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Kitchen security system

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Abstract

The kitchen is the most dangerous place in the house, there is a high possibility accidents happen. from catching fire to gas seeking, causing disasters where sometimes leads to injuries and deaths. Also, it is considered a big danger if a kid or pet is there.

To solve this problem, a system that alerts and secures the user is presented in this project. The system alerts the user with information.

In the end, the system worked in general and did the objectives.First,it collects the data and stores,sends information about temperature and humidity,alerts about human detection for safety of children and pets in the kitchen and if there is a gas leak or smoke then shuts down the gas valve .

keywords : kitchen ,safety,gas leak ,gas valve,gas sensors,temperature,humidity, gsm shield,SMS message.

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Chapter 1

Introduction

1.1 Overview of the project

The kitchen is considered as a dangerous place; a lot of accidents are happening there and causing disasters, sometimes causing injuries and deaths. People use a variety of heat sources to cook food, including gas, wood, and electricity which sometimes could be harmful.

As a result, the system is reliable considering the customer has been alert of the kitchen's info and the system has taken action.

1.2 Motivations:

The project is proposed in order to help avoid the situation that causes people danger in the kitchen. Also, we could use the information to solve the problem before it happens. So, that saving lives and the building itself.

Moreover, using the knowledge that we learn during college years to end this project that covers a lot of topics that are learned from the classes in the field (Computer Systems Engineering) like microcontroller, scientific research methods and labs.

1.3 Importance:

Speed of fire is insane! In less than 30 seconds a small flame can turn into a great fire. The thick black smoke takes minutes to fill the house or to be engulfed in flames. Also, in just 2 minutes, a fire can become life threatening. Moreover, in five minutes a fire could catch the home. So, an alarm in the beginning will give us a chance to avoid the danger

1.4 Objective:

In below are the primary objectives that we want to accomplish for this project:

- Measuring the humidity, temperature and giving an alert to the user if it's out of the range.
- Ensuring that flames or smoke are in the normal and safe range.
- Closing the solenoid valve electrically when the sensors measure something abnormal.

1.5 Short description of the system:

A cheap but reliable security system that works to provide a safe environment, by monitoring the situation in the kitchen to avoid unexpected accidents

So, the system informs the user about the safety of the kitchen in order to take any required action. Moreover, a solenoid valve closes automatically if the system discovers a gas leak. The system should have a microcontroller; GSM technology in order to send messages in emergency cases and updates every while.

1.6 Problem Statement

1.6.1 Problem Analysis

The kitchen is known as a hazardous location; frequent incidents occur there, resulting in hazards that often result in injuries and deaths. People cook with a variety of heat sources, including coal, wood, and electricity, which can be hazardous sometimes.

Each of the heat sources can create indoor air pollution during cooking. Which could be toxic to people and pets. In conclusion, using a wood stove or fireplace to cook can result in high levels of indoor air pollution from wood smoke or flames that cause fires. Which sometimes could be massive and cause disasters.

On the other hand, children inside the kitchen lead to a huge mess and mostly the child gets hurt if there is no oversight from parents.

1.6.2 List of Requirements:

System requirements can summaries as:

- The system should have immediate response.
- The system should be able to do the required functions in dangerous situations effectively.

1.6.3 Expected Result:

The system will prevent fire from catching up the house by alerting the user and taking an action to close the gas valve .

Chapter 2
Background

2.1 Literature Review

A lot of related projects similar to our project have been developed:

Research from Universitas Pendidikan Indonesia considering Automation and Monitoring Smart Kitchen Based on Internet of Things (IoT) [1]. The system is built so that it can constantly track and transmit different details about the kitchen state, although when the user is not there. There is monitor temperature and fire changes caused by the use of gas stoves in the kitchen. DHT11 sensor detects temperature variations in the kitchen, while an MQ-135 gas sensor detects Liquefied Petroleum Gas (LPG) leaks, an IR flame sensor detects flames, and PIR sensors detect human behavior. Besides a relay in this device that controls the fan, which controls the temperature and blows out gas in the case of a gas leak or smoke from the kitchen in case of fire catching. This system can be managed and tracked through the internet at any time, even if the user is out of the kitchen, using laptops or Smartphones. In the event of a fire or gas leak, this device will sound an alarm and send information through SMS, e-mail, or in-app notification on a smartphone.

