure         | temp | humi |
+---------------------+------+------+
| 2021-06-01 16:44:53 | 26.1 | 44.4 |
| 2021-06-01 16:45:01 | 26.1 | 44.2 |
| 2021-06-01 16:45:20 | 26.1 | 45.1 |
| 2021-06-01 16:56:46 | 25.5 |   44 |
| 2021-06-03 14:48:54 | 24.7 | 83.1 |
| 2021-06-03 14:51:06 | 24.7 | 82.9 |
| 2021-06-03 14:54:51 | 24.7 | 82.7 |
| 2021-06-03 14:56:26 | 24.7 | 82.9 |
| 2021-06-05 16:00:49 | 25.7 | 80.7 |
| 2021-06-05 19:15:12 | 26.1 | 60.3 |
| 2021-06-05 23:52:30 | 26.4 |   61 |
| 2021-06-20 01:59:09 | 29.3 | 42.9 |
+---------------------+------+------+
12 rows in set (0.002 sec)
```

Fig.44. Results of the DHT22 Database

We wrote a program in PHP language so that we can see the results in the web server. Then we downloaded the following JavaScript files to get the graphical DHT22 Data representation:

- jquery.js https://code.jquery.com/jquery-3.2.1.min.js
- highcharts.js https://code.highcharts.com/zips/Highcharts-5.0.14.zip
- gray.js https://code.highcharts.com/zips/Highcharts-5.0.14.zip

- Result of the web page for the temperature humidity sensing with DHT22 sensor

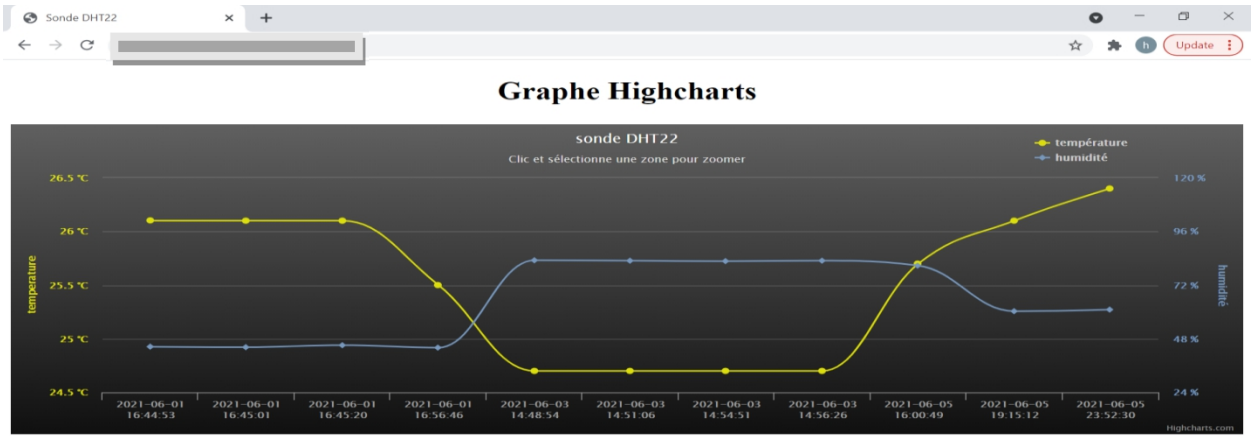

Fig.45. graphical data representation

3.8 ThingSpeak:

ThingSpeak is IoT platform that is designed to enable meaningful connections between people, and things in addition to collecting and storing data from connected objects using the HTTP protocol over the Internet or over a local network. Features of ThingSpeak is real-time data collection, data analysis, data processing of the position information, data visualization, message transmission, etc. using a connected SNS, via an open source API to support a various platforms. With ThingSpeak, you can create sensor-logging applications or a social network for connected objects. It helps you easily transfer data from embedded devices such as Raspberry Pi. It supports various languages and environments such as C, Node.js, and Python [83] [84].

3.8.1 Creating our Account on ThingSpeak platform:

First we create our Math work account, After that, we click on “New Channel” to create our personal one to store the information and get our data to stream into it by doing our channel settings as shown in figure.

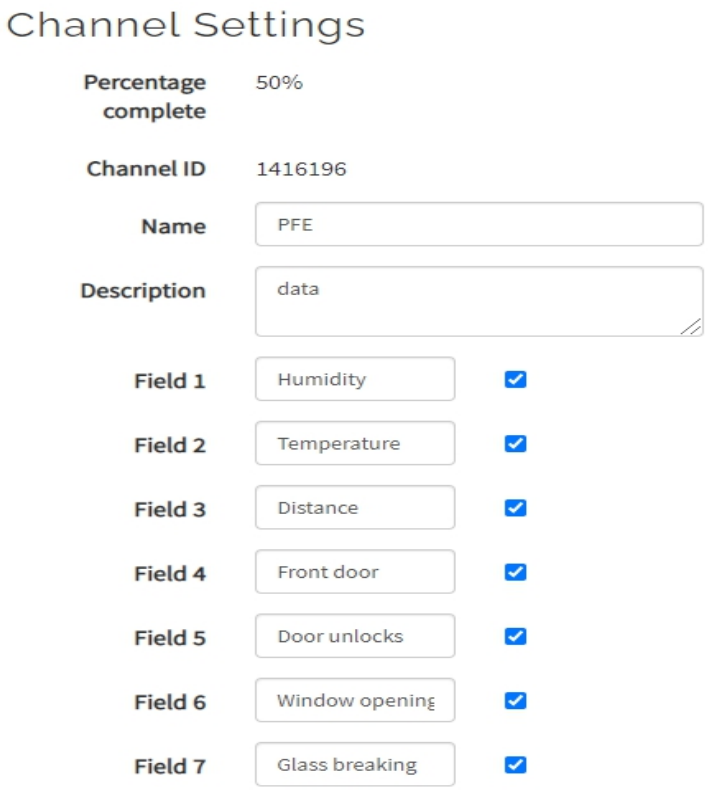

Fig.46. our channel settings

The fig shows our created channel to store data from different physical components sensors RFID module and buttons each component needs a field only DHT22 temperature and humidity sensor needs two fields.

- API Keys

API (Application Programming Interface) keys are the keys to access our channel. We clicked on the API tab to know our API keys. We have blurred our API Keys for security reasons.

Fig.47.The API key of our channel

3.8.2 Results and Discussion:

In testing and cutover phase, three experiments were conducted, First the connectivity test of different sensors, buttons and LEDs with the Raspberry pi, generation of voice alerts with TTS technology and integration test of cloud storage.

- In the first part, the connectivity of DHT22 sensor ultrasonic sensor, RFID module in addition to the buzzer and the buttons with the raspberry Pi board as shown in Fig.38were tested. The connections of the sensors to the Raspberry Pi board were by using the general-purpose input/output (GPIO) pins. The Raspberry Pi was switched on and Python script was run in the terminal, where the raspberry pi read the distance of the water level from the ultrasonic sensor and displayed the data in the Raspberry PI terminal. The DHT-22 sensor sensed the temperature and humidity reading whereas the ultrasonic sensor determine the distance of the water level in the tank. Moreover, The RFID card reader is used to read the RFID tag registered card, and the RPI controlled the magnetic door lock. The three buttons with each LED are functional.
- The second part was to send a voice alert with the speech synthesis technology to the person inside the house when the temperature value reaches the threshold limit based on the values listed in fig.11of the DHT22 operating flowchart. The threshold value was configured in the main program (SmartHome.py). The same command was executed to initiate the system and calibrates the readings from the sensors. Voice alarm was heard when the set threshold had been met. Fig.32 presents the data retrieved from the sensors and the warning message that was synthesized by eSpeak synthesizer and heard by the house owner. When the distance of the water level in the tank was close to the limit of the threshold, the water level condition was stated as the tank is almost full and voice alert was sent to the user. Fig.34 represents the sample of the warning notification that was heard by the user when the water level is up and the tank is full. The buttons with each LED are functional as glass break sensor, window-opening sensor and as door knocking sensor. Fig.35, Fig.36, and Fig.37 Show the warning messages of each button that was heard by the house owner .With these warning voice alerts the disabled person or the elderly is aware of the current condition of the indoor environment and further action to amend the situation can be considered.

- The third part was to examine the functionality of web-based cloud storage for record keeping and data presentation. All parts such as sensors, RFID module, buttons and the LEDs plus the Raspberry Pi and ThingSpeak web-based cloud storage were set up accordingly and mainly for monitoring the house environment. ThingSpeak cloud storage was used and proper login was required. An account and privet channel were created in the implementation phase. The channel ID and API key were added into the main script (SmartHome.py) to enable the reading process from the sensors and data saving in the cloud storage, which means in the online cloud database. Figure.46 shows the screen shot on the ThingSpeak cloud channel creation to record the current reading of data from the system in graphical form. Furthermore the necessary python API's are called and libraries are imported for uploading the sensors data to the cloud inside the software on the Raspberry Pi. To get all the information of the indoor and outdoor environment, the latitude and longitude parameters of each sensor are enabled at corresponding sensor's channel settings. The person at the remote place with an internet connection can log in into the thingspeak.com and can view all the data's of the different sensors and module. The same data is plotted in a graph with respective x and y-axis parameters settings for each channel. Figure 39 shows the hardware implementation on the smart home prototype where the Raspberry Pi is connected with different sensors and RFID module. The figures bellow (Fig.48 utill Fig.60) illustrates the data reading retrieved from the sensors, which comprises of temperature, humidity and water level in addition to the values of each buttons and the RFID module for the door security system. The data from the sensors were sent to the cloud storage, and displayed in graphical form and numbers. Which shows that the cloud storage received the data successfully.

❖ Temperature and Humidity:

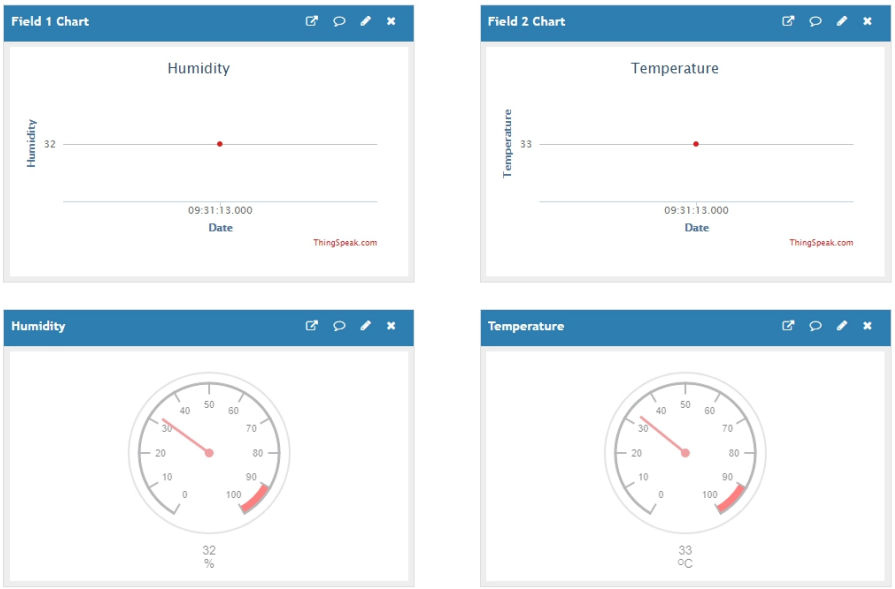

Fig.48.DHT22 Sensor data of the smart home visualized in ThingSpeak.

- The recorded temperature and humidity are stored in a cloud database (ThingSpeak), and the results are displayed in a web page, from where the user can view them directly this is the first indoor environment when the 34^{O}C ≥Temperature > 30^{O}C.
- The second indoor environment when the Temperature > 34^{O}C

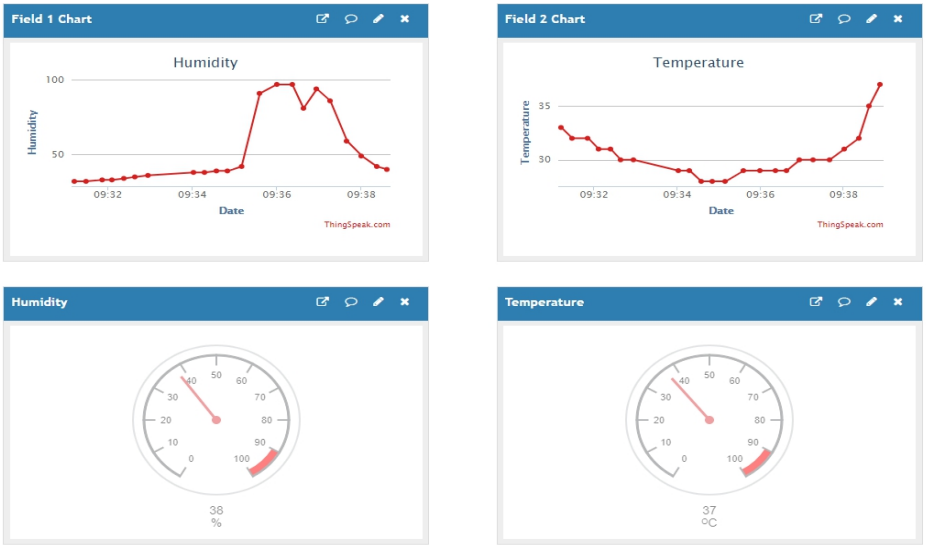

Fig.49. the temperature and humidity data of the smart home visualized in ThingSpeak (Second environment).

❖ The Level of water in the tank

When 5cm ≥ distance >3cm, which means the tank, is almost full.

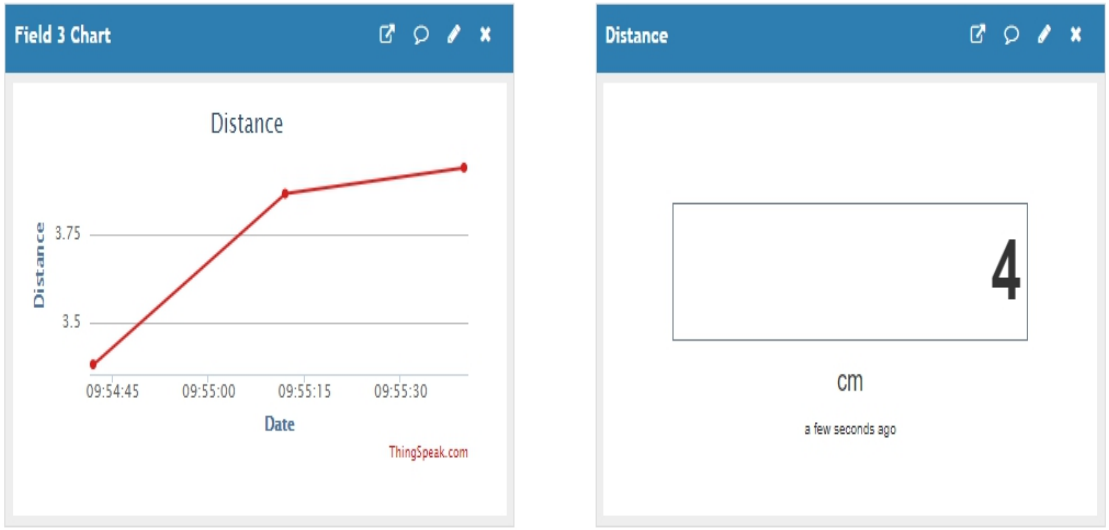

Fig.50.Graphical Data representation of the ultrasonic distance sensor

When the Distance ≤ 3cm that mean the tank is now full.

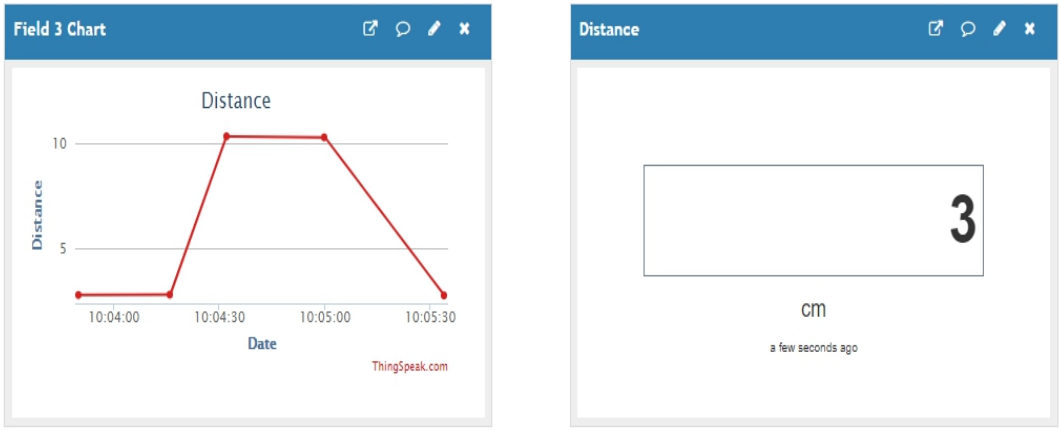

Fig.51. the distance graphical data visualized in ThingSpeak (Second environment)

- Here the data of ultrasonic sensor is shown graphically and connected to IOT. This will help us to analyze the variation in the acquisition of data and to act accordingly.

❖ The front Door security system with RFID card and TAG:

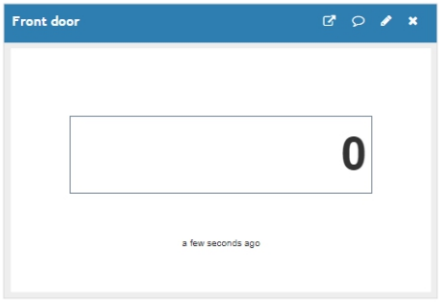

Fig.52. the RFID module data of the Looked door visualized in ThingSpeak

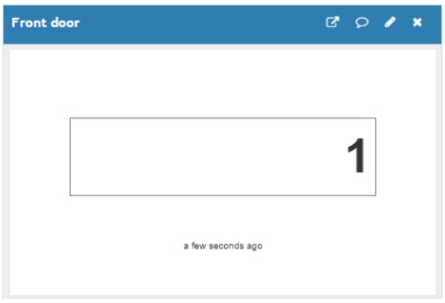

Fig.53. the RFID module Data of the unlooked door

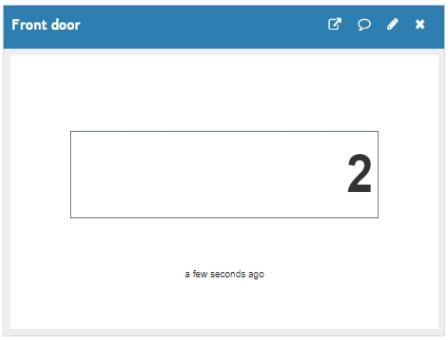

Fig.54.The Data of the RIFD card visualizer in ThingSeak

- Fig.54. shows an attempt to open the front door, which means that the person is not authorized to enter the house because his TAG is not registered in the door security system.

❖ The Door security system :

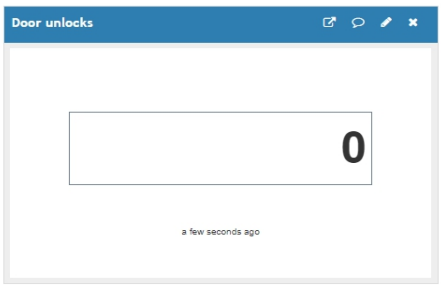

Fig.55. the first button data when there is no knocking

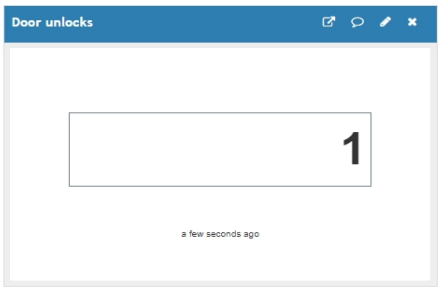

Fig.56. the first button data when someone is knocking

❖ The window security system

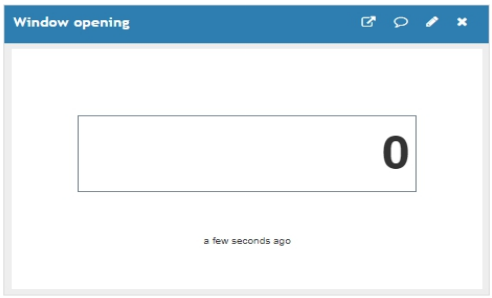

Fig.57. the second button Data when the window is closed

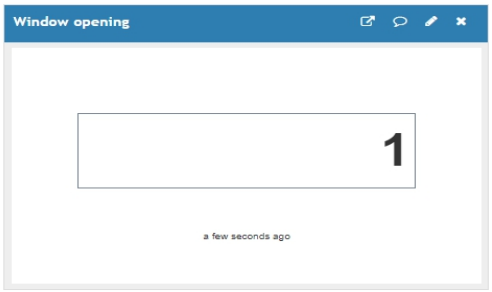

Fig.58. the second button Data when the window is open

❖ Glass breaking in the Kitchen

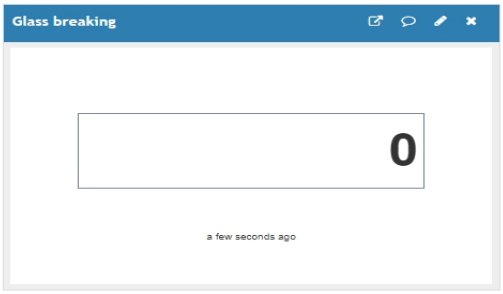

Fig.59. the Third button Data when there is no glass breaking

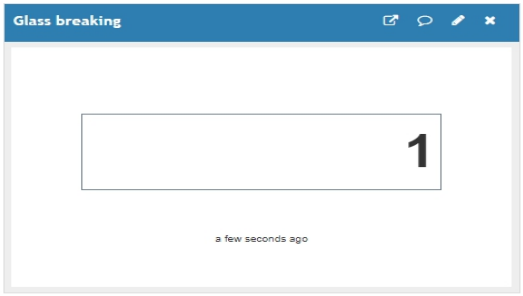

Fig.60. the Third button Data when there is a glass breaking

3.9 Conclusion:

Within this chapter, we tested the two parts of our smart home system. The hardware and software .The system was able to operate in a good performance. We have shown the development of the proposed solution of speech synthesis technology in the smart home, which integrates Raspberry Pi microprocessor, RFID module for the door security system, temperature and humidity sensor, ultrasonic sensor for the water level, in addition to the Buttons and LEDS to form our security system for the elderly. The Raspberry Pi runs with the operating system called as Raspbian, on which the necessary libraries are included and the sensors scripts are developed using Python, which is a multi-paradigm programming language that helps in rapid development and integration of the sensors in the smart home systems.

In the other hand the system is provided by speech synthesis, when sensing a high temperature or a glass break the system calls the function of the voice alert and the detected text is then converted into speech using a compact open source software speech synthesizer eSpeak. Finally, the synthesized speech is produced by TTS method, and heard through the speakers.

We heard the pi utter the warning messages such as warning high temperature in the room, the front door just opened and the tank is now full. The eSpeak synthesizer quality sound was good we were able to hear all the voice alerts in a clear understandable voice. It can be used at high speeds, but is not as natural or smooth as larger synthesizers, which are based on human speech recordings.

Furthermore, we used an open source cloud IoT platform called ThingSpeak as a cloud services for sensors and the smart home monitoring system. The recorded temperature and humidity, water level, door and window security system were stored in a cloud database (ThingSpeak), and the results were displayed in our web page in graphical form and numbers. From where the caretaker can view them directly. These are the objectives and scope of the project that we have achieved.

General Conclusion

Conclusion

In this work, we proposed a cost-effective safety system for elderly and disabled persons to respond in real-time. The proposed system provides the complete smart home environment for the security of the elderly with the speech synthesis technology. This project exhibits several strengths, such as providing an open source cloud IoT platform called ThingSpeak that is used as a real time web based cloud service to monitor, update, and display the collected data from the connected sensors of the house appliances. Where the caretaker or the parents can monitor the entire house environment from the platform, and see the data visualized in graphical and dashboard form. Moreover, they can take precautionary action in case any abnormality is detected.

We have designed a prototype for our home automation system, by conception of a smart home box based on the Raspberry Pi single-board computer and different sensors. One of the house environment monitoring addressed in this work is the temperature humidity sensing in real-time using DHT22 sensor, attached to the house living room. In addition to the window and door security system with functional buttons and LEDS, ultrasonic sensor for the water level in the tank. For the homeowner to feel secured and comfortable as the way to open their front door is by using registered RFID tag cards in the system, and they can easily and comfortably control the authorized tags and card. If the tag is not registered in the door security system, the person will not be authorized to enter the house. Moreover, to ensure the safety of the older person we detected the glass breaking sound in the kitchen using a button and a buzzer.

These sensors are connected to Raspberry Pi that is responsible for processing and decision making in the detection of any abnormal activity, a Voice alert was sent and heard by homeowner. The TTS technology provides the warning messages heard by the elderly where espeak synthesizer, synthesized the text messages and produced the spoken sound.
Speech synthesis can simplify the interpretation of computer display material, by a visually disabled individual. Furthermore, to increase the understanding of a text message, by producing a spoken sound version of the warning messages.

Further, we are of the aim to implement this system on a larger scale and extend it to a commercial product. There are many more things we wish to do to make the smart home more

useful for the elderly and the disabled persons by adding voice recognition, which means the voice, based control system that will allow home residents to wirelessly control any electrical appliances that can be configured to operate virtually. The IoT plateform dashboard can be improved. SMS and mails to informe concerned healthcare persons and members of family would be perfect.

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