**ĐẠI HỌC ĐÀ NẴNG**

**TRƯỜNG ĐẠI HỌC BÁCH KHOA**

**KHOA ĐIỆN TỬ - VIỄN THÔNG**

**BÁO CÁO ĐỀ TÀI PBL3**

**Lớp HP: 20N39A – Nhóm: 2**

**ĐỀ TÀI:**

**HỆ THỐNG PHÁT SÁNG CẢNH BÁO TIẾNG ỒN Ở BỆNH VIỆN**

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**LỜI NÓI ĐẦU**

Bệnh viện được coi là nơi cung cấp chăm sóc y tế chất lượng cao cho bệnh nhân, nhưng môi trường ồn ào có thể gây ra những tác động tiêu cực đến sức khỏe và phục hồi của bệnh nhân. Trong ngữ cảnh này, đề tài về chống tiếng ồn ở bệnh viện trở nên ngày càng quan trọng để đảm bảo môi trường y tế thuận lợi và thoải mái. Bên cạnh đó việc sử dụng cảm biến tự động bật tắt đèn mang lại đảm bảo rằng ánh sáng chỉ hoạt động khi cần thiết, giảm lượng điện tiêu thụ không cần thiết trong khu vực hành lang.

Lý Do Quan Tâm Đến Chủ Đề:

1. Ảnh Hưởng Đến Sức Khỏe Bệnh Nhân:
   * Nhiều nghiên cứu đã chỉ ra rằng tiếng ồn có thể gây stress, lo âu, và ảnh hưởng đến quá trình phục hồi của bệnh nhân sau mổ hay các liệu pháp điều trị.
2. Hiệu Quả Của Quy Trình Chữa Trị:
   * Môi trường yên tĩnh giúp tăng cường hiệu quả của các quy trình chữa trị và phục hồi.
3. Thuận Tiện Cho Đội Ngũ Y Tế:
   * Mức độ ồn thấp cũng mang lại điều kiện làm việc tốt hơn cho đội ngũ y tế, giúp họ tập trung hơn vào công việc của mình.
4. Tiết kiệm Năng Lượng:
   * Thiết bị tự động có thể dựa vào cảm biến để bật đèn khi có người di chuyển trong hành lang và tự động tắt khi không có hoạt động.

Mục Tiêu Nghiên Cứu:

Đề tài này nhằm mục đích nghiên cứu và áp dụng các biện pháp chống tiếng ồn hiệu quả trong bệnh viện, nhằm cải thiện môi trường làm việc và chăm sóc bệnh nhân. Cụ thể, các mục tiêu nghiên cứu có thể bao gồm:

1. Đo Lường và Đánh Giá Mức Độ Tiếng Ồn:
   * Sử dụng các công cụ đo lường để xác định mức độ tiếng ồn hiện tại trong bệnh viện.
2. Nghiên Cứu Nguyên Nhân Tiếng Ồn:
   * Xác định nguồn gốc của tiếng ồn trong bệnh viện để đề xuất biện pháp giảm tiếng ồn tương ứng.
3. Thử Nghiệm Các Biện Pháp Chống Tiếng Ồn:
   * Áp dụng và đánh giá hiệu quả của các biện pháp chống tiếng ồn như cách âm, vật liệu cách âm, hoặc thay đổi quy trình làm việc.

Ý Nghĩa và Hậu Quả Dự Kiến:

Nghiên cứu này không chỉ mang lại hiểu biết mới về vấn đề chống tiếng ồn trong môi trường y tế mà còn đóng góp vào việc cải thiện chất lượng chăm sóc bệnh nhân và môi trường làm việc cho đội ngũ y tế. Hiểu rõ hơn về nguyên nhân và biện pháp chống tiếng ồn sẽ giúp tối ưu hóa không gian bệnh viện để đáp ứng nhu cầu y tế hiện đại.

**CAM ĐOAN**

Nhóm sinh viên – Trần Phước Đăng Khoa, Hồ Hoàng Quốc Huy,Phạm Văn Thái và Nguyễn Văn Thịnh xin cam đoan đây là đồ án do nhóm tự thực hiện dưới sự hướng dẫn của thầy Huỳnh Việt Thắng và thầy Vũ Vân Thanh. Đề tài này nhóm thực hiện dựa trên sách vở và nghiên cứu từ tài liệu online để hoàn thiện đề tài, không sao chép từ bất cứ công trình nào đã có trước đó**.**

Nhóm thực hiện đồ án xin được gửi lời cảm ơn đặc biệt đến giảng viên hướng dẫn thầy Huỳnh Việt Thắng và thầy Vũ Vân Thanh vì đã giúp đỡ nhóm trong quá trình thực hiện đồ án, người đã đưa ra hướng nghiên cứu, giải đáp thắc mắc, cũng như tận tình quan sát nhóm làm việc. Trong quá trình thực hiện nhóm đã tiếp thu được những kiến thức thực tế và cách làm việc nghiêm túc, hiệu quả từ thầy.

Nhóm sinh viên thực hiện

(Chữ ký, họ và tên các sinh viên)

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* 1. **Tổng quan về internet of things**

***1.1.1 Giới thiệu về Internet of Things (IoT)***

Ngày nay, nhu cầu phát triển các ứng dụng liên quan đến Internet ngày càng cao. Và IoT (Internet of things) là một công nghệ quan trọng bởi chúng ta có thể tạo ra nhiều ứng dụng đa dạng phục vụ đa số mọi lĩnh vực trong đời sống từ nó. Về cơ bản, IoT là một hệ thống mạng lưới mà trong đó tất cả các thiết bị, đối tượng được kết nối Internet thông qua thhiết bị mạng (network devices) hoặc các bộ định tuyến (routers). IoT cho phép các đối tượng được điều khiển từ xa dựa trên hệ thống mạng hiện tại công nghệ tiên tiến này giúp giảm công sức vận hành của con người bằng cách tự động hóa việc điều khiển các thiết bị.



Hình 1.1 Internet of things(IoT)

Các thành phần chính trong một hệ thống IoT:

* **Thiết bị:**

Mỗi thiết bị sẽ bao gồm một hoặc nhiều cảm biến để phát hiện các thông số của ứng dụng và gửi chúng đến Platform.

* **IoT- Platfrorm:**

Nền tảng này là một phần mềm được lưu trữ trực tuyến còn được gọi là điện toán đám mây, các thiết bị được kết nối với nhau thông qua nó.

Nền tảng này thu thập dữ liệu từ thiết bị, toàn bộ dữ liệu được phân tích, xử lý, phát hiện nếu có lỗi phát sinh trong quá trình hệ thống vận hành.

* **Kết nối Internet:**

Để giao tiếp được trong IoT, kết nối Internet của các thiết bị là một điều bắt buộc. Wifi là một trong những phương thức kết nối Internet phổ biến.

* **Ứng dụng:**

Ứng dụng là giao diện để người dùng điều khiển.

***1.1.1 Lịch sử hình thành***

Khái niệm về một mạng lưới thiết bị được kết nối với nhau đã được thảo luận vào đầu năm 1982, với một máy bán hàng tự động Coke được thực hiện ở Đại học Carnegie Mellon trở thành thiết bị kết nối Internet đầu tiên trên thế giới. Thuật ngữ “Internet of things” được sử dụng lần đầu tiên bởi Kevin Ashton vào năm 1999. Sau đó IoT trải qua nhiều giai đoạn và có bước phát triển nhảy vọt cho đến ngày nay.

**1.1 Công nghệ wifi**

***1.1.1 Giới thiệu***

Wifi là một mạng thay thế cho mạng có dây thông thường, thường được sử dụng để kết nối các thiết bị ở chế độ không dây bằng việc sử dụng công nghệ sóng vô tuyến. Dữ liệu được truyền qua sóng vô tuyến cho phép các thiết bị truyền nhận dữ liệu ở tốc độ cao trong phạm vi của mạng Wifi. Kết nối các máy tính với nhau, với Internet và với mạng có dây.

Wifi (Wireless Fidelity) là thuật ngữ dùng chung để chỉ tiêu chuẩn IEEE802.11 cho mạng cục bộ không dây (Wireless Local Networks) hoặc WLANs.

Việc sử dụng rộng rãi và tính sẵn có của nó ở nhà và nơi công cộng như công viên, quán café, sân bay, … đã khiến Wifi trở thành một trong những công nghệ truyền nhận dữ liệu phổ biến nhất hiện nay.



Hình 1.2 Biểu tượng Wifi

***1.1.1 Công nghệ truyền nhận dữ liệu***

* **IEEE 802.11b**

Xuất hiện năm 1999

Sóng vô tuyến với tần số 2.4GHz

Tốc độ 11Mbps (lý thuyết), 4 – 6Mbps (thực tế).

Phổ biến nhất, ít có khả năng mở rộng.

Ảnh hưởng của các thiết bị Bluetooth và điện thoại di động có thể làm giảm tốc.

* **IEEE 802.11a**

Giới thiệu năm 2001.

Sóng vô tuyến với tần số 5.0GHz.

Tốc độ 54Mbps (lý thuyết), 15 – 20Mbps (thực tế).

Có khả năng mở rộng.

Không tương thích với chuẩn 802.11b.

* **IEEE 802.11g**

Giới thiệu năm 2003.

Sóng vô tuyến với tần số 2.4GHz.

Kết hợp tính năng của hai tiêu chuẩn a và b.

Tốc độ 54Mbps.

Tương thích với chuẩn 802.11b.

***1.1.1Thành phần của mạng Wifi***

* **Access Point (AP)**

AP là bộ thu phát không dây LAN (Local – Area Network), hoặc là trạm cơ sở có thể kết nối đồng thời một hoặc nhiều thiết bị không dây với Internet.

* **Wifi Card**

Cho phép chấp nhận tín hiệu không dây và thông tin chuyển tiếp.

* **Safeguards**

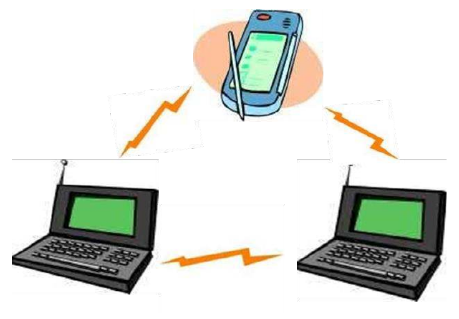
Khả năng bảo vệ: tường lửa và phần mềm chống virus giúp giữ an toàn thông tin cho người dùng.

***1.1.1 Cấu trúc liên kết***

* **Peer to peer**

Là cấu trúc liên kết ngang hàng, không bắt buộc AP, các thiết bị bên trong có thể giao tiếp trực tiếp với nhau.

Phù hợp để thiết lập mạng không dây một cách nhanh chóng và dễ dàng.

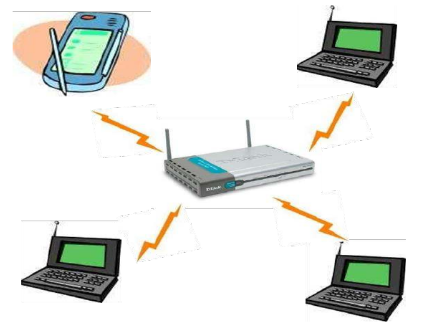


Hình1..2.4.1 : Cấu trúc liên kết ngang hàng

* **Infrastructure Mode**

Là cấu trúc liên kết dựa trên AP, liên lạc với nhau qua địa điểm truy cập (Access Point). Bất kỳ thông tin truy cập nào đều phải thông qua AP.

Nếu một trạm di động như máy tính hoặc điện thoại muốn giao tiếp với một trạm di động khác đầu tiên cần phải gửi thông tin đến AP, sau đó AP sẽ gửi ngược lại trạm di động đó.



Hình1.2.4.2: Cấu trúc liên kết dựa trên AP

* **Hotspot**

Hotspot là một khu vực dễ dàng truy cập mạng không dây.

Hotspot được trang bị kết nối Internet với băng thông rộng và có một hoặc nhiều AP cho phép người dùng truy cập Internet không dây***.***

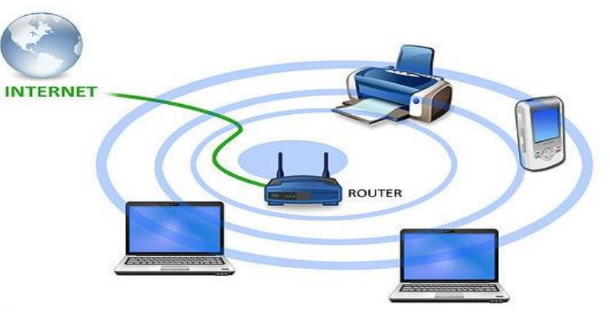
* **Cáchthức hoạt động**

Một Wifi Hotspot được tạo ra bằng cách cài đặt điểm truy cập vào kết nối Internet.

Một điểm truy cập hoạt động như một trạm cơ sở.

Khi thiết bị hổ trợ Wifi bắt gặp điểm phát sóng, thiết bị có thể kết nối không dây với mạng đó.

Một điểm truy cập duy nhất có thể hổ trợ tối đa đến 30 người dùng, nhiều điểm truy cập có thể được kết nối với nhau thông qua cáp Ethernet để tạo ra một mạng lớn.



Hình1.2.6: Cách thức hoạt động của mạng wifi

* + 1. ***Giao tiếp trong Wifi***

Trao đổi dữ liệu trong Wifi được chia làm 3 giai đoạn:

* **Giai đoạn 1**

Dữ liệu được chuẩn bị để truyền, nó được mã hóa thay đổi thành tín hiệu số.

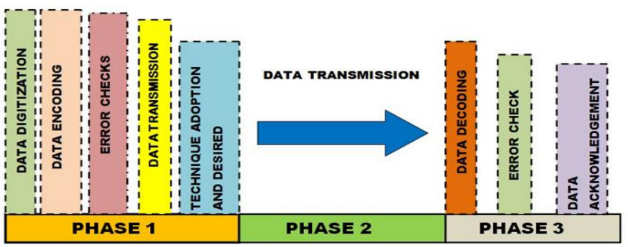
Tại đây tần số truyền dữ liệu cũng được lựa chọn tùy thuộc vào kỹ thuật sử dụng để gửi tín hiệu không dây.

* **Giai đoạn 2**

Dữ liệu được truyền thông qua sóng vô tuyến.

* **Giai đoạn 3**

Dữ liệu được nhận sau đó tiến hành giải mã tín hiệu số, xác nhận và cuối cùng là sử dụng.



Hình1.2.7: Cách thức giao tiếp trong mạng Wifi

* + 1. ***Ưu nhược điểm***
* **Ưu điểm**

Dễ dàng cài đặt.

Tính linh hoạt cao.