On another research from (International Conference on Information Technology (ICIT)) and published by IEEE titled "FireDS-IoT: A Fire Detection System for Smart-Home Based on IoT Data Analytics" [2]. Bhoi et al. developed a smart home IoT fire warning system that uses data collection, in decision tree machine learning algorithms, and emergency response sensors. These devices simply read sensors and do not avoid fires directly.

In the market there is "Fire Avert", which is made in the United States, plugs into your stove outlet, and it monitors (responds to) smoke detector activation. When it receives a signal, the switches turn off the electricity from the outlet [3].

2.2 Technologies to be used in the project :

This section describes the technology that will be used in this project, as well as the tasks will be performed.

1. **Arduino-Makefile:**

   An open-source Makefile for Arduino sketches. It will automate the following: compiling code, flashing it to Arduino and even communicating through Serial.

2. **Arduino IDE:**

Arduino IDE is the environment where the Arduino sketches are written, compiled and uploaded to the board. It will be used by the Arduino-Makefile.

3. **Microsoft Visual Studio:**

"Visual Studio, also known as Microsoft Visual Studio and VS, is an integrated development environment for Microsoft Windows. It is a tool for writing computer programs, websites, web apps, and web services. It includes a code editor, debugger, GUI design tool, and database schema designer, and supports most major revision control systems "[4].

3.2 Hardware Components of the System:

In this section, the major hardware components that are needed are going to be discussed. Also, explain how each component works.

1. **Arduino mega:**

"The **Arduino Mega 2560** is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Mega 2560 board is compatible with most shields designed for the Uno and the former boards Duemilanove or Diecimila" [5].

- **Other option: 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. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python." [6]

Raspberry pi vs. Arduino Mega:

These are some of the reasons of why Arduino Mega is chosen:

- It is low cost; the project will design to be lower cost than other systems are presents in the market.
- Mega Provides all features and pins are required so there is no need for the raspberry pi.

2. **Arduino Nano:**

"The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3.x). It has more or less the same functionality of the Arduino Duemilanove, but in a different package. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one." [7]

- **Other option**: Seeeduino Nano:

- "The Seeeduino Nano is a compact board similar to the Seeeduino V4.2/Arduino UNO, and it is fully compatible with Arduino Nano on pinout and sizes.
  The same as Seeedunio V4.2, Seeeduino Nano is built around Atmega328P -- 8-bit AVR microcontroller. So, you can use the same program code on both boards. However, the dimensions of the two are significantly different. Less than a quarter of the size, but with almost the same features, Seeeduino Nano will save more space for your project, more suitable for space-constrained scenes'' [7]

  - **Arduino Nano is used because** it is available, and it's more reliable as a microcontroller.

3. **9V power supply.**
   A power supply for feeding the microcontroller and the GSM shield**.**

4. **5V fan:**

   The system needs a fan to ensure airflow and prevent overheating.

5. **GMS Modem/shield:**

   "A GSM/GPRS MODEM is device that modulates and demodulates the signals from the Wireless Network and allows internet connectivity. A GSM MODEM generally consists of a GSM Module along with some other components like a SIM Card, a device to modulate and demodulate the signals and power supply" [9].

   - **<u>Other option:</u> GSM module:**

     - "A GSM/GPRS Module is an IC or chip that connects to the GSM Network using a SIM (Subscriber Identity Module) and Radio Waves. The common radio frequencies in which a typical GSM Module operates are 850MHz, 900MHz, 1800MHz and 1900MHz" [10].

     - But the GSM module is not used because it's not possible to interface directly to an external device like a microcontroller unlike GSM modem.

6. **Keyes DHT11 (Temperature and Humidity Sensor):**

   DHT11 read both temperature and humidity. They play a part in the gas concentrations that sensors measure. The accuracy of readings will be affected by high humidity and temperature, as well as dramatic changes in each. So, it is beneficial to be able to keep track of these factors.

7. **MQ-2 & MQ-9 Gas Sensor (Gas & smock Sensor):**

   MQ-2 and MQ-9 gas sensors are used to measure toxic gasses including Propane, Butane and Carbon Monoxide. They use a gas-sensitive resistor (SnO2) to detect concentrations of toxic gasses and have an internal heating element to keep the sensor at the right temperature. The circuits used for these devices are practically the same as the circuits for the MiCS sensor.

8. **PIR sensor:**

PIR (passive infrared sensor) sensor is used to detect the movement of a human or animal who passes by the sensor area using infrared radiation. The maximum distance that can be detected is nearly 290 cm.

9. **Solenoid Valve:**

"A solenoid valve is an electrically controlled valve. The valve features a solenoid, which is an electric coil with a movable ferromagnetic core (plunger) in its center. In the rest position, the plunger closes off a small orifice. An electric current through the coil creates a magnetic field. The magnetic field exerts an upwards force on the plunger opening the orifice. This is the basic principle that is used to open and close solenoid valves" [11].

10. **NRF24L01 Transceiver Module:**

- The nRF24L01 is a wireless transceiver module, which means it can send and receive data wirelessly. When used correctly, the modules may reach a distance of up to 100 meters (200 feet), making it an excellent solution for any wireless remote-controlled applications.IT configured and operated through a Serial Peripheral Interface (SPI).

  - Other option: XBee

- " The XBee radios can all be used with the minimum number of connections — power (3.3 V)، ground, data in and data out (UART)، with other recommended lines being Reset and Sleep.Additionally, most XBee families have some other flow control, input/output (I/O)، analog-to-digital converter (A/D) and indicator lines built in."[12]

  - The NRF24L01 Transceiver Module is chosen because it is lower cost; the project will be designed to be lower cost than other systems in the market.

2.3 Specification and design constraints

- **Design Specifications:**

The project contains 3 main ideas. First, a PIR sensor has been connected with a GSM shield in Low angle view (security camera) for children and pets, so when the sensor detects any motion, the GSM shield sends an alert to the user.

Also, there are sensors for gas leak that detect if the gas goes out of the normal range and if that happens it will send a message through the GSM shield to the user phone with this information, so he can discover the leak position and ventilate the kitchen. At the same time,the nrf module sent a signal to the Arduino nano which connected with Solenoid Valve to shut the gas valve off.

Finally, temperature and smoke sensors which detect high temperature, will send a warning that the kitchen is on fire or might be .Besides, the humidity sensor helps knowing if the reads is not in the range for a long time to warn the user to take action.

In the end, the system every day will send all readings to the user phone.

- **Design Constraints:**

- The project will use both GSM shield and Arduino, the features of each one above shows that the Arduino is best for sensor reading, Processing data, while GSM shield connects the system to the network. GSM shield gives the feature of simple connection to the mobile phone network and it can send the data from Arduino to the user phone. Briefly, Arduino will be used for controlling the sensors and the GSM in order to send that data to the user phone, so the user has up-to-date information.

- Use inexpensive products and devices as much as possible.

Chapter 3
Design

- In this section, the system will be explained by using diagrams and pseudocode.

3.1 Detailed design:

- Figure (3.1) presents a schematic Layout - the receive system - which contains the arduino nano that takes the data from the nrf module.The nrf module receives a signal from the sending nrf module in fig(3.2) .The signal will tell the arduino to open or shut down the gas valve according to data reads in in fig(3.2) .

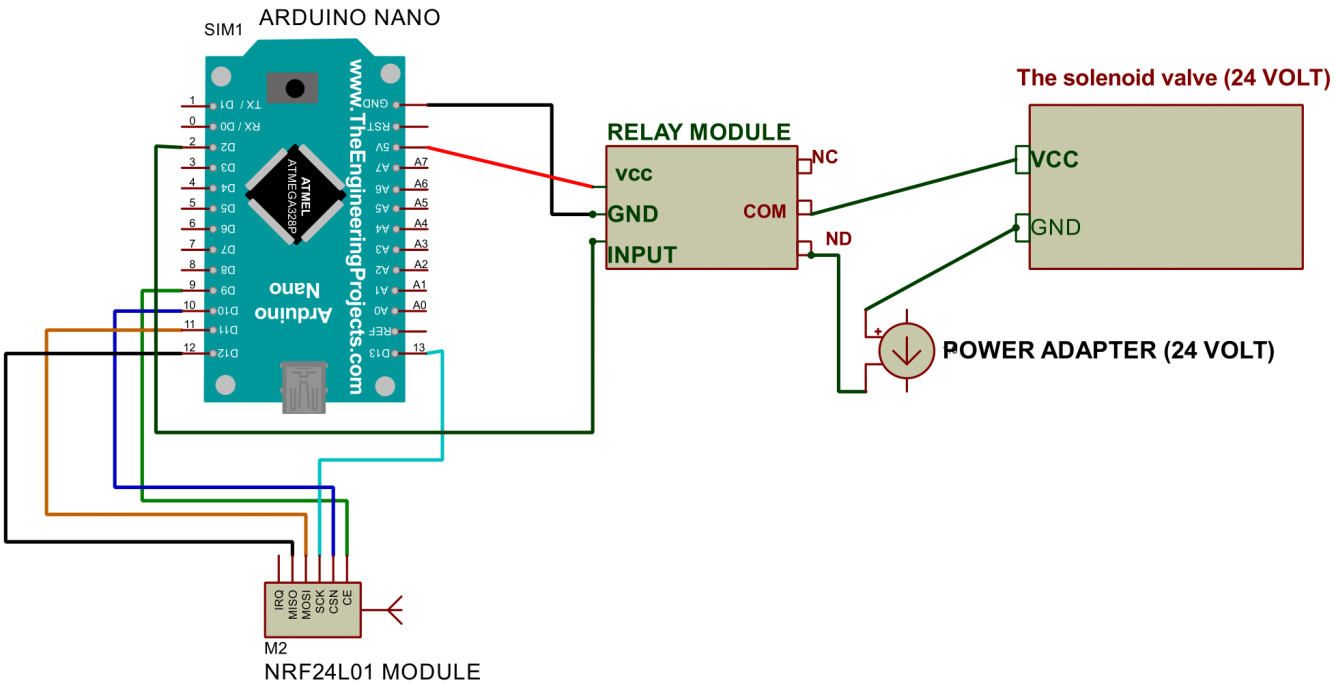

Fig (3.1): schematic Layout of the valve system (receive section).

- Figure (3.1) presents a schematic Layout of the main part system; it shows how components in the system are connected. First, we have the GSM modem connected to the top of the Arduino microcontroller and connected through 7 & 8 digital pins, then every component is connected to the Arduino microcontroller.

- The system reads the data and if there any out of range send from GSM shield an sms to user phone and make the nrf module send a signal to the receiving nrf module in Figure (3.1) to shut down the gas valve.

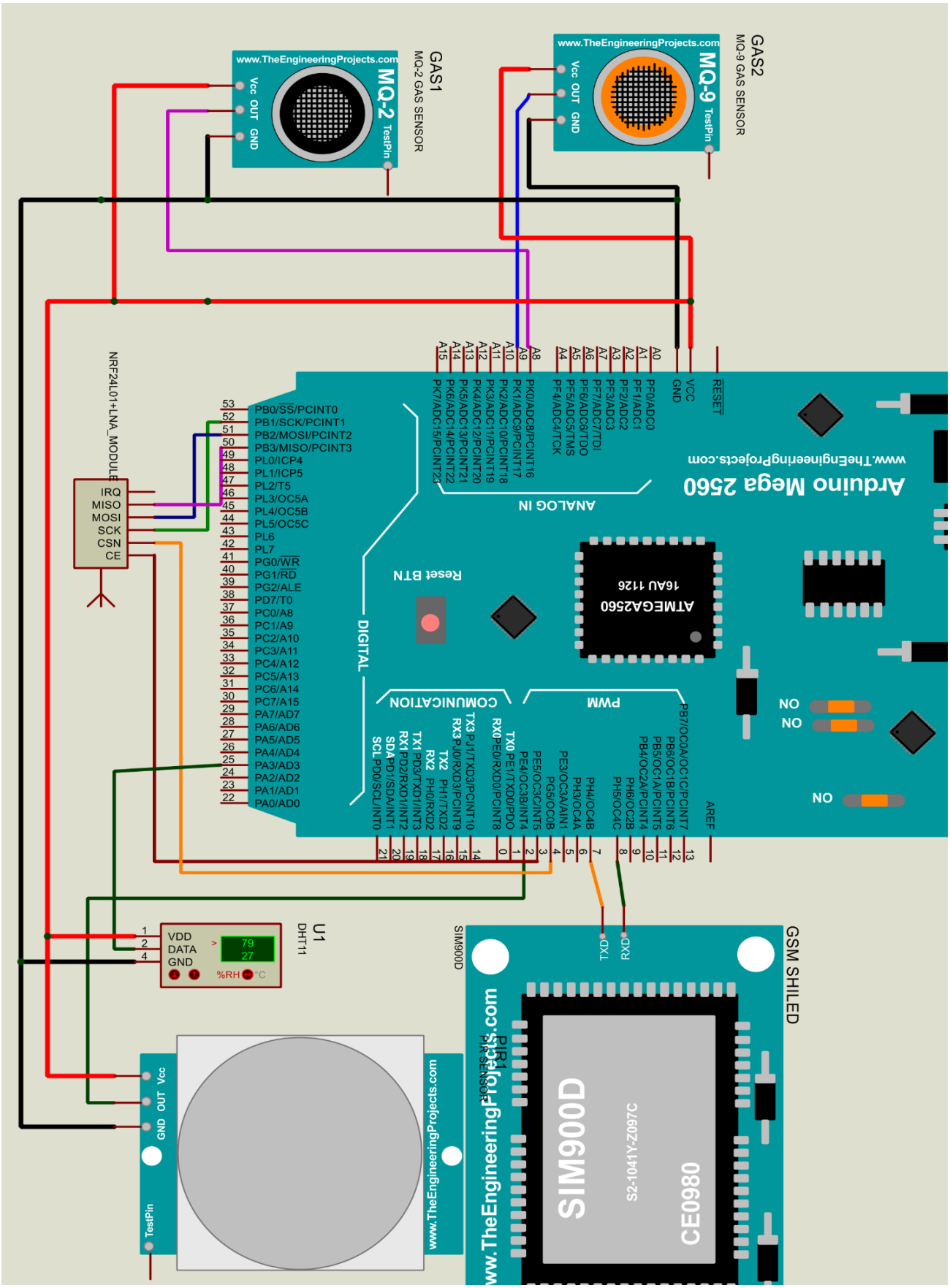

Fig (3.2): schematic Layout of main part system(reading data system).

3.2 Block diagrams:

Figure 3.2 presents the block diagram of the system. It shows the components of the system and how they are communicating.The reading data system collecting the data through the sensors takes an action according to it. Send a sms as an alert to the user phone or close the gas valve by communication between the two nrf modules.

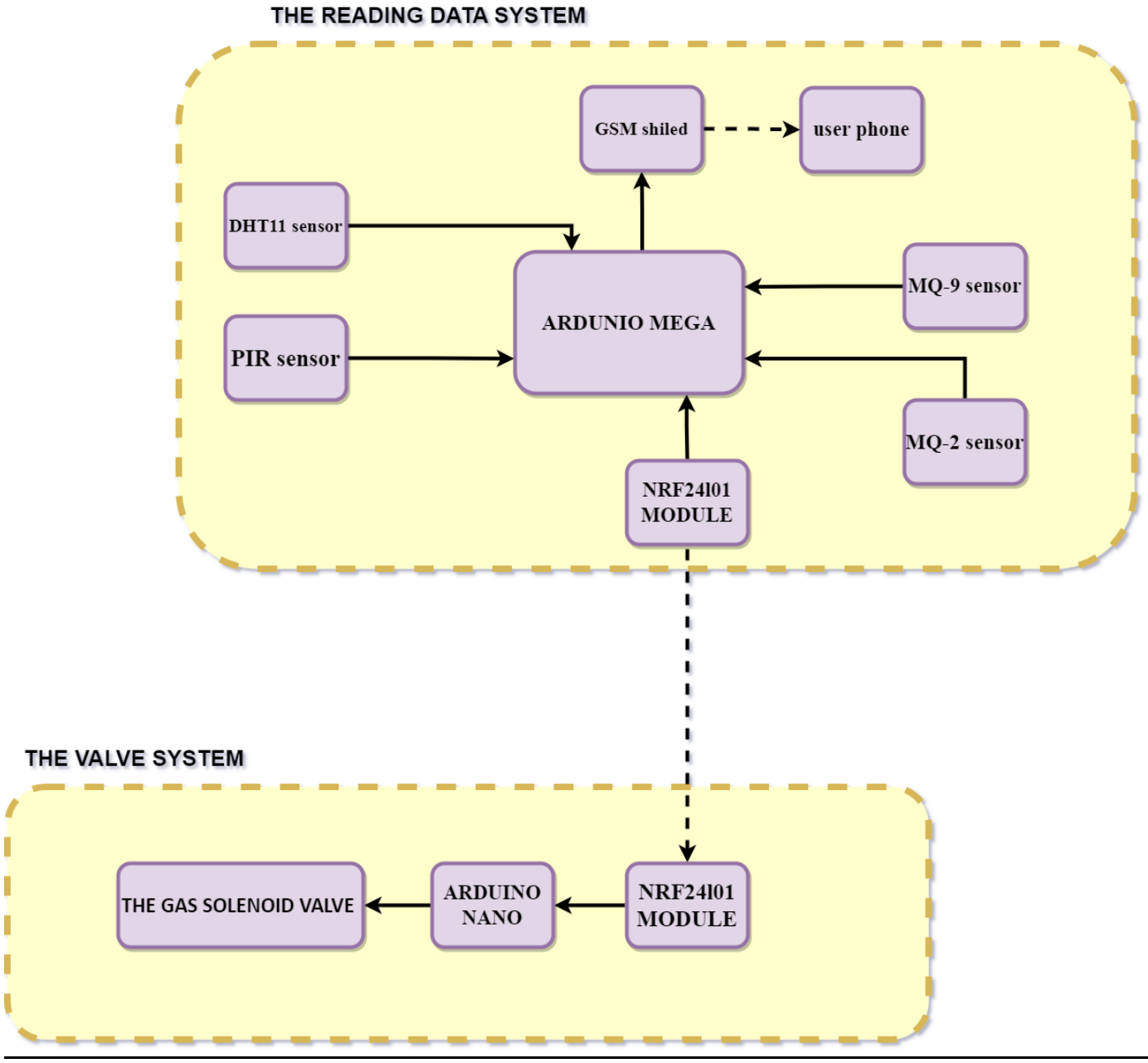

Fig (3.3): Block Diagram of the system.

3.3 Flow charts and algorithms/pseudo-code:

3.3.1 Flow charts:

The flowchart in figure 3.3 explains the basic system algorithm, which detects if there is any motion for making a safe environment for children or pets .Also,if there is out of range sensor's reads and then informs the user by sending sms through the GSM shield and close the gas valve.Lastly,take reads and send it in the end of day as report.

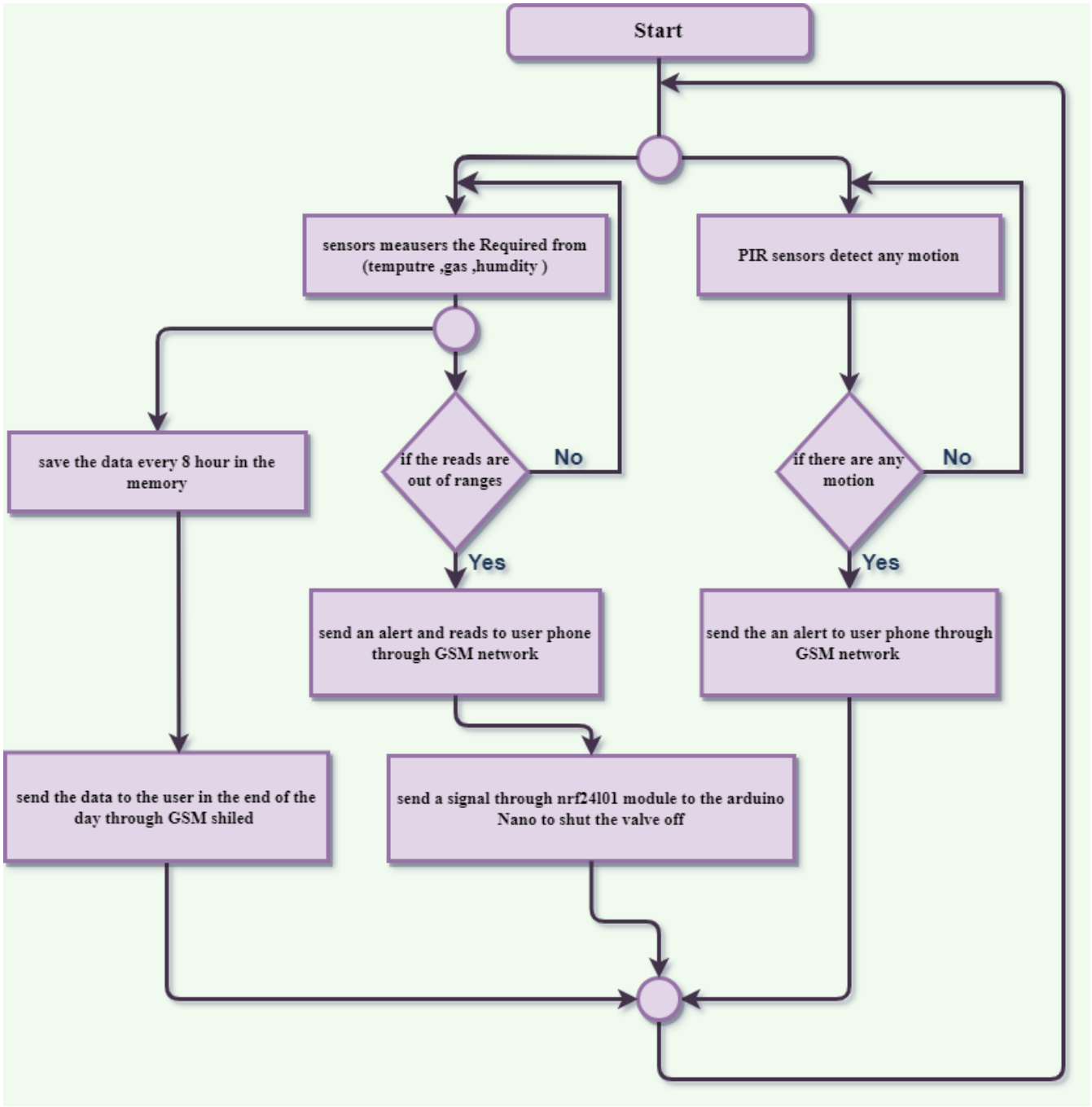

Fig (3.4): Flowchart of the system.

3.3.2 pseudo-code:

boolean motion =False;

boolean gas=False;

// the following functions calls when system sensors get a motion or alert.

Function pir_sensor;

Pass In: nothing

the pir sensor recognize a motion

Pass Out: nothing

Endfunction

Function sensor_gas

Pass In: nothing

the gas sensor recognize that gas is out of range

Pass Out: nothing

Endfunction

// this function is for sending an alert from sensor reads to user phone.

Function send alert

Pass In: data

gsm_modem send alert to the user phone with data in the message;

Pass Out: message

Endfunction

// this function send the sensor information to the user phone.

Function sensor_information

Pass In: sensor_information

send sensor_information to the user phone that has been stored in the memory every 6 hours.

Pass Out: message

Endfunction

// this function clear all the data in the SD card.

Function SD_clear

Pass In: nothing

clear the SD card information after send it to the user phone.

Pass Out: nothing

Endfunction

// the following 2 functions to get the acknowledgement from the user phone that he saw the message within minute.

Function acknowledgmentalert

Pass In: nothing

the user sends an acknowledgment that he gets the info before 1 minute pass for the last alert message;

Pass Out: nothing

Endfunction

Function acknowledgmentpicture

Pass In: nothing

the user sends an acknowledgment that he gets the picture before 1 minute pass for the last picture message;

Pass Out: nothing

Endfunction

// this loop is work as long as the system is on

Loop

wait for data

If (call(pir_sensor))

If (! call (acknowledgmentpicture))

```
        motion =True;
      EndIf
    EndIf

  If (call(sensor_gas))
      If (! call(acknowledgmentalert))
          gas=True;
       EndIf
    EndIf

    if (motion == True)
          call (send alert);
          motion=False;
    EndIf

    if (gas == True)
          call (send alert);
          gas=False;
    EndIf

    Repeat (every 24 hour)
              call(sensor_information)

Forever
```

Chapter 4
Software and hardware implementation

This chapter explains how the project's software and hardware were accomplished, including the different components and tools that were used to complete this project.

4.1 Installing needed library for hardware to program it with Arduino IDE:

- **MQ-2 sensor library:**

  The mq-2 sensor needs this library to be defined to the Arduino IDE and use these functions to read smoke, LPG and CO (readCO (), readLPG (), readSmoke ()).

- **DHT sensor library:**

  DHT sensor use this library to read temperature and humidity with instance functions (dht. temperature (), dht. humidity ()).

- **SD reader master library:**

  This library is for the SD reader to write and read to file in SD with these functions (SD. open (), initializesd ()). And, we use SPI.h library which defied the spi pins on arduino hardware to send and receive data..

- **SoftwareSerial.h library:**

  We insert this library to the code in order to allow the GSM send and receive messages and make calls with this code line

  SoftwareSerial my Serial (7, 8);

  Which makes the 7 and 8 pins is the tx and rx to connect the mega with GSM shield to transfer the data back and forth between the GSM shield and the arduino mega.

- **RF24.h library:**

  This library for the nrf modules to connect with each other with these functions(radio.openWritingPipe(),radio.stopListening(),radio.setPALevel(),radio.begin(),radio.write(),radio.openReadingPipe(),radio.read()).

4.2 Hardware implementation:

This session describes the hardware implementations that have been completed as part of our project.

4.3.1 GSM Shield:

To interact with the Mega, mount it on top of an Arduino board. And change the jumpers in (Tx, Rx) to make it a software serial which connects with arduino by interior pins without need to connect it with wires. As a result, I used the AT commands to send SMS to the user phone.

4.3.2 Solenoid Valve:

Interfacing using a relay module, the solenoid valve is wired to the Arduino. Because most modules have an optocoupler, they may ensure that the Arduino board is completely isolated from external circuitry. Relay interfaces may also control solenoid valves with a wide variety of operating voltages. The relay module attaches to 24V DC power supply to give it to the Solenoid Valve and Arduino nano

Chapter 5
Validation and testing

This chapter presents the results of the system implementation.

5.1: GSM shield test:

For testing The GSM shield .In the beginning, connect to the Arduino mega and let it take the power from the Arduino, then run the code which sends a message to the user number which is written in the code. The message was received on the phone in about 10 seconds.

5.2: solenoid valve test:

First, connect the relay with the valve then put the power supply for the valve in the power socket. Connecting the relay with Arduino nano to programming it to make the valve shut down. The relay turns on the green light when the valve is shut down. Because it's normally open.

5.3: nrf24l01+ module test:

I connected one of the nrf modules with the Arduino mega and the other one with the Arduino nano. And wrote a code with a pipe to send the data from one module to the other one. Test it to send and receive between the two modules and test numeric data. Lastly, let the system take an action like sending an order to close the valve if there's a gas leak or smock detected.

5.4: Sensor’s test:

- **Gas sensors:**

  - After connecting the MQ sensors to Arduino mega with the analog pins as input devices, we set up the library for (MQ2). Then we measure the sensor volt if it comes high that means there is a gas leak or smock. I used a torch to test that the sensors work fine. Lastly, we print the values for lpg, co and smoke.

- **Temperature and humidity sensor (DHT11):**

  - The sensor connects with a digital pin to read the data. Then I compare the reading data with the data on the internet.

- **PIR sensor:**

  - The reading pin in the sensor connects with the PWM digital pin in arduino mega to see if it's high then there's a detect of motion. I run the code then test it by my hand.

5.5: Implementation issues:

5.5.1: Hardware issues:

- The GSM shield was hard to connect with the mega because the library was working with uno Arduino. So, I tried many methods and it didn't work. Until I change the jumpers on the (Tx, Rx) pins on the shield and use the softwareSerial.h library with AT commands.

- The solenoid valve didn't work with the Arduino and the relay .Until I added a power adapter it gave enough power to the valve to work.

5.5.2: Software Issues:

- The receive nrf module didn't work for many times and codes .So I found a code that makes sure if the module works and connected properly to the microcontroller And I tried to connect it many times until it worked and shown as worken module in the results of code. Then, the module send and receive data with the other module.

5.6: System validation:

The system is able to send an SMS when there is an alert and take the reads and store them but the PIR sensor sometimes gives a wrong alert because it may be just a person in the kitchen not a child or pet. Finally, the NRF sends the data and shuts down the valve when there is a smock or gas leak.

Chapter 6
Conclusion and future work

This chapter summarizes the project's outcomes, presents the main goals that were accomplished, and suggests future work that may be done with the system.

6.1 Conclusion:

To conclude, the project's main objectives were accomplished. The system can measure the required values, alert the user when an issue comes up, and close the valve if a danger exists. But, the PIR sensor sometimes gives a wrong dedication .Also, the GSM shield not working all time the area must be network coverage and the antenna of the GSM shield must be uncovered. This was done by using the proper hardware components and installing the needed libraries. The hardware and software for the project have been implemented and found to be meeting expectations.

6.2 Future Work:

To improve the kitchen security system, these future works are recommended:

- put a security camera to stream to the user phone or laptop .
- connect the system with a fire sprinkler safety system to work in fire c

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