Chi phí phù hợp.

Độ tin cậy.

Khả năng bảo mật.

Tốc độ.

* **Nhược điểm**

Tiêu thụ điện năng cao.

Phạm vi hoạt động giới hạn.

* + 1. ***Bảo mật***

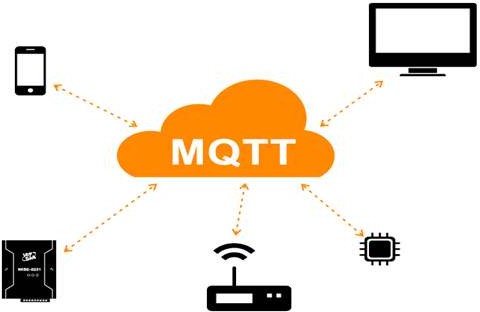
Từ khi ra đời, Wifi được cho là không đảm bảo an toàn về quyền riêng tư, dữ liệu truyền qua Wifi có thể dễ dàng bị đánh cắp. Từ đó, các biện pháp bảo mật cho Wifi đã được sử dụng, có hai tiêu chuẩn bảo mật phổ biến: Wireless Equivalent Privacy (WEP) và Wifi Protected Access (WPA).

**1.2Giao thức MQTT**

* + 1. ***Giới thiệu***

MQTT (Message Queuing Telemetry Transport) là giao thức truyền thông điệp (message) theo mô hình giao tiếp Publish/Subscribe, phù hợp cho việc vận chuyển dữ liệu từ xa

Là một giao thức rất nhẹ do đó được sử dụng để giao tiếp các thiết bị (M2M – Machine to Machine), WSN (Wireless Sensor Networks) và phổ biến nhất trong các dự án IoT.

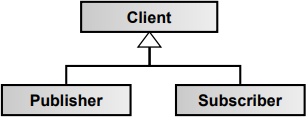
 Giao thức này được thiết kế để trao đổi dữ liệu giữa máy chủ (server) và khách hàng (client). Ngoài ra với kích thước nhỏ gọn, đơn giản, mức sử dụng năng lượng thấp, các gói dữ liệu được tối ưu hóa và dễ dàng thực hiện đã khiến nó trở nên lý tưởng hơn.

Hình1.3.1: Giao thức MQTT

* + 1. ***Lịch sử***

MQTT được tạo ra bởi tiến sĩ Andy Stanford-Clark của IBM và Arlen Nipper của Arcom vào năm 1999 như là một cách hiệu quả, đáng tin cậy để kết nối các thiết bị được sử dụng trong ngành dầu khí với các máy chủ doanh nghiệp từ xa nhằm điều khiển giám sát và thu thập dữ liệu từ các cảm biến.

* + 1. ***Thành phần của MQTT***
* **Client (Publisher, Subscriber)**
* Client (khách hàng) đăng ký một chủ đề để gửi và nhận message:
* Khi một client muốn gửi dữ liệu cho Broker: đây là hoạt động Publisher
* Khi một client muốn nhận dữ liệu từ Broker: đây là hoạt động Subscriber.

 Vì vậy Publisher và Subscriber đóng vai trò đặc biệt của client.

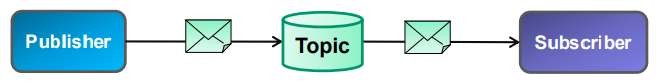
Hình1.3.3.1: Hoạt động của client

* **Server (Broker)**

Server trong MQTT gọi là một Broker được xem là trung tâm, là điểm giao của các kết nối đến từ client. Nhiêm vụ chính của Broker là nhận đăng ký từ các client về các chủ đề (topic), nhận tin nhắn (message), sắp xếp các message theo hàng đợi rồi chuyển chúng đến một địa chỉ dựa trên việc đăng ký của client. Nhiệm vụ phụ của Broker là có thể đảm nhận thêm một vài tính năng liên quan đến truyền thông như: bảo mật message, lưu trữ message.

* **Topic**

Là nơi mà một client muốn đặt hoặc truy xuất message. Cụ thể khi một message được publish vào một Topic thì những subscriber của Topic đó sẽ nhận được message này.



Hình1.3.3.2 . Hoạt động của Topic

* **Message**

Là đơn vị trao đổi dữ liệu mà thiết bị nhận được khi Subscribing (đăng ký) một Topic hoặc gửi đi khi Publishing một Topic.

* ***MQTT QoS***

QoS (Quality of Service): MQTT cung cấp các mức đảm bảo sự chắc chắn trong việc gửi và nhận dữ liệu giữa các client và Broker. MQTT hổ trợ 3 mức:

* **QoS0**

Đảm bảo mức thấp nhất, dữ liệu được gửi đi đúng một lần và sẽ không được kiểm tra đã đến các Broker hay chưa.

* QoS1

Đảm bảo đã đến nơi nhận, ít nhất một lần được xác nhận.

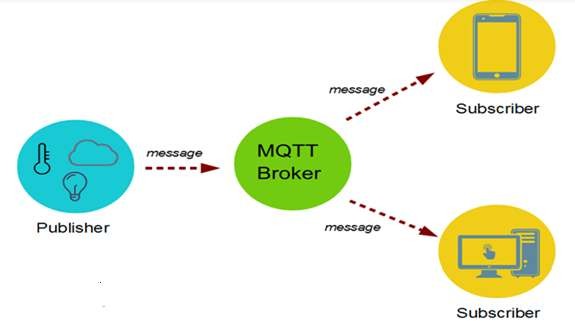
* QoS2

Mức đảm bảo cao nhất, Broker đảm bảo các dữ liệu có QoS2 sẽ đến nơi nhận chỉ đúng một lần duy nhất, không bị trùng lặp, không thất lạc dữ liệu, đồng thời tốn băng thông hơn hai cách trên.

* + 1. ***Broker trong IoT***

Một trong những thành phần của hệ thống IoT là Platform (điện toán đám mây), nó chịu trách nhiệm kết nối các thiết bị với nhau, cho phép người dùng kiểm soát và giám sát các thiết bị của mình. Và Broker cũng chính là Platform, nó nằm trong hệ thống IoT.

Có hai cách tạo ra một Broker:

* Tự tạo Broker MQTT trên máy tính, raspberry, server, …
* Sử dụng các dịch vụ MQTT Broker có sẳn như CloudMQTT.

Hình1.3.5: Thành phần của một MQTT trong hệ thống IoT

* + 1. ***Ưu điểm***

Đây là một giao thức nhẹ. Do đó, dễ dàng thực hiện trong phần mềm và nhanh chóng trong việc truyền nhận dữ liệu, ít bị ảnh hưởng bởi tốc độ mạng.

Giao thức dựa trên kỹ thuật tin nhắn, vì vậy tốc độ khá nhanh.

Gói dữ liệu truyền được tối ưu hóa.

Sử dụng nguồn điện năng thấp, tiếp kiệm năng lượng cho thiết bị được kết nối.

Thời gian thực, đây là điều đặc biệt quan trọng trong các dự án IoT

* + 1. ***Bảo mật***

MQTT được thiết kế một cách nhẹ và linh hoạt nhất có thể. Do đó nó chỉ có một lớp bảo mật ở tầng ứng dụng: bảo mật xác thực (xác thực các client được quyền truy cập đến Broker). Tuy nhiên, MQTT vẫn có thể được cài đặt kết hợp với các giải pháp bảo mật đa tầng khác như kết hợp với VNP ở tầng mạng học hoặc SSLL/TLS ở tầng transport.

MQTT được thiết kế nhằm phục vụ truyền thông machine-to-machine nhưng trên thực tế chứng minh nó lại hoạt động một cách linh hoạt hơn mong đợi. Nó hoàn toàn có thể áp dụng cho các kịch bản truyền thông khác nhau: machine to machine, app to app. Chỉ cần có một Broker phù hợp và MQTT Client được cài đặt đúng cách, các thiết bị xây dựng trên nhiều nền tảng khác nhau có thể giao tiếp được với nhau một cách dễ dàng.

* 1. **Firebase**
     1. ***Giới thiệu***

Firebase là dịch vụ cơ sở dữ liệu hoạt động trên nền tảng đám mây – cloud. Kèm theo đó là hệ thống máy chủ cực kỳ mạnh mẽ của Google. Chức năng chính là giúp người dùng lập trình ứng dụng bằng cách đơn giản hóa các thao tác với cơ sở dữ liệu.

Cụ thể là những giao diện lập trình ứng dụng API đơn giản. Mục đích nhằm tăng số lượng người dùng và thu lại nhiều lợi nhuận hơn.

Đặc biệt, còn là dịch vụ đa năng và bảo mật cực tốt. Firebase hỗ trợ cả hai nền tảng Android và IOS. Không có gì khó hiểu khi nhiều lập trình viên chọn Firebase làm nền tảng đầu tiên để xây dựng ứng dụng cho hàng triệu người dùng trên toàn thế giới

* + 1. ***Cách thức hoạt động***

Sau khi được Google mua lại và tiến hành phát triển, Firebase thực hiện nhiều hoạt động hỗ trợ. Dưới đây là 3 cách thức hoạt động nổi bật của Firebase.

* **Firebase Realtime Database:** Đầu tiên, để sử dụng nền tảng này tạo ứng dụng, lập trình viên cần đăng ký tài khoản Firebase. Đăng ký xong, bạn sẽ sở hữu một Realtime Database có dạng JSON được đồng bộ thời gian đến tất cả kết nối client. Dữ liệu trong các database được tự động cập nhật liên tục khi lập trình viên tiến hành phát triển ứng dụng. Sau khi được cập nhật, những dữ liệu này sẽ được truyền tải thông qua kết nối SSL có chứng nhận 2048 bit. Tại những ứng dụng đa nền tảng toàn bộ máy khách đều dùng chung một database. Trong trường hợp kết nối Internet bị gián đoạn, các dữ liệu sẽ được lưu trữ trên local và cập nhật khi đường truyền ổn định.
* **Freebase Authentication:** Hoạt động kế tiếp của Firebase là tạo lập quy trình xác thực người dùng thông qua các phương tiện như Goolge, Email, GitHub, Facebook, Twitter và xác thực nặc danh đối với các ứng dụng. Việc xác thực giúp bảo vệ an toàn dữ liệu về thông tin cá nhân của người dùng mạng
* **Firebase Hosting:** Các thức hoạt động tiêu biểu cuối cùng, không thể không nhắc đến của Firebase là cung cấp hosting. Firebase hosting thông qua sự hỗ trợ của SSL đến từ mạng CDN. Nhờ vậy mà lập trình viên có thể tiết kiệm rất nhiều thời gian thiết kế cũng như phát triển ứng dụng.
  + 1. ***Ưu điểm***
* Tạo tài khoản và sử dụng dễ dàng
* Tốc độ phát triển nhanh
* Nhiều dịch vụ trong một nền tảng
* Theo dõi lỗi
* Được cung cấp bởi Google •
* Tập trung vào phát triển giao diện người dùng
* Firebase không có máy chủ
* Học máy (Machine Learning)
* Tạo lưu lượng truy cập
* Sao lưu
  + 1. ***Nhược điểm***
* Không phải là mã nguồn mở
* Người dùng không có quyền truy cập mã nguồn
* Firebase không hoạt động ở nhiều quốc gia
* Chỉ hoạt động với Cơ sở dữ liệu NoSQL
* Truy vấn chậm
* Không phải tất cả các dịch vụ Firebase đều miễn phí
* Firebase khá đắt và giá không ổn định
* Chỉ chạy trên Google Cloud
* Thiếu Dedicated Servers và hợp đồng doanh nghiệp
* Không cung cấp các API GraphQL
  1. **Giới thiệu chip Wifi ESP32**
     1. ***Tổng quan ESP32***
* Giới thiệu sơ lược ESP32

ESP32 là một chip được tích hợp công nghệ Wifi và Bluetooth với công nghệ tiêu thụ năng lượng cực thấp. Nó cung cấp một nền tảng tích hợp mạnh mẽ, đáp ứng nhu cầu hiệu năng tốt nhất, tính linh hoạt, thiết kế nhỏ gọn, hiệu suất cao và độ tin cậy trong nhiều ứng dụng. Các dòng chip ESP32 bao gồm ESP32-D0WDQ6, ESP32- D0WD, ESP32-D2WD và ESP32-S0WD.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Thành phần** | | |
| **Module** | **Chip** | **Flash** | **RAM** |
| ESP-WROOM-32 | ESP32-D0WDQ6 | 4MB | - |
| ESP-WROOM-32D | ESP32-D0WD | 4MB | - |
| ESP-WROOM-32U | ESP32-D0WD | 4MB | - |
| ESP-SOLO-1 | ESP32-S0WD | 4MB | - |
| ESP-WROVER | ESP32-D0WDQ6 | 4MB | 8MB |
| ESP-WROVER-I | ESP32-D0WDQ6 | 4MB | 8MB |

Espressif đã thiết kế và sản xuất ra một số module để người dùng dễ dàng tiếp cận hơn với dòng chip ESP32. Các thành phần chính trên những module này bao gồm chip ESP32, bộ tạo dao động thạch anh, mạch ăngten, chỉ khác nhau về một số chức năng tùy từng phiên bản như số lượng chân GPIO, các thiết bị ngoại vi được thêm vào như: màn hình LCD, bảng cảm ứng, khe cắm thẻ SD, module máy ảnh,… dưới đây là một số phiên bản đã được phát triển và đưa vào sử dụng.

* + 1. ***Đặc điểm***
* Mức năng lượng thấp

Chip ESP32 được thiết kế cho các ứng dụng di động, điện tử, ứng dụng IoT. ESP32 có tất cả các đặc tính của một chip tiêu thụ mức năng lượng thấp, nhiều chế độ hoạt động giúp giảm thiểu tối đa n ăng lượng mà chip tiêu tốn. Ví dụ cảm biến trong ứng dụng IoT, ESP32 được đánh thức theo chu kỳ và chỉ phát hiện khi có một điều kiện cụ thể.

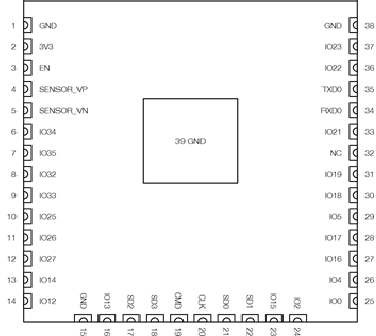
* Tích hợp hoàn chỉnh

Chip ESP32 có khả năng tích hợp cao Wifi và Bluetooth cho các ứng dụng IoT, với khoảng 20 thiết bị ngoại vi. ESP32 tích hợp ăngten, sóng RF (Radio frequency), bộ khuếch đại công suất, bộ khuếch đại thu tiếng ồn, module quản lý năng lượng, …

* + 1. ***Sơ đồ chân của module ESP32-WOOM-32***

Module tổng cộng có 38 chân

|  |  |  |  |
| --- | --- | --- | --- |
| **Tên** | **Số** | **Loại** | **Chức năng** |
| GND | 1 | P (nguồn) | Ground |
| 3V3 | 2 | P | Chân nguồn cung cấp 3V3 |
| EN | 3 | I (input) | Cho phép module hoạt động, mức cao |
| SENSOR\_VP | 4 | I | GPIO36, ADC1\_CH0, RTC\_GPIO0 |
| SENSOR\_VN | 5 | I | GPIO39, ADC1\_CH3, RTC\_GPIO3 |
| IO34 | 6 | I | GPIO34, ADC1\_CH6, RTC\_GPIO4 |
| IO35 | 7 | I | GPIO35, ADC1\_CH7, RTC\_GPIO5 |
| IO32 | 8 | I/O (input, output) | GPIO32, XTAL\_32K\_P, ADC1\_CH4, TOUCH9, RTC\_GPIO9 |
| IO33 | 9 | I/O | GPIO33, XTAL\_33K\_N, ADC1\_CH5, TOUCH8, RTC\_GPIO8 |
| IO25 | 10 | I/O | GPIO25, DAC\_1, ADC2\_CH8, RTC\_GPIO6 |
|  |  |  |  |
| IO26 | 11 | I/O | GPIO26, DAC\_2, ADC2\_CH9, RTC\_GPIO7 |
| IO27 | 12 | I/O | GPIO27, ADC2\_CH7, TOUCH7 RTC\_GPIO17 |
| IO14 | 13 | I/O | GPIO14, ADC2\_CH6, TOUCH6, RTC\_GPIO16 |
| IO12 | 14 | I/O | GPIO12, ADC2\_CH5, TOUCH5,  RTC\_GPIO15 |
| GND | 15 | P | Ground |
| IO13 | 16 | I/O | GPIO13, ADC2\_CH4, TOUCH4,  RTC\_GPIO14 |
| SHD/SD2 | 17 | I/O | GPIO9, SD\_DATA2, U1RXD |
| SWP/SD3 | 18 | I/O | GPIO10, SD\_DATA3, U1TXD |
| SCS/CMD | 19 | I/O | GPIO11, SD\_CMD, U1RTS |
| SCK/CLK | 20 | I/O | GPIO6, SD\_CLK, U1CTS |
| SDO/SD0 | 21 | I/O | GPIO7, SD\_DATA0, U2RTS |
| SDI/SD1 | 22 | I/O | GPIO8, SD\_DATA1, U2CTS |
| IO15 | 23 | I/O | GPIO15, ADC2\_CH3, TOUCH3, RTC\_GPIO13 |
| IO2 | 24 | I/O | GPIO2, ADC2\_CH2, TOUCH2, RTC\_GPIO12 |
| IO0 | 25 | I/O | GPIO0, ADC2\_CH1, TOUCH1, RTC\_GPIO11, CLK\_OUT1 |
| IO4 | 26 | I/O | GPIO4, ADC2\_CH0, TOUCH0, RTC\_GPIO10 |
| IO16 | 27 | I/O | GPIO16, HS1\_DATA4, U2RXD |
| IO17 | 28 | I/O | GPIO17, HS1\_DATA5, U2TXD |
| IO5 | 29 | I/O | GPIO5, HS1\_DATA6 |
| IO18 | 30 | I/O | GPIO18, HS1\_DATA7 |
| IO19 | 31 | I/O | GPIO19, U0CTS |
| NC | 32 | - | - |
| IO21 | 33 | I/O | GPIO21, VSPIHD |
| RXD0 | 34 | I/O | GPIO3, U0RXD, CLK\_OUT2 |
| TXD0 | 35 | I/O | GPIO1, U0TXD, CLK\_OUT3 |
| IO22 | 36 | I/O | GPIO22, VSPIWP, U0RTS |
| IO23 | 37 | I/O | GPIO23, VSPID |
| GND | 38 | P | Ground |



Hình 1.5.3 Sơ đồ bố trí chân của module ESP32-WOOM-32

* + 1. ***Chức năng tích hợp trong ESP32***

**CPU và kiến trúc bộ nhớ**

**CPU**

Chip ESP32 là bộ xử lý lõi kép (Dual core) của vi điều khiển Xtensa® 32bit LX6 với các đặc trưng:

Hổ trợ xung nhịp lên đến 240MHz.

Hổ trợ DSP như bộ nhân 32bit, bộ chia 32bit, MAC 40bit.

Hổ trợ 32 vector interrupt.

**Bộ nhớ nội (Internal Memory)**

* Bộ nhớ nội của ESP32 bao gồm:

448KB ROM cho việc khởi động và các chức năng cốt lõi.

520KB SRAM trên chip cho dữ liệu.

8KB SRAM trong RTC (Real Time Control): được gọi là bộ nhớ RTC FAST.

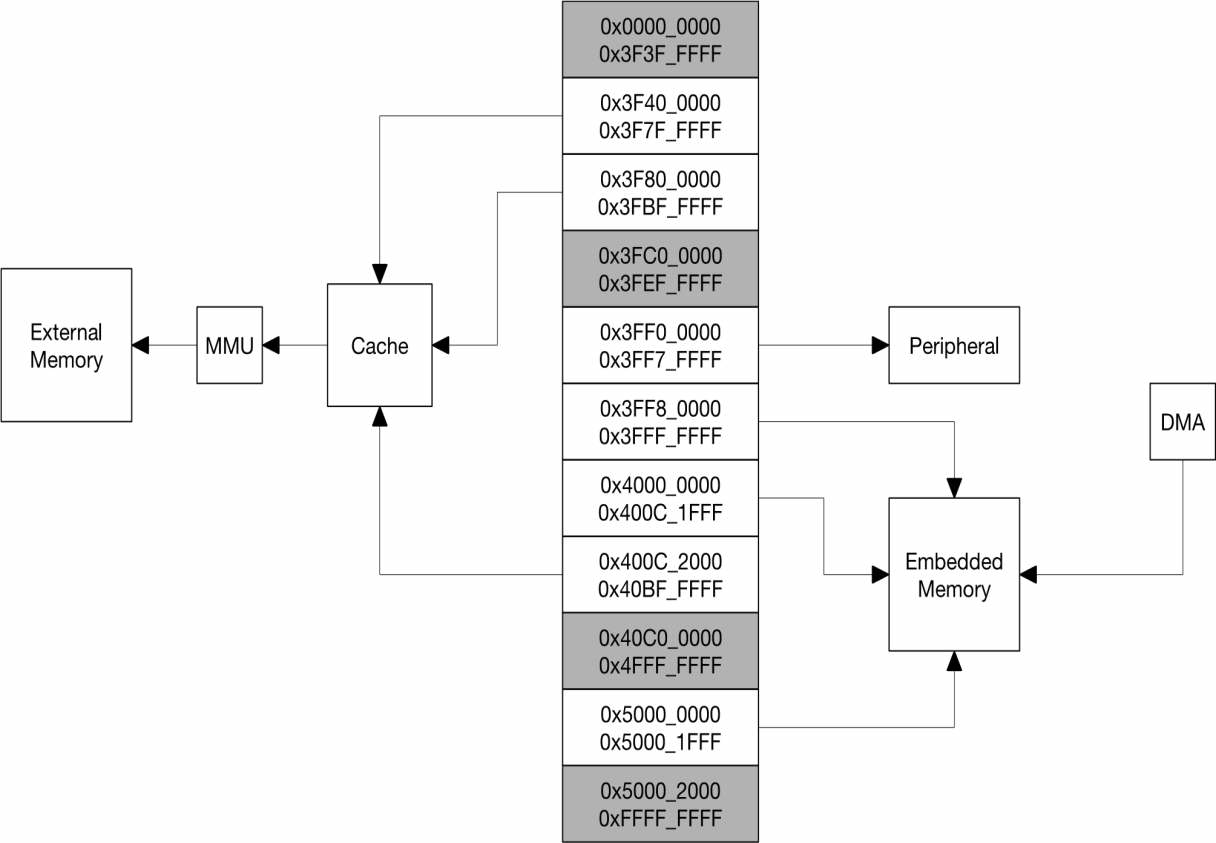
8KB SRAM trong RTC: được gọi là bộ nhớ RTC LOW.

1Kbit eFuse: 256bit sử dụng cho hệ thống, 768bit chuyển đổi cho ứng dụng.

**External Flash (bộ nhớ flash ngoài) và SRAM**

ESP32 hổ trợ nhiều external QSPI flash và SRAM, có thể truy cập ở tốc độ cao. SRAM được hổ trợ lên đến 8MB, đọc và ghi 8bit, 16bit, 32bit.

**Tổ chức bộ nhớ**



Hình 1.5.4 Cấu trúc và địa chỉ bộ nhớ của ESP32

**Timers và Watchdogs**

**Timer 64bit**

* Có 4 Timer bên trong ESP32. Chúng đều là bộ định thời 64bit dựa trên bộ chia trước 16bit và bộ định thời đếm lên, xuống.
* Đặc trưng của Timer:
* Bộ chia 16bit từ 2 đến 65536.
* Timer 64bit.
* Cho phép cấu hình Timer đếm lên, đếm xuống.
* Cho phép dừng và tiếp tục bộ đếm thời gian.

**Timer Watchdogs (Bộ định thời giám sát)**

ESP32 có 3 Timer Watchdogs bao gồm 2 module hẹn giờ (Main Watchdogs Timer) và một module RTC (RTC Watchdog Timer). Một bộ đếm thời gian Watchdog có 4 giai đoạn, mỗi giai đoạn có thể kích hoạt một trong bốn hành động là: ngắt, thiết lặp lại CPU, thiết lặp lại lõi, thiết lặp lại hệ thống.

**Hệ thống xung đồng hồ (Clock)**

**CPU Clock**

Khi được reset, dao động thạch anh bên ngoài được đặt lại mặc định cho CPU. Dao động thạch anh kết nối với PLL (Phase-Locked Loop) để tạo ra xung tần số cao (160MHz).

Ngoài ra, ESP32 có bộ dao động nội 8MHz và có thể sử dụng được bộ dao động này cho một số ứng dụng nhất định.

**RTC Clock (Real Time Clock)**

RTC Clock có các nguồn hoạt động:

* Thạch anh bên ngoài tốc độ thấp (32KHz).
* Thạch anh bên ngoài với bộ chia 4.
* Bộ dao động nội RC (150KHz, có thể điều chỉnh được).
* Bộ dao động nội 8MHz.
* Xung nội 32.25KHz.

Khi ở chế độ bình thường, cần truy cập CPU nhanh hơn, ứng dụng có thể chọn xung tốc độ cao bên ngoài với bộ chia 4 hoặc dao động nội 8MHz. Khi hoạt động ở chế độ năng lượng thấp, ứng dụng có thể chọn thạch anh bên ngoài tốc độ thấp (32KHz), dao động nội RC hoặc xung nội 31.25KHz.

**Wifi**

ESP32 thực hiện giao thức TCP/IP và Wifi 802.11 b/g/n, quản lý năng lượng được xử lý để giảm thiểu thời gian thực hiện các tác vụ. Các thư viện của Wifi cung cấp để định cấu hình và giám sát chức năng kết nối mạng ESP32, nó cấu hình cho:

* Chế độ trạm (hay chế độ STA hoặc chế độ Wifi client): ESP32 kết nối với một điểm truy cập.
* Chế độ AP (hay chế độ Soft-AP hoặc chế độ điểm truy cập): các trạm kết nối với ESP32.
* Chế độ kết hợp AP-STA (ESP32 đồng thời là điểm truy cập và là trạm được kết nối với các điểm truy cập khác).
* Các chế độ bảo mật khác nhau cho các chế độ trên (WPA, WPA2, WEP, …).
* Quét các điểm truy cập (chủ động và thụ động).
* Chế độ giám sát các gói Wifi của tiêu chuẩn IEEE802.11.

**Bluetooth**

ESP32 tích hợp bộ điều khiển liên kết Bluetooth, thực hiện các giao thức như điều chế, giải điều chế, xử lý gói, xử lý luồng bit, …

**RTC và quản lý năng lượng thấp**

Với việc sử dụng công nghệ quản lý năng lượng tiên tiến, ESP32 có thể chuyển đổi giữa các chế độ năng lượng khác nhau. Bao gồm các chế độ:

**Chế độ hoạt động**

Chip được bật, có thể truyền, nhận.

**Chế độ ngủ modem**

CPU được hoạt động và xung đồng hồ có thể cấu hình. Wifi/Bluetooth bị tắt.

**Chế độ ngủ light**

CPU tạm dừng hoạt động. Bộ nhớ RTC và các thiết bị ngoại vi RTC cũng như bộ xử lý đồng thời ULP vẫn chạy. Bất kỳ sự kiện đánh thức nào sẽ đánh thức chip hoạt động.

**Chế độ ngủ sâu**

Chỉ bật bộ nhớ RTC và thiết bị ngoại vi RTC. Dữ liệu kết nối Wifi và Bluetooth được lưu trữ trong bộ nhớ RTC.

**Chế độ ngủ đông**

Bộ tạo dao động nội 8MHz và bộ đồng xử lý ULP bị tắt. Bộ nhớ RTC khôi phục bị tắt. Chỉ có bộ đếm thời gian RTC và một số RTC GPIO nhất định hoạt động.

* + 1. ***Thiết bị ngoại vi và cảm biến của ESP32***
* GPIO (General Purpose Input/Output Interface)

ESP32 với số lượng lớn chân GPIO tùy thuộc vào từng phiên bản module, mỗi chân được tích hợp nhiều chức năng khác nhau bằng cách lập trình thanh ghi. Có một số loại chân GPIO như: chỉ đọc dữ liệu số (0 hoặc 1), cho phép analog, cho phép cảm ứng điện dung, …

Hầu hết các chân GPIO số (digital) có thể được cấu hình điện trở kéo lên (pull- up) hoặc kéo xuống (pull-down) hoặc trở kháng cao. Mỗi chân có thể có nhiều chức năng khác nhau như SDIO, UART, SPI,

* ADC (Analog to Digital Converter)

ESP32 tích hợp ADC 12bit và hổ trợ đo 18 kênh. Với thiết lập thích hợp, các ADC có thể được cấu hình để đo điện áp tối đa 18 chân.

* DAC (Digital to Analog Converter)

ESP32 có hai kênh DAC 8bit được sử dụng để chuyển đổi tín hiệu số sang tín

hiệu analog, được tích hợp điện trở và bộ đệm.

* Touch Sensor (Cảm ứng điện dung)

ESP32 có 10 chân GPIO sử dụng được cảm ứng điện dung, phát hiện vật thể bằng cách chạm vào các chân GPIO.

* Bộ điều khiển SDIO/SPI

ESP32 tích hợp giao tiếp thiết bị SD phù hợp với tiêu chuẩn SDIO, hổ trợ các tính năng sau:

* Chế độ truyền SPI, SPIO 1bit, SPIO 4bit.
* Truy cập trực tiếp đến máy chủ.
* Ngắt để bắt đầu truyền dữ liệu.
* Kích thước khối dữ liệu lên đến 512 byte.
* UART (Universal Asynchronous Receiver Transmitter)

ESP32 tích hợp ba UART: UART1, UART2, UART3 cung cấp chuẩn giao tiếp bất đồng bộ (RS232 và RS485) với tốc độ lên đến 5Mbps, có thể truy cập bởi bộ điều khiển DMA hoặc trực tiếp bởi CPU.

* I2C Interface (Inter-Integrated Circuit)

ESP32 có hai giao tiếp I2C, có thể vận hành ở chế độ master hoặc slave phụ thuộc vào người sử dụng cấu hình, nó hổ trợ:

* Chế độ tiêu chuẩn (100Kbit/s).
* Chế độ nhanh (400Kbit/s).
* Tốc độ lên đến 5MHz.
* Chế độ kép.
* I2S Interface (Inter-IC Sound)

Hai giao tiếp I2S có sẵn trên ESP32, có thể hoạt động ở chế độ master hoặc slave. Và được cấu hình để hoạt động ở độ phân giải 8/16/32/48/64bit làm kênh đầu vào hoặc đầu ra. Hổ trợ tần số từ 10KHz đến 40KHz.

* Điều khiển hồng ngoại từ xa (Infrared Remote Controller)

Bộ điều khiển hồng ngoại từ xa hổ trợ 8 kênh điều khiển truyền và nhận. Hổ trợ các giao thức hồng ngoại khác nhau.

* Bộ đếm (Pulse Counter)

Bộ đếm counter có 7 chế độ. Có 8 kênh mỗi kênh thu được 4 tín hiệu cùng một lúc. Bốn tín hiệu đầu vào bao gồm 2 tín hiệu xung và 2 tín hiệu điều khiển.Khi bộ đếm đạt được đến ngưỡng đặt, thì một interrupt được tạo ra.

* PWM (Pulse Width Modulation)

Bộ điều khiển độ rộng xung (PWM) được sử dụng để điều khiển động cơ kỹ thuật số và đèn thông minh. Bộ điều khiển bao gồm: định thời PWM, hệ thống PWM và các module chuyên dụng. Mỗi bộ định thời cung cấp thời gian ở dạng đồng bộ hoặc độc lập.

* SPI (Serial Peripheral Interface)

ESP32 có ba SPI (SPI, HSPI, VSPI) ở chế độ master và slave.

Tất cả SPI có thể kết nối đến Flash/SRAM và LCD.

* + 1. ***Đặc tính về điện***

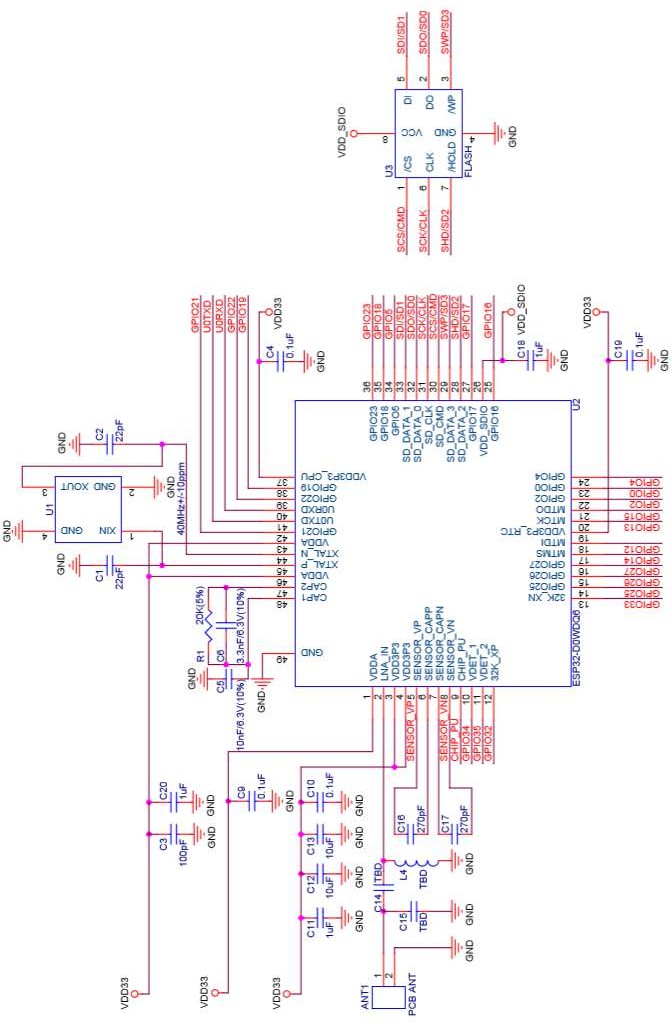
Các giới hạn đề nghị để module ESP32-WOOM-32 hoạt động tốt.

Các thông số đề nghị cho module ESP32-WOOM-32

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Ký hiệu** | **Chức năng** | **Min** | **Đề nghị** | **Max** | **Đơn vị** |
| VDD | Điện áp cung cấp | 2.7 | 3.3 | 3.6 | V |
| I | Dòng cung cấp | 0.5 | - | - | A |
| T | Nhiệt độ | -40 | +25 | +85 | ℃ |

Module hoạt động ổn định ở điện áp 3.3V, nhiệt độ 25℃

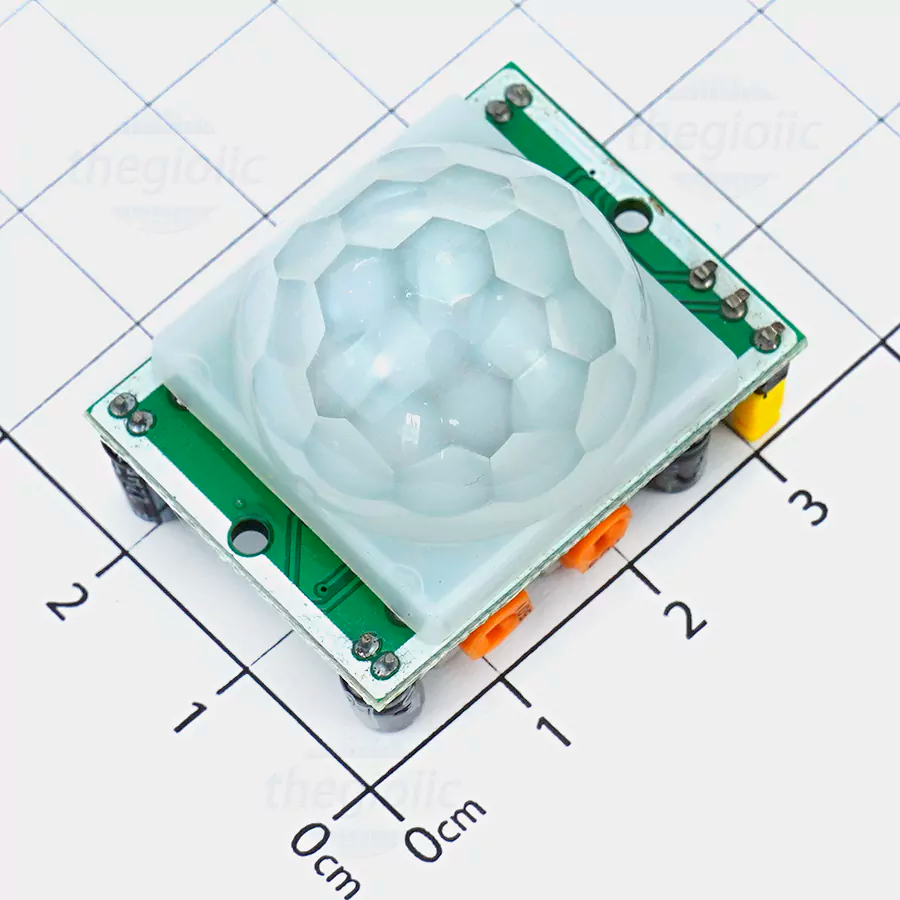
* + 1. ***Sơ đồ nguyên lý module ESP32-WOOM-32***



Hình 1.5.7 Sơ đồ nguyên lý module

**1.6 Giới thiệu Cảm biến chuyển động PIR**

**1.6.1 Tổng quan**

PIR là viết tắt của Passive InfraRed, cảm biến chuyển động PIR là bộ cảm biến điện tử thụ động, có thể nhận tín hiệu hồng ngoại phát ra từ người, động vật hay từ các nguồn phát bất kỳ. Đặc điểm của loại cảm biến này là không phát ra bất kỳ nguồn hồng ngoại nào. Cảm biến PIR thường được sử dụng trong báo động an ninh và các ứng dụng chiếu sáng tự động.  


[Cảm biến chuyển động HC-SR501](https://www.thegioiic.com/hc-sr501-cam-bien-chuyen-dong-pir)

Về mặt kỹ thuật, PIR được làm bằng một cảm biến nhiệt điện, có thể phát hiện các mức bức xạ hồng ngoại khác nhau. Ví dụ, mọi thứ phát ra bức xạ ở mức độ khác nhau và mức độ bức xạ sẽ tăng lên khi nhiệt độ của vật thể tăng lên. Trên thực tế, máy dò chuyển động được tách biệt bởi hai phần vì thay đổi chuyển động là những gì chúng ta quan tâm, chứ không phải mức IR. Đầu ra sẽ tăng cao hoặc thấp nếu một nửa bức xạ IR khác với nửa kia của cảm biến.  
**1.6.2 Cấu tạo và nguyên lý hoạt động**  
Một bộ cảm biến chuyển động PIR cơ bản gồm có 3 bộ phận chính: đầu dò cảm biến nhiệt IR, kính Fresnel và mạch khuếch đại tín hiệu ngõ ra.  
![A diagram of a person's diagram

Description automatically generated](data:image/jpeg;base64,/9j/7gAOQWRvYmUAZAAAAAAB/+ERXkV4aWYAAE1NACoAAAAIAAgBDgACAAAANgAACHoBOwACAAAAEgAACLBHRgADAAAAAQAFAABHSQADAAAAAQBjAACHaQAEAAAAAQAACMKcmwABAAAAUAAAEOKcnQABAAAAJAAAETLqHAAHAAAIDAAAAG4AAAAAHOoAAAAIAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABOZ3V5w6puIGzDvSBsw6BtIHZp4buHYyBj4bqjbSBiaeG6v24gY2h1eeG7g24gxJHhu5luZwB3d3cudGhlZ2lvaWljLmNvbQAAAeocAAcAAAgMAAAI1AAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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Cách hoạt động của cảm biến chuyển động

Loại cảm biến này sử dụng một cặp cảm biến nhiệt để phát hiện ánh sáng hồng ngoại từ môi trường xung quanh. Hai cảm biến này được thiết kế nằm cạnh nhau để tạo sự chênh lệch về tín hiệu từ đó xác định chuyển động. Có 2 vùng phát hiện hồng ngoại tương ứng với 2 đầu cảm biến của đầu dò. Khi có nguồn nhiệt đi qua, ánh sáng hồng ngoại từ nguồn nhiệt hội tụ lại vào một trong hai cảm biến bằng cách sử dụng thấu kính Fresnel. Những thấu kính này giúp mở rộng vùng cảm nhận của cảm biến và được đặt bao phủ bên ngoài cảm biến. Cảm biến nhận ánh sáng hồng ngoại và xuất tín hiệu ngõ ra. Tín hiệu này được cho vào mạch khuếch đại và xử lý để tạo thành tín hiệu điều khiển cho các ứng dụng. 

Vật liệu Pyroelectric được kẹp giữa hai bản cực, khi có sự kích thích từ ánh sáng hồng ngoại, trên hai bản cực sẽ xuất hiện tín hiệu điện, nhưng tín hiệu này khá yếu nên cần có mạch khuếch đại.  
![Diagram of a red rectangular object with arrows and lines

Description automatically generated](data:image/jpeg;base64,/9j/7gAOQWRvYmUAZAAAAAAB/+ERGEV4aWYAAE1NACoAAAAIAAgBDgACAAAAGQAACHoBOwACAAAAEgAACJRHRgADAAAAAQAFAABHSQADAAAAAQBjAACHaQAEAAAAAQAACKacmwABAAAAJgAAEMacnQABAAAAJAAAEOzqHAAHAAAIDAAAAG4AAAAAHOoAAAAIAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABD4bqjbSBiaeG6v24gbmhp4buHdCBQSVIAAHd3dy50aGVnaW9paWMuY29tAAAB6hwABwAACAwAAAi4AAAAABzqAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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 
Trong đầu dò PIR, người ta gắn 2 cảm biến nhiệt nằm ngang. Khi cảm biến Pyroelectric thứ nhất nhận được tia nhiệt, nó sẽ phát ra tín hiệu và khi nguồn phát di chuyển ngang, sẽ đến cảm biến Pyroelectric thứ hai nhận được tia nhiệt và nó lại phát ra tín hiệu điện. Sự xuất hiện của 2 tín hiệu này cho nhận biết là đã có một nguồn nhiệtdi động ngang và mạch điện tử sẽ phát ra tín hiệu điều khiển.

**1.6.3 Ứng dụng**

PIR có thể phát hiện chuyển động của động vật / con người trong một phạm vi yêu cầu, được xác định bởi thông số kỹ thuật của cảm biến cụ thể. Bản thân cảm biến không phát ra bất kỳ năng lượng nào mà tiếp nhận một cách thụ động, phát hiện bức xạ hồng ngoại từ môi trường. Khi có bức xạ hồng ngoại từ cơ thể người hay vật với nhiệt độ, tập trung vào hệ thống quang học khiến thiết bị nhiệt ra tín hiệu điện đột ngột và báo động được phát ra hay để điều khiển thiết bị.  
Cảm biến chuyển động rất hữu ích khi chúng hoạt động cùng với các thiết bị khác như camera an ninh, đèn chiếu sáng... Trên thực tế, cảm biến này được sử dụng phổ biến nhất để bảo vệ tài sản và cảnh báo xâm nhập trái phép trong nhà. Ngày nay, cảm biến chuyển động cũng được tích hợp vào một số công nghệ mới như cửa tự động, điện thoại thông minh, tay cầm chơi game, robot...  
![A person walking with a light bulb

Description automatically generated](data:image/jpeg;base64,/9j/7gAOQWRvYmUAZAAAAAAB/+ERQEV4aWYAAE1NACoAAAAIAAgBDgACAAAAKwAACHoBOwACAAAAEgAACKZHRgADAAAAAQAFAABHSQADAAAAAQBjAACHaQAEAAAAAQAACLicmwABAAAAPAAAENicnQABAAAAJAAAERTqHAAHAAAIDAAAAG4AAAAAHOoAAAAIAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAADhu6huZyBk4bulbmcgY+G6o20gYmnhur9uIGNodXnhu4NuIMSR4buZbmcAAHd3dy50aGVnaW9paWMuY29tAAAB6hwABwAACAwAAAjKAAAAABzqAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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ICAgICAgICAgICAg863Zwe37l7Z55gNzgZU0eV2Ost74HjUF0sR92T8j9Cggy5LY6zGMhv+N3AdNdj9wqbZWNI/wCkpZXRP/jag+EgIO7ba5JUYduFhGV0sz6efHL5b7g2aM6OAp6hjzp8oCCdlZa+K6Wm13KB/vIbjRwVMT/S2WMOB/jQfUQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEFpc0a6uA011+ZBpn7+vMrtG08V32h2KuNNfdyJ430uR5fC4TUlkDxo6OEjVslRofkZ46lBGtudyrbvX1t0uVVJX3G4zyVNfXTOL5JppXF75HuPElxOpQfPQEFzS4HVuvUNCCOYOvBBOu2ZfUv2l21fWhwq341bDUdXA9X2ZmuqD0xAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBBxSTxQskkmkbFFE1z5ZXkNa1rRq5znHgABzJQaCvMJ8y9sYvOyXbrfQ95ElHmu5FG7gNdWyUdvkHzh8g+RvpQaBXzOlkkllkdLLKXPmkkJc5znHUkk8SSeJKD86AgqATyQezdve1l43n3m2824s9OZ5sivNNHWnQlsdJHIJKmR+nINja4oJwttpILXb6G2wNEdPb6eKmha0cA2JgYB/AEH7wQeSCqAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAg/Bc7pbrNQVl1u1dBbbZb4XVFfcKmRsUMMTBq58j3EBoA8SUEbfzBfMmrtzai67O7C3eote3cL30uU5rTExVF6eNWuipnDR0dN6/rP9Q4INL3UNANPlQcaAgqBqQBzKDkjje57WMaXvcQ1jGjqLiToAAOepQScfKy7NKvZ3Ept79xrQaLcTOKURY5a6huk1rtMnHVzT9WWo4EjmG8PFBm73c9zmK9rO0l2zy7OirsjrQ+jwjHOsNkr7hI32OHP3cf1pDpwCDxHy6O7+p7oNs7pR5pXQP3UwqqczI4YgIxU0k7i6mqoo/BunsO9YQbFWuDtdPA6FBcgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgILS4A6H0a/Mg63luYYzgmPXXLcwvNNj2OWSB1TdLtWPEcMUbBrqSeJJ8AOJ8EEXDv28w7I+426XDbrbeqqsd2VoKgtc1pMNVfXxnQTVXSeER01bH/hehBq6LtdNNRpyHoQWoCCoHUQB4oP0QU09RPDT08Tqmone2OCniaXvke46Na1o1JJJ0ACCQR5dXluvtT7Jvv3AWIC5MLKzA9u61g/InnHW3CN34XiyM8ubvQg3E71b2bebAYDddwdxb1FabLb2FtLTAj7RW1AHsU1LFrq97jw0HAczoEEQLur7nM07pN0LjneTSvorNTl1Lh2LMeXQW2iafZYByL383u04lB+PtU7gb922b0YpuTaJZX22mnbSZZa2nRtba5iGzxOHLUD2mnwIQTRsRyiyZpjFiy/Ga1lzx/JKKG42etjIIkgqGB7DwJ4gHQjwKDsgII1HzoKoCAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgoTpp60Hne6O6ODbOYZeM/3Dv1Pj2NWWIvqKyZw6pH6exDAz60kjzwa1oQRQu9bvtzvuryOS00Lp8W2is07v8AZ7EI3kOqi0kNq68t+vI4cQ3k35eKDAYnUk6aa+AQUQEFQNSAg73t1trm262X2rBtv8fq8lya8S9FJb6SMuLW68ZZXco2N5uc4gBBJx7LPLVwLt8ht2eblMpM93dLGzRySNEltszyNXMpWO/ykjddDI4fzR4oMse6Hul277VsFbl+cyz1lfczJT4tjVI3We41bWFwjDvqsaPwnE8Agic9zndPud3SZu/K89rzBaqNzo8YxCle4UFtpyeDI2/hPI+s8jU+rkgxpLtUAEDXhrqgkCeUB3VuqYLh2yZnc9ZqcS3PbGeofzj+tVUDXOPgfbYPWQOSDfo3QDhyQXICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAg823b3Uw3ZbAMh3Izy5ttmN45TmapfqPeTSHhHBC38KSR3BoCCIT3c94O4ndZnVTd79VS2rBbXM9uF4PE8imo4NdGySgcJJngaucfkHAIMQydST6UFEBBeGjiCePqQZc9qnZnut3V5MyjxWhdZsKoJmtyPPq2NzaKmZr7TIj/0sunJjflOgQSpe2vtR2k7XcVjx/b+yNfeKljRkGaVjGuuNwkA4ukk49DNSeljeAQZM9Pya+nRBjT3X9t+N9zuz2RbeXhkdPejE6sw6+OaC+hucQJheDzDHH2Xj8UlBDHzjDch29yvIMIyy3y2rI8XrprddqCVpa6OWF3SdQfA8wfEIOpoCDtuC5lkG3mXY7nGK1z7bkOL18NwtVZGdCyWFwcB6weRHoQTSu2Lf3H+4/ZzFNzbE9ram5QCnyK2tOpo7lAA2phcPAdXtN9LSEGQoQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEFrteQPEoIw3m3dzdy3C3dbsZYq4swna5zTeIYn+xW3mZge90mnMQMcGtHgS5Bp/J6vUgogIORsZfoGAueSAGgakk/Ig2+dkvlfZXvGbVuRvhT1mGbZPcyotuOlrobnemcHNOh4wQO/GI1P4PpQST8JwTEduMbtmIYPYKPGsbs8LYLfaqGNsUTGtGmpDebjzJPEoO1hoGmnDTkguQWuALTr4cUGirzce0Q361x9y+B2rrutiiZS7n0VMz2pqMaNhr+kczF9V5/F4nkgjvPa1oHS7UnmEHGgqDog2geV/wB1jth9324DlFx9xttupPDRVplcRFQXT6lLVDXgOvX3bz6NPQglcsIc0EEEHiCOIIPiEFyAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICD5l6uDLRZ7rdpBrHa6OerePSII3PP9xBBU3UympzbcvPcuq3OdPkV/uFcS46kNmne5g19TdAg6CgIOz4lh+S53kFrxTDrFW5Hkd6lbBbbRQxGWaWR3INa3w9JPJBI97JfK3xzaz9E7mb/AFJS5XuFGI6q04eSJrbaJB7TXSg+zPM316tB5INyjIo2NAY0NaAA1o4AAcgAg5EBAQEHzLxabbfLXcbNd6KK42q608tJcaCdodHNBM0skje08CHNJBQQ8e+3tYr+17em52Sip5ZNvcrMt1wC5O4g0rnavpXO/Hgcek+kaFBhMQBy/hQWoOeF8kTo5InOjljcHxytJBaWnUOBHiCglp+W13Y0vcNszRYxkFeHbnbYwQ23JIZCPeVlG0dNJXNHM9TW9D/5TdfFBshHIIKoCAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAg8m34vcWObLbqXuZ/u47fi10eX66aE0z2j+MoIL8j3SPdI86vkcXPd6STqT/GgsQEG/wB8k7baklbu7utV0MUlbTPpcfs1ZIwF8YkaZpzG4jVuugadCg3+hrdNANB6EFyAgICAgoQCCCNQeYQYhd6fa/Z+6XZm74b0Q0mZ2ZrrngN6e0awXCJpIic7n7uYew/5dfBBDfybHrzid/u+MZFbpbTfbBVy0F3t04LZIaiBxY9jgfQQg+CgqCR4/IgyZ7Su4S89tW9uKbj0Mkk1njlFDl9sa4htVbKhwbO0gc3MHtt9Y9aCaDjOS2bMMdsmU47Xx3GxZBRQXC010RDmSw1DQ9hBGvp0PoKDsKAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgIMRO/S8Q2PtD32rJZTCZMckpoXA6EvmljYAPl1QQvz4IKILgBoSefgEEuHys8DOE9oGD1U9OIazNaqsv8kvSA58VTJpASeZ0a3gg2MoCAgICAgILHjUev+AoI/3m69pEomg7ncGtQdC4R0W6dJTx8Wu+rBcS1o5EaMkPyOJQaCn6BxAGiCxBUEjkfUgkP+T53Quu9lu3bVmF0dJX2Nj7ttu+d+pdRE/0qiZ1f9W4h7APAuQb2xyHh6kFUBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBAQEBBrb8129Gz9nGYxh3T+mrxarceOmokkdJp/8NBEoPggog+ha7fU3e4W+1UbPeVdzqoaSlYOJdJO8MYAPWSEE6baHDaPb7a3b7CaCEQUuMWChoI4Rx6TFC0OGv8AO1QejICAgICAgICD4WTY7Z8tx+9YxkFDFc7JkFHNQXW3zNDmSwTtLHtIII5FBDU7ye2i9dr29N8wepiknxS4udcsDu7tSKm2SuPQ3q/Hi+o/1j1oMTHc0FEHpO0m5N82h3Gw3cnHJ3QXfD7pBXwtaS33sbHD3sLiD9WRhc0oJum1+4Fj3W2/xDcXGqltVZcutkFxo3sOvSZWgvYfWxwLT8iDv6AgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAg05edHlD7d2/YFirfq5RlraiT5LdTucP450EZE/3EFEGWXY7gB3K7p9mscdH10sF+hutdqNR7q2g1Z1BHiYgEE0hoAaABoBwA+RBcgICAgI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Ứng dụng cảm biến chuyển động để bật tắt đèn tự động

### **1.7 Giới thiệu cảm biến âm thanh**

1.7.1 Tổng quan

A red and silver electronic device

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[KY-037 Cảm Biến Âm Thanh](https://www.thegioiic.com/max4466-cam-bien-am-thanh)

Cảm biến âm thanh là một thiết bị được sử dụng với mục đích là để phát hiện ra những cường độ âm thanh xung quanh trong khu vực. Chúng có nhiều ứng dụng trong đời sống từ chuyển đổi tín hiệu, giám sát hay bảo mật,.. Với độ chính xác và độ nhạy rất cao, cảm biến âm thanh có thể điều chỉnh và thay đổi phù hợp giúp người dùng có thể dễ dàng sử dụng.

Có khả năng xác định được mức độ nhiễu cấp DB (decibel) với khoảng tần số từ 3kHz – 6kHz xấp xỉ mức tần số nghe mà tai người có thể cảm nhận được. Vậy cảm biến âm thanh được cấu tạo như thế nào để làm đc điều đó.

### **1.7.2 Cấu tạo và nguyên lý hoạt động**

Trong một thiết bị cảm biến âm thanh sẽ có cấu tạo gồm các phần như là màng loa, biến trở, IC điện trở, tụ điện, chân pin,..

Phần chân pin là nơi đóng vai trò quan trọng trong 1 thiết bị âm thanh. Tại đây sẽ có 3 phần chân pin khác nhau để giúp thực hiện hoạt động của cảm biến gồm:

* Chân pin 1 (VCC): 4 V – 6V.
* Chân pin 2 (GND): là chân nối Mass.
* Chân pin 3 (OUT): là chân đầu ra của tín hiệu số.

![A diagram of a circuit

Description automatically generated](data:image/jpeg;base64,/9j/7gAOQWRvYmUAZAAAAAAB/+ERrEV4aWYAAE1NACoAAAAIAAcBDgACAAAAOAAACG4BOwACAAAAEgAACKaHaQAEAAAAAQAACLicmwABAAAAVAAAENicnQABAAAAJAAAESycnwABAAAAVAAAEVDqHAAHAAAIDAAAAGIAAAAAHOoAAAAIAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABD4bqjbSBiaeG6v24gw6JtIHRoYW5oIGhv4bqhdCDEkeG7mW5nIG5oxrAgdGjhur8gbsOgbyA/AHd3dy50aGVnaW9paWMuY29tAAAB6hwABwAACAwAAAjKAAAAABzqAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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z0a+2sEsvk/wDkqjOrNT0t7zIb6e9/58TcuXLly5cuXLl/KTGkMaQxp3u48kfswxbon3mhjkftBfnGlmW56tzBOl+8DFPpKu73K97g69a/fwxHuU7FcH6SCJCVK4VK4VKhGVK4nCpX0gcCXGHBhwdIcGEYw4P0icNuDNpfB04bA3i0q1CUIjDgwhH6RGMvgsGXwGXBcV6xVbly+C8bl8SP0piX26+yXpy3mh9R+5qeTHq/+TdcSx48Z1idgy18a6LgpinQhu75fv5xp8xHTTq9maDy18nWBQPV83so9hUXzf5NT4zWmvxynuLPYPm5e9MfGpZXBbhi+vy65fbv6evjcv8A6apBqNH7fvy/Eqg8bvEy1Bla9GvqLQ9fyiWxrb71UUsun+TPlG7z/wBxf//aAAgBAwMBPxD/AO0Rz6P4jsGBkXgjycs/UOr0fxMxe5MMOpNXkfz8a4a8pgHVmCeAuDf0/r+RNHmfiZt4aR0TnBp8npvHkfT/AD5+Te2n/j/Y4+5+03r41zneOXO0co5kdGZI8iOUdq5cv5w5fBt/kX8vuys43/Pwlf76eCXo7Pc71K1OUMwzOfSbX3B9G3K7h9x+YqfIv+n7Jot+bzomF3v/AI/yYD5Hu+GJBdP5hwbWV/npL7oe8TQur8fQ7nWMuGIYle8S5UqVKlSpUqVKld0mCvWLdugfaafM/j6LXujsXwH52Laiv1e23jrPbv2cdojinTvllx1l8b43Ljxvi8b4anOn8fONqjntuXy77fhvE7JrKhHgESEI8CVw2TmPyA59H8RWPKOqdH8wZDaPI6fuGrdYIrHlxK3hD5Fgnn+uBGEJXEwjrwEeBBcXd96uObOR+rhwC0IrPj9Xo/iYDymtdH8x5m+EeR0fzD6PGZq9H8TS8vk4wdF/HAI8KmeFRhKiSmVGEVN8Ajmt/wDK/EDg6Yh8iriYgfEdY618Nc17nBrxZrN1cVaG7Bsv58Eu3Px6rMr1a+sd68FviYTlBj6RZcuXLly5cuXLh9NVKlcUpqOtRINyu42ro+P3NH0uM/SK0IDNoNXn8xuXwv5a6nymVO/6mTcPl99oj8rcRxHHy++6HtEdZXeXeGVl8bHwmQ+efvNL7/efv/OP13uz0H8Tm6n7m/qfzM9YHoZs6l/eI010l242joef6Zgldf18TUqVKlSpUqVKlfKXMcxz3uz5P4jmnU9pefRPvFUMMSjHQqOR617Rc2es0qud+yRNOnwzDuR7C8B+klg8FweFweFy4wly+LwuX9IPBlQi8DWPA1jwIwhrHgH0i8N+BN5XA14bnlAsclg2GEeBHWMPpFISuARJXBJUwgVpAoqVK4BK4VK7B9KZldu/ulbc9pt9H+TSc2fQm24hDsPxptqK4D1Iqquf6+cfugsvZ7wyHP8AMu0+n2jxj494djVW/wDZpfGaE0er+Z7ZNPmfj5uHevxo03wCo5rp8uqV26+nq41K/wCmotmXz5fqXl8bHFwXEl6dfqLU9Pwg0V0o9lgNBr/qFVj/ALi//9k=)

Cảm biến âm thanh hoạt động dựa theo cơ chế ở tai người, bằng cách nhận diện những rung động trong môi trường để chuyển nó thành tín hiệu điện. Nguyên nhân là do khi có bất kỳ nguồn âm thanh nào phát ra trong không khí cũng sẽ khiến cho các phân tử không khí ở bề mặt bị rung động làm cho những phân tử không khí bên cạnh chúng cũng sẽ rung động theo.

Với phần màng loa được thiết kế cùng nhiều nam châm được xoắn bằng dây kim loại để tạo thành. Khi có tín hiệu âm thanh chạm vào phần màng loa thì phần nam châm này trong cảm biến sẽ bắt đầu rung động, từ cuộn dây kim loại có thể kích thích tạo thành dòng điện. Tín hiệu điện sẽ được truyền qua các thiết bị lọc và xử lý có trong cảm biến, chuyển thông tin tín hiệu thành dạng 0 và 1. Từ đó sẽ giúp phát hiện, nhận biết được âm thanh.

Dựa vào thông số hiển thị ở chân pin 3 (chân OUT) mà chúng ta có thể biết được âm thanh ở mức độ nào: Chân pin 3 (chân pin OUT) hiện 1 là mức bình thường cao. Khi có âm thanh và tiếng động vượt quá ngưỡng so sánh thì lúc này chân pin 3 sẽ hiện 0 là mức thấp.

### **1.7.3 Ứng dụng**

Cảm biến âm thanh được sử dụng rất nhiều trong các dự án điện tử khác nhau với sự trợ giúp của bo mạch Arduino, nó có thể cảm nhận và điều khiển những đối tượng khác nhau thông qua tín hiệu được lấy từ các cảm biến. Chúng ta có thể kể đến một số ứng dụng của cảm biến âm thanh như là:

* Hệ thống bảo mật cho các chung cư và tòa nhà
* Mô hình nhà thông minh.
* Điện thoại thông minh.
* Nhận dạng âm thanh xung quanh.
* Bộ khuếch đại âm thanh.
* Nhận dạng mức âm thanh khác nhau.

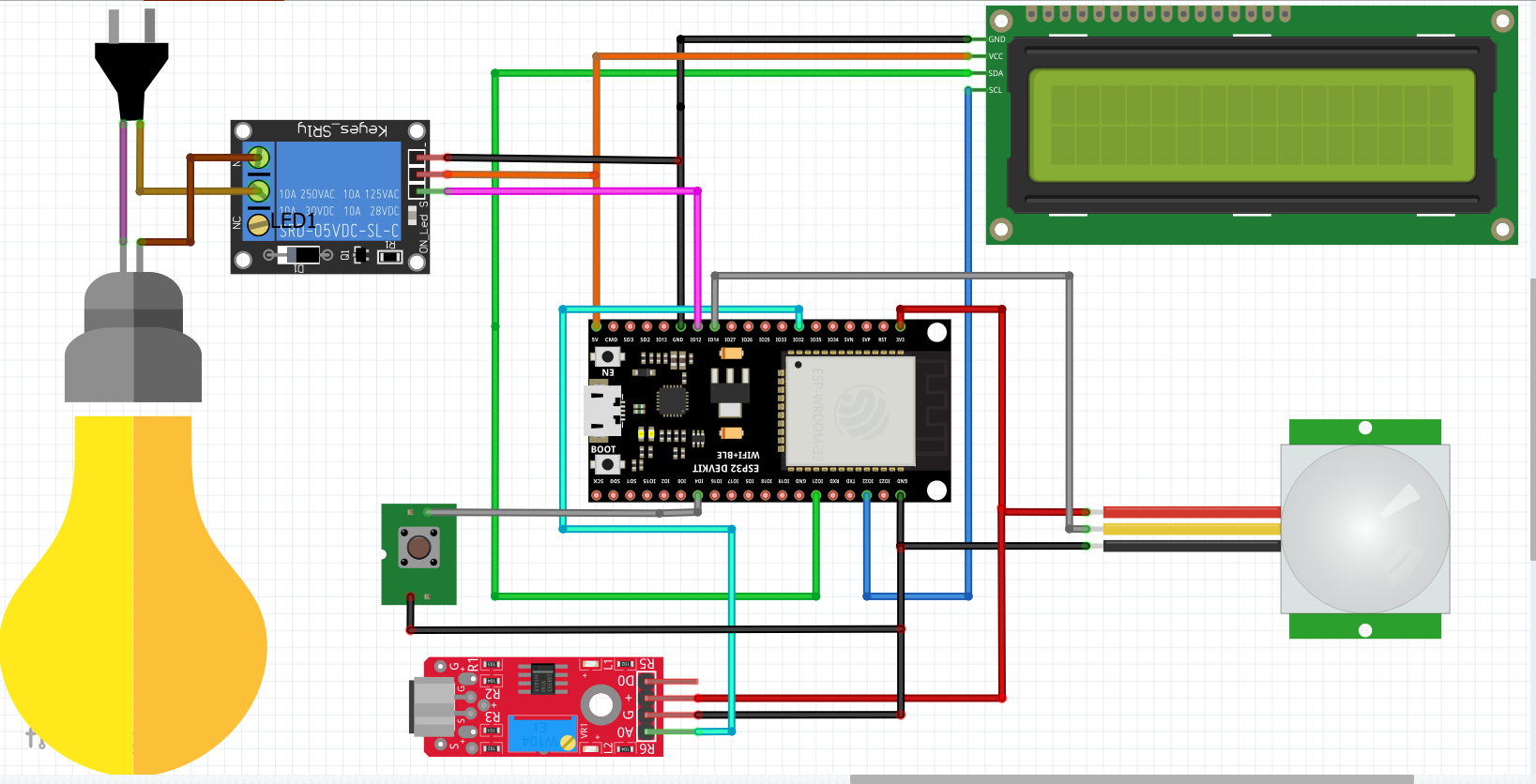
**Chương 2: Thiết kế hệ thống**

**2.1 Giới thiệu**

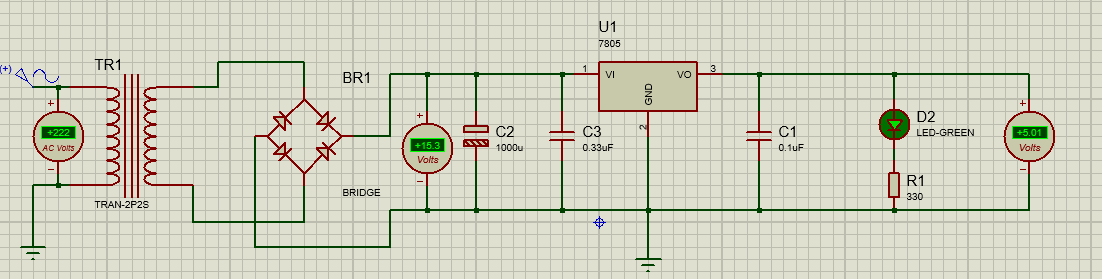
**S**au khi tính toán và thiết kế sơ đồ nguyên lý của hệ thống, chương này là chương thi công phần cứng, vẽ PCB, lập trình code cho chương trình và cùng một số hình ảnh hệ thống trong quá trình thi công.

**2.2 Thi công hệ thống**

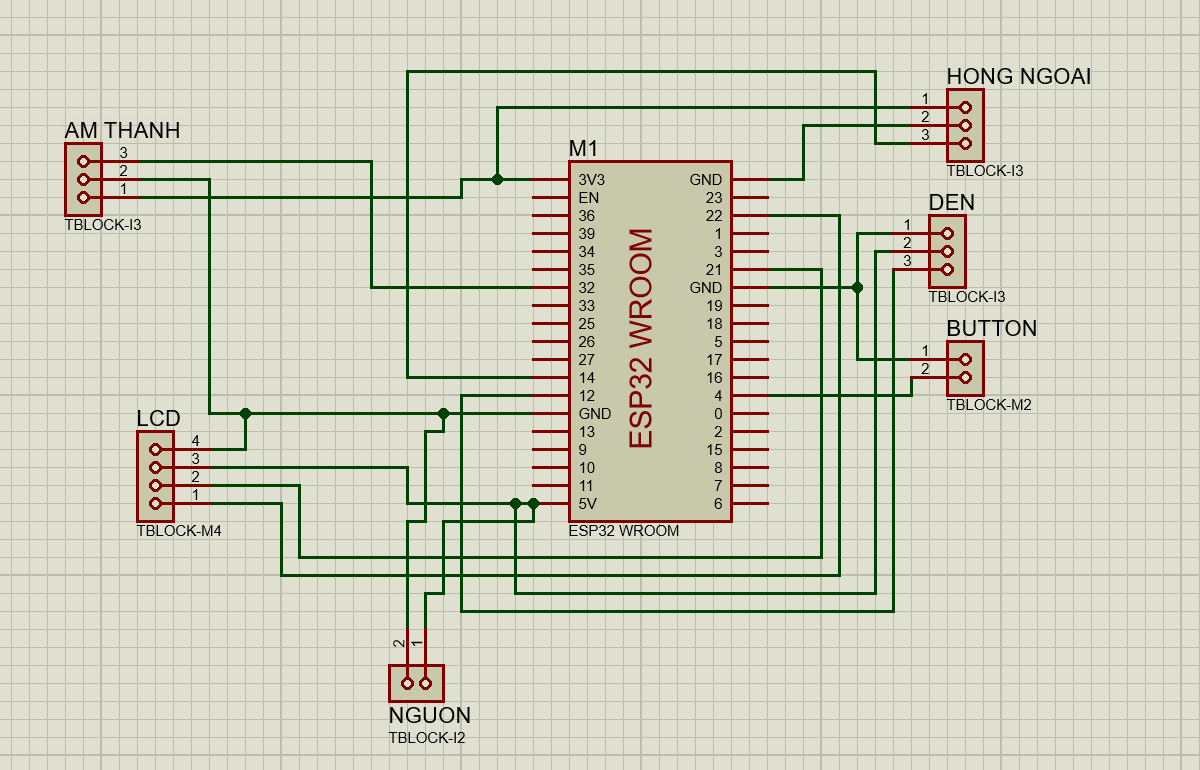
Sau khi vẽ sơ đồ nguyên lý cho mạch điện, tiến hành vẽ sơ đồ nối dây cho mạch



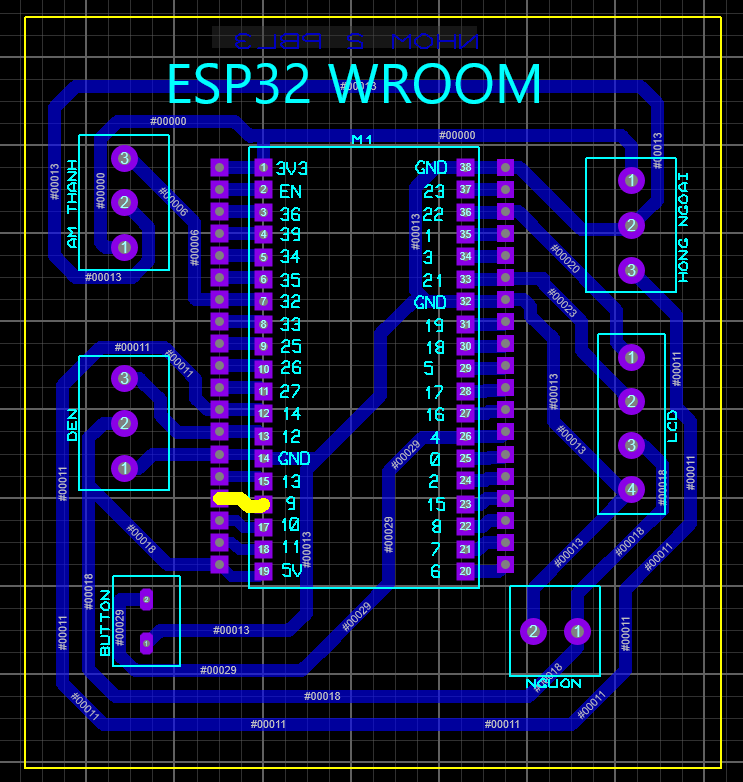
Hình 2.2.1 :



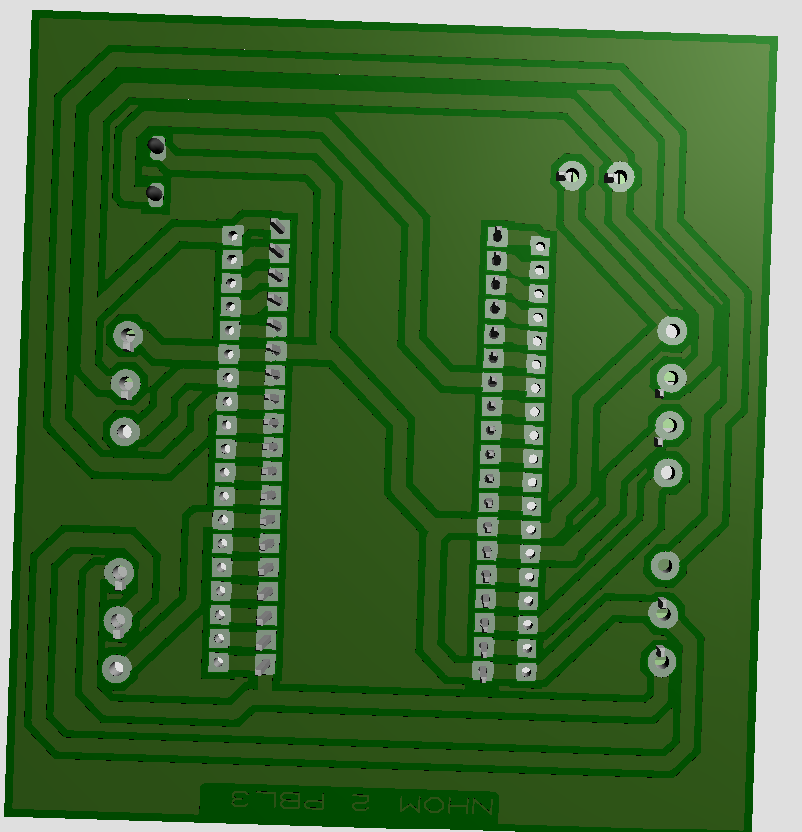
Hình 2.2.2 : Mạch Nguồn



Hình 2.2.2 Mạch mô phỏng

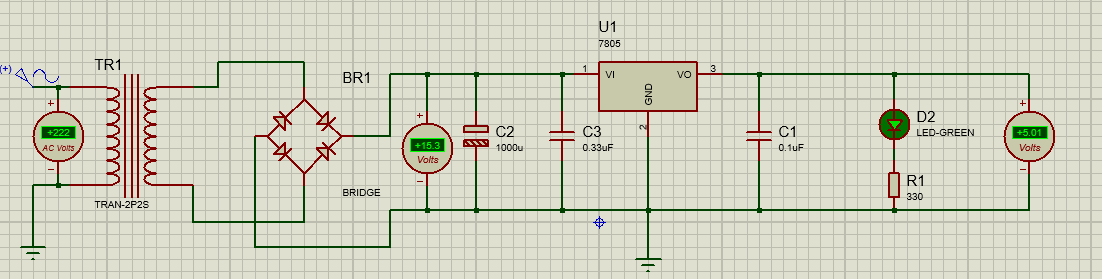


Hình 2.2.4 Mạch in



Hình 2.2.5

**2.3 Tính Toán Nguồn**



**Tính chọn**

**R1:**

Theo định luật Ohm: Trong đó:

V : điện áp cung cấp (5V)

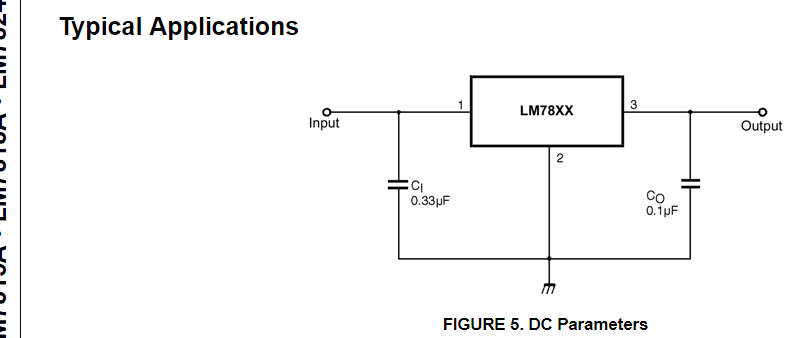
I : dòng điện cần để LED sáng (10 - 20mA), chọn I = 15mA

**Chọn**

**C1, :**

có tác dụng lọc nhiễu cao tần và quá độ, cung cấp sự ổn định cho IC LM7805. Dựa theo mạch thiết kế mẫu trong datasheet ta:

**Chọn**



**C2:**  
 có tác dụng làm mịn, phẳng điện áp một chiều cấp cho IC LM7805

Ta có: Trong đó:

I : điện áp ngõ ra của mạch khi gắn tải (0.9 – 1A)

T : chu kỳ = với = 100hz

∆V: hiệu điện thế giữa: giá trị điện áp cao nhất ngõ vào() và điện áp tối thiểu để LM7805 có hoạt động ổn định()

**Chọn**

Code Web:

<!DOCTYPE html>

<html lang="en">

<head>

<meta charset="UTF-8">

<meta http-equiv="X-UA-Compatible" content="IE=edge">

<meta name="viewport" content="width=device-width, initial-scale=1.0">

<title>Web PBL3 </title>

<meta charset="UTF-8">

<meta http-equiv="X-UA-Compatible" content="IE=edge">

<meta name="viewport"

content="width=device-width, initial-scale=1.0">

<link rel="stylesheet" href="https://pro.

fontawesome.com/releases/v5.10.0/css/all.css"/>

<style>

body {

font-size: 20px;

display: flex;

flex-direction: column;

justify-content: center;

align-items: center;

height: 100vh;

margin: 0;

padding: 0;

text-align: center;

}

.sensor-container {

display: flex;

justify-content: space-between;

align-items: center;

height: 50vh; /\* Giả sử bạn muốn chiều cao là 50% của chiều cao màn hình \*/

}

.sensor-box {

background-color: #d5d3d2;

border: 1px solid #00f5d0;

box-shadow: 0 2px 4px rgba(0, 0, 0, 0.1);

padding: 20px;

width: 200px; /\* Kích thước của .sensor-box \*/

height: 200px; /\* Kích thước của .sensor-box \*/

margin-left: auto; /\* Di chuyển .sensor-box sang bên phải \*/

}

.sensor-box:hover {

box-shadow:none

}

strong {

font-weight: bold;

}

span {

font-size: 30px;

color: #ff008c;

}

body {

background-image: url('https://image.slidesdocs.com/responsive-images/background/geometric-funny-alphabet-education-colorful-cute-letters-powerpoint-background\_ba877b436a\_\_960\_540.jpg');

background-size: cover;

background-repeat: no-repeat;

background-attachment: fixed;

text-align: center;

}

</style>

<style>

body {

font-size: 20px; /\* Chỉnh kích thước chữ cho phần body \*/

}

h1 {

font-size: 10px;

border: 2px solid #000; /\* Viền 2px đen xung quanh chữ \*/

padding: 10px; /\* Khoảng trắng 10px từ nội dung đến viền \*/

display: inline-block; /\* Để chỉ chiếm không gian cần thiết xung quanh chữ \*/

margin-bottom: -50px;

}

h2 {

font-size: 30px; /\* Tăng kích thước font cho tiêu đề h2 \*/

margin-bottom: 2px; /\* Giảm khoảng cách dưới tiêu đề h2 \*/

}

h3 {

font-size: 20px;

color: #ffffff; /\* Màu chữ trắng \*/

background-color: #3498db; /\* Màu nền xanh \*/

border: 2px solid #000; /\* Viền 2px đen xung quanh chữ \*/

padding: 10px; /\* Khoảng trắng 10px từ nội dung đến viền \*/

display: inline-block; /\* Để chỉ chiếm không gian cần thiết xung quanh chữ \*/

margin-bottom: 2px;

}

</style>

<script src="https://cdn.jsdelivr.net/npm/chart.js"></script>

<script src="https://cdn.jsdelivr.net/npm/chartjs-adapter-date-fns@2.0.0/dist/chartjs-adapter-date-fns.bundle.min.js"></script>

</head>

<body>

<h3>NHÓM 2 </h3>

<h2>ĐỀ TÀI: THIẾT BỊ PHÁT SÁNG, CẢNH BÁO TIẾNG ỒN HÀNH LANG BỆNH VIỆN <i class="fas fa-hospital-alt"></i> </h2>

<i id="lightbulbIcon" class="fas fa-lightbulb"></i>

<div>

<button id="toggleButton">ấn nút</button>

</div>

<h1>BẬT/TẮT ĐÈN</h1>

<div class="sensor-container">

<div >

<style>

#irValue {

display: none;

}

</style>

<p><span id="irValue">0</span></p>

</div>

<div class="sensor-box">

<i class="fas fa-volume-up"></i>

<p><strong>Âm thanh:</strong></p>

<p><span id="soundValue">0</span></p>

</div>

<!-- Canvas for the chart -->

<div style="width: 900px; padding: 40px; margin: auto auto;">

<canvas id="sensorChart"></canvas>

</div>

<!-- Add Firebase SDK using ES modules -->

<script type="module">

// Import Firebase modules as needed

import { initializeApp } from "https://www.gstatic.com/firebasejs/10.5.0/firebase-app.js";

import { getDatabase, ref, onValue, set } from "https://www.gstatic.com/firebasejs/10.5.0/firebase-database.js";

// Firebase configuration

const firebaseConfig = {

apiKey: "AIzaSyCIKfBR07ejF-PBrijlbjdqCdUjy9N42jk",

authDomain: "pbl3-da653.firebaseapp.com",

databaseURL: "https://pbl3-da653-default-rtdb.firebaseio.com",

projectId: "pbl3-da653",

storageBucket: "pbl3-da653.appspot.com",

messagingSenderId: "613590800645",

appId: "1:613590800645:web:80a886746bbc903a05bf6c",

measurementId: "G-NHW94BCML2"

};

// Initialize Firebase

const app = initializeApp(firebaseConfig);

const database = getDatabase(app);

// Create a reference to the ButtonState in Firebase

const buttonStateRef = ref(database, 'ButtonState/value');

const irSensorRef = ref(database, 'IRSensor/value');

const soundSensorRef = ref(database, 'SoundSensor/value');

// Initialize the button state as 'false'

set(buttonStateRef, false);

// Initialize a variable to keep track of the current state

let buttonState = false;

const toggleButton = document.getElementById('toggleButton');

const lightbulbIcon = document.getElementById('lightbulbIcon');

toggleButton.addEventListener('click', () => {

// Toggle the button state

buttonState = !buttonState;

// Update the ButtonState value on Firebase

set(buttonStateRef, buttonState);

// Toggle the lightbulb icon

lightbulbIcon.className = buttonState ? 'fas fa-lightbulb' : 'far fa-lightbulb';

});

// Listen for changes in the Firebase Realtime Database

onValue(buttonStateRef, (snapshot) => {

const firebaseButtonState = snapshot.val();

// Update the local button state based on Firebase

buttonState = firebaseButtonState;

// Update the button text based on the local button state

toggleButton.innerText = buttonState ? 'ON' : 'OFF';

});

onValue(irSensorRef, (snapshot) => {

const irValue = snapshot.val();

document.getElementById('irValue').textContent = ${irValue};

if (irValue > 0) {

// Display a notification on the webpage

const notification = document.createElement('div');

notification.textContent = 'CÓ CHUYỂN ĐỘNG ';

// You can style the notification here

notification.style.backgroundColor = 'red';

notification.style.color = 'white';

notification.style.padding = '10px';

// Add the notification to the page

document.body.appendChild(notification);

// Set a timeout to remove the notification after 5 seconds

setTimeout(() => {

notification.remove();

}, 5000);

}

});

onValue(soundSensorRef, (snapshot) => {

const soundValue = snapshot.val();

document.getElementById('soundValue').textContent = ${soundValue};

if (soundValue > 200) {

// Giá trị lớn hơn 200, hiển thị thông báo

showNotification(" VUI LÒNG GIỮ YÊN LẶNG !");

}

});

// Rest of the code remains the same...

function showNotification(message) {

// Tạo và hiển thị một thông báo tùy chỉnh

const notification = document.createElement('div');

notification.className = 'notification';

notification.textContent = message;

// Thêm thông báo vào phần tử gốc

document.body.appendChild(notification);

// Ẩn thông báo sau một khoảng thời gian

setTimeout(() => {

notification.style.display = 'none';

}, 10000); // 10 giây

};

// Chart.js code

const irData = [];

const soundData = [];

const labels = [];

const ctx = document.getElementById('sensorChart').getContext('2d');

const sensorChart = new Chart(ctx, {

type: 'line',

data: {

labels: labels,

datasets: [

{

label: 'Sound Sensor',

data: soundData,

borderColor: 'rgb(54, 162, 235)',

fill: false,

},

],

},

options: {

scales: {

x: {

type: 'time',

time: {

unit: 'second',

parser: 'HH:mm:ss',

},

displayFormats: {

second: 'HH:mm:ss'

}

},

y: {

beginAtZero: true,

},

},

},

});

const soundSensorRefChart = ref(database, 'SoundSensor/value');

// Function to update chart data

function updateChartData() {

onValue(soundSensorRefChart, (snapshot) => {

const soundValue = snapshot.val();

soundData.push(soundValue);

});

labels.push(new Date().toLocaleTimeString());

// Update the chart

sensorChart.update();

}

// Initial call to updateChartData

updateChartData();

// Set interval to update chart data every 60 seconds

setInterval(updateChartData, 60000);

</script>

</body>

</html>

**Chương 3: Kết quả và đánh giá**

**3.1 Giới thiệu:**

Sau thời gian 17 tuần thực hiện đề tài, qua quá trình nghiên cứu và tìm hiểu nhóm đã học hỏi được nhiều kiến thức mới, công nghệ mới. Đồng thời áp dụng được nhiều lý thuyết vào dự án thực tế.

**3.2 Kết quả đạt được:**

Board ESP32 là mạch điều khiển chính trong hệ thống. Nhóm đã biết cách ứng dụng chức năng tích hợp Wifi trong board để phát triển hệ thống điều khiển thiết bị từ xa. Từ đó nắm được bản chất điều khiển, để có thể mở rộng cho các ứng dụng IoT sau này, điều khiển được một hệ thống lớn.

Thông qua đề tài nhóm đã biết cách điều khiển và giám sát thiết bị qua Internet (Wifi). Đồng thời thiết kế được giao diện Web, ứng dụng Android cho hệ thống điều khiển. Tất cả đều được lưu trữ tại dịch vụ lưu trữ Cloud MQTT.

Đề tài có sử dụng cảm biến tiếng ồn,nhiệt độ qua đó nhóm biết được cấu tạo, nguyên lý hoạt động cũng như cách sử dụng cảm biến. Cảm biến này rất phổ biến, thích hợp cho việc giám sát nhiệt độ, độ ẩm trên các hệ thống nhỏ.

**3.3 Kết quả thực nghiệm:**

Mô Hình :

A light bulb inside a box

Description automatically generated

Điều khiển và giám sát thiết bị, cảm biến qua Web :

A screenshot of a graph

Description automatically generated

**TÀI LIỆU THAM KHẢO**

* **Sách tham khảo**

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**PHỤ LỤC**

**SOURCE CODE**

**Chương trình điều khiển**

**Hàm main**

#include <Arduino.h>

#if defined(ESP32)

#include <WiFi.h>

#include <WiFiMulti.h>

#elif defined(ESP8266)

#include <ESP8266WiFi.h>

#include <ESP8266WiFiMulti.h>

#endif

#include <Firebase\_ESP\_Client.h>

#include <Wire.h>

#include <LiquidCrystal\_I2C.h>

LiquidCrystal\_I2C lcd(0x27, 16, 2); // Địa chỉ I2C của LCD và kích thước màn hình

const int buttonPin = 4; // Chân nút nhấn

bool lastButtonState = HIGH;

bool currentButtonState = HIGH;

bool isLcdOn = false;

#define IR\_SENSOR\_PIN 14

#define SOUND\_SENSOR\_PIN 32

#define ALARM\_PIN 12

#define BUTTON\_PIN 4

#include "addons/TokenHelper.h"

#include "addons/RTDBHelper.h"

#define API\_KEY "AIzaSyCIKfBR07ejF-PBrijlbjdqCdUjy9N42jk"

#define DATABASE\_URL "pbl3-da653-default-rtdb.firebaseio.com/"

FirebaseData fbdo;

FirebaseAuth auth;

FirebaseConfig config;

bool signupOK = false;

bool alarmSystemActive = false;

bool previousAlarmSystemActive = false;

unsigned long lastAttemptTime = 0;

WiFiMulti wifiMulti;

void connectToWiFiAndFirebase() {

wifiMulti.addAP("THINH NGUYEN - 2.4G", "1007200");

wifiMulti.addAP("Khoa 20dtclc1", "aaaaaaaa");

wifiMulti.addAP("Redmi Note 11", "1234567890");

Serial.print("Connecting to Wi-Fi");

unsigned long startTime = millis();

while (wifiMulti.run() != WL\_CONNECTED){

if (millis() - startTime > 10000) {

Serial.println("Failed to connect to WiFi");

Serial.println("\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_");

Serial.println(" OFFLINE MODE ");

return;

}

Serial.print(".");

delay(300);

}

Serial.println();

Serial.print("Connected with IP: ");

Serial.println(WiFi.localIP());

Serial.println();

config.api\_key = API\_KEY;

config.database\_url = DATABASE\_URL;

if (Firebase.signUp(&config, &auth, "", "")){

Serial.println("ok");

signupOK = true;

}

else{

Serial.printf("%s\n", config.signer.signupError.message.c\_str());

}

config.token\_status\_callback = tokenStatusCallback;

Firebase.begin(&config, &auth);

Firebase.reconnectWiFi(true);

}

void setup(){

pinMode(IR\_SENSOR\_PIN, INPUT);

pinMode(SOUND\_SENSOR\_PIN, INPUT);

pinMode(ALARM\_PIN, OUTPUT);

pinMode(BUTTON\_PIN, INPUT\_PULLUP);

Serial.begin(115200);

Wire.begin(21,22); //Thiết lập chân kết nối I2C (SDA,SCL);

lcd.init(); // Khởi tạo LCD

lcd.backlight(); //Bật đèn nền

lcd.setCursor(0, 0); // Đặt con trỏ vị trí trái trên cùng của LCD

lcd.print("WELCOME GROUP 2"); // In GIOI THIEU

pinMode(buttonPin, INPUT\_PULLUP); // Đặt chân nút nhấn là INPUT\_PULLUP (nút mở và nối đất)

connectToWiFiAndFirebase();

}

void loop(){

delay(500);

if (digitalRead(BUTTON\_PIN) == LOW) {

alarmSystemActive = !alarmSystemActive;

delay(200);

}

if (alarmSystemActive) {

int irValue = digitalRead(IR\_SENSOR\_PIN);

int soundValue = analogRead(SOUND\_SENSOR\_PIN);

// Display sensor values on Serial Monitor

Serial.print("IR Value: ");

Serial.print(irValue);

Serial.print("\tSound Value: ");

Serial.println(soundValue);

if (irValue == 1) {

digitalWrite(ALARM\_PIN, HIGH);

lcd.clear();

lcd.setCursor(0, 1); // Set cursor to the beginning of the second line

lcd.print("CO CHUYEN DONG !");

} else {

digitalWrite(ALARM\_PIN, LOW);

}

}

currentButtonState = digitalRead(buttonPin);

if (currentButtonState == HIGH && lastButtonState == LOW) {

isLcdOn = !isLcdOn;

if (isLcdOn) {

lcd.clear(); // Xóa màn hình

lcd.setCursor(0, 0);

lcd.print("TAT DEN SANG");

} else {

lcd.clear(); // Xóa màn hình

lcd.setCursor(0, 0);

lcd.print("BAT DEN SANG");

lcd.setCursor(0, 1);

lcd.print(" OFFLINE MODE "); // trang thai ofline

}

delay(200); // Đợi một chút để tránh đọc nút nhấn liên tục

}

lastButtonState = currentButtonState;

if (WiFi.status() != WL\_CONNECTED) {

unsigned long currentMillis = millis();

if (currentMillis - lastAttemptTime > 300000) { // 5 minutes

lastAttemptTime = currentMillis;

Serial.println("Lost WiFi connection. Trying to reconnect...");

connectToWiFiAndFirebase();

}

} else {

int irValue = digitalRead(IR\_SENSOR\_PIN);

int soundValue = analogRead(SOUND\_SENSOR\_PIN);

if (Firebase.ready() && signupOK ) {

if (Firebase.RTDB.setInt(&fbdo, "IRSensor/value",irValue)){

Serial.print("IRSensor: ");

Serial.println(irValue);

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

if (Firebase.RTDB.setInt(&fbdo, "SoundSensor/value", soundValue)){

Serial.print("SoundSensor: ");

Serial.println(soundValue);

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

if (alarmSystemActive != previousAlarmSystemActive) {

if (Firebase.RTDB.setInt(&fbdo, "ButtonState/value", alarmSystemActive)){

Serial.print("ButtonState: ");

Serial.println(alarmSystemActive);

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

previousAlarmSystemActive = alarmSystemActive;

}

if (Firebase.RTDB.getInt(&fbdo, "ButtonState/value")){

alarmSystemActive = fbdo.intData();

Serial.print("Updated ButtonState: ");

Serial.println(alarmSystemActive);

if (alarmSystemActive == 1) {

lcd.clear(); // Clear the LCD screen

lcd.setCursor(0, 0);

lcd.print("BAT DEN SANG"); // Display "BAT CANH BAO" when value is 1

} else {

lcd.clear(); // Clear the LCD screen

lcd.setCursor(0, 0);

lcd.print("TAT DEN SANG"); // Display "TAT CANH BAO" when value is 0

}

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

}

}

Serial.println("\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_");

}

#define BUTTON\_PIN 4

#include "addons/TokenHelper.h"

#include "addons/RTDBHelper.h"

#define API\_KEY "AIzaSyCIKfBR07ejF-PBrijlbjdqCdUjy9N42jk"

#define DATABASE\_URL "pbl3-da653-default-rtdb.firebaseio.com/"

FirebaseData fbdo;

FirebaseAuth auth;

FirebaseConfig config;

bool signupOK = false;

bool alarmSystemActive = false;

bool previousAlarmSystemActive = false;

unsigned long lastAttemptTime = 0;

WiFiMulti wifiMulti;

void connectToWiFiAndFirebase() {

wifiMulti.addAP("THINH NGUYEN - 2.4G", "1007200");

wifiMulti.addAP("Khoa 20dtclc1", "aaaaaaaa");

wifiMulti.addAP("Redmi Note 11", "1234567890");

Serial.print("Connecting to Wi-Fi");

unsigned long startTime = millis();

while (wifiMulti.run() != WL\_CONNECTED){

if (millis() - startTime > 10000) {

Serial.println("Failed to connect to WiFi");

Serial.println("\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_");

Serial.println(" OFFLINE MODE ");

return;

}

Serial.print(".");

delay(300);

}

Serial.println();

Serial.print("Connected with IP: ");

Serial.println(WiFi.localIP());

Serial.println();

config.api\_key = API\_KEY;

config.database\_url = DATABASE\_URL;

if (Firebase.signUp(&config, &auth, "", "")){

Serial.println("ok");

signupOK = true;

}

else{

Serial.printf("%s\n", config.signer.signupError.message.c\_str());

}

config.token\_status\_callback = tokenStatusCallback;

Firebase.begin(&config, &auth);

Firebase.reconnectWiFi(true);

}

void setup(){

pinMode(IR\_SENSOR\_PIN, INPUT);

pinMode(SOUND\_SENSOR\_PIN, INPUT);

pinMode(ALARM\_PIN, OUTPUT);

pinMode(BUTTON\_PIN, INPUT\_PULLUP);

Serial.begin(115200);

Wire.begin(21,22); //Thiết lập chân kết nối I2C (SDA,SCL);

lcd.init(); // Khởi tạo LCD

lcd.backlight(); //Bật đèn nền

lcd.setCursor(0, 0); // Đặt con trỏ vị trí trái trên cùng của LCD

lcd.print("WELCOME GROUP 2"); // In GIOI THIEU

pinMode(buttonPin, INPUT\_PULLUP); // Đặt chân nút nhấn là INPUT\_PULLUP (nút mở và nối đất)

connectToWiFiAndFirebase();

}

void loop(){

delay(500);

if (digitalRead(BUTTON\_PIN) == LOW) {

alarmSystemActive = !alarmSystemActive;

delay(200);

}

if (alarmSystemActive) {

int irValue = digitalRead(IR\_SENSOR\_PIN);

int soundValue = analogRead(SOUND\_SENSOR\_PIN);

// Display sensor values on Serial Monitor

Serial.print("IR Value: ");

Serial.print(irValue);

Serial.print("\tSound Value: ");

Serial.println(soundValue);

if (irValue == 1) {

digitalWrite(ALARM\_PIN, HIGH);

lcd.clear();

lcd.setCursor(0, 1); // Set cursor to the beginning of the second line

lcd.print("CO CHUYEN DONG !");

} else {

digitalWrite(ALARM\_PIN, LOW);

}

}

currentButtonState = digitalRead(buttonPin);

if (currentButtonState == HIGH && lastButtonState == LOW) {

isLcdOn = !isLcdOn;

if (isLcdOn) {

lcd.clear(); // Xóa màn hình

lcd.setCursor(0, 0);

lcd.print("TAT DEN SANG");

} else {

lcd.clear(); // Xóa màn hình

lcd.setCursor(0, 0);

lcd.print("BAT DEN SANG");

lcd.setCursor(0, 1);

lcd.print(" OFFLINE MODE "); // trang thai ofline

}

delay(200); // Đợi một chút để tránh đọc nút nhấn liên tục

}

lastButtonState = currentButtonState;

if (WiFi.status() != WL\_CONNECTED) {

unsigned long currentMillis = millis();

if (currentMillis - lastAttemptTime > 300000) { // 5 minutes

lastAttemptTime = currentMillis;

Serial.println("Lost WiFi connection. Trying to reconnect...");

connectToWiFiAndFirebase();

}

} else {

int irValue = digitalRead(IR\_SENSOR\_PIN);

int soundValue = analogRead(SOUND\_SENSOR\_PIN);

if (Firebase.ready() && signupOK ) {

if (Firebase.RTDB.setInt(&fbdo, "IRSensor/value",irValue)){

Serial.print("IRSensor: ");

Serial.println(irValue);

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

if (Firebase.RTDB.setInt(&fbdo, "SoundSensor/value", soundValue)){

Serial.print("SoundSensor: ");

Serial.println(soundValue);

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

if (alarmSystemActive != previousAlarmSystemActive) {

if (Firebase.RTDB.setInt(&fbdo, "ButtonState/value", alarmSystemActive)){

Serial.print("ButtonState: ");

Serial.println(alarmSystemActive);

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

previousAlarmSystemActive = alarmSystemActive;

}

if (Firebase.RTDB.getInt(&fbdo, "ButtonState/value")){

alarmSystemActive = fbdo.intData();

Serial.print("Updated ButtonState: ");

Serial.println(alarmSystemActive);

if (alarmSystemActive == 1) {

lcd.clear(); // Clear the LCD screen

lcd.setCursor(0, 0);

lcd.print("BAT DEN SANG"); // Display "BAT CANH BAO" when value is 1

} else {

lcd.clear(); // Clear the LCD screen

lcd.setCursor(0, 0);

lcd.print("TAT DEN SANG"); // Display "TAT CANH BAO" when value is 0

}

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

}

}

Serial.println("\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_");

}

unsigned long startTime = millis();

while (wifiMulti.run() != WL\_CONNECTED){

if (millis() - startTime > 10000) {

Serial.println("Failed to connect to WiFi");

Serial.println("\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_");

Serial.println(" OFFLINE MODE ");

return;

}

Serial.print(".");

delay(300);

}

Serial.println();

Serial.print("Connected with IP: ");

Serial.println(WiFi.localIP());

Serial.println();

config.api\_key = API\_KEY;

config.database\_url = DATABASE\_URL;

if (Firebase.signUp(&config, &auth, "", "")){

Serial.println("ok");

signupOK = true;

}

else{

Serial.printf("%s\n", config.signer.signupError.message.c\_str());

}

config.token\_status\_callback = tokenStatusCallback;

Firebase.begin(&config, &auth);

Firebase.reconnectWiFi(true);

}

void setup(){

pinMode(IR\_SENSOR\_PIN, INPUT);

pinMode(SOUND\_SENSOR\_PIN, INPUT);

pinMode(ALARM\_PIN, OUTPUT);

pinMode(BUTTON\_PIN, INPUT\_PULLUP);

Serial.begin(115200);

Wire.begin(21,22); //Thiết lập chân kết nối I2C (SDA,SCL);

lcd.init(); // Khởi tạo LCD

lcd.backlight(); //Bật đèn nền

lcd.setCursor(0, 0); // Đặt con trỏ vị trí trái trên cùng của LCD

lcd.print("WELCOME GROUP 2"); // In GIOI THIEU

pinMode(buttonPin, INPUT\_PULLUP); // Đặt chân nút nhấn là INPUT\_PULLUP (nút mở và nối đất)

connectToWiFiAndFirebase();

}

void loop(){

delay(500);

if (digitalRead(BUTTON\_PIN) == LOW) {

alarmSystemActive = !alarmSystemActive;

delay(200);

}

if (alarmSystemActive) {

int irValue = digitalRead(IR\_SENSOR\_PIN);

int soundValue = analogRead(SOUND\_SENSOR\_PIN);

// Display sensor values on Serial Monitor

Serial.print("IR Value: ");

Serial.print(irValue);

Serial.print("\tSound Value: ");

Serial.println(soundValue);

if (irValue == 1) {

digitalWrite(ALARM\_PIN, HIGH);

lcd.clear();

lcd.setCursor(0, 1); // Set cursor to the beginning of the second line

lcd.print("CO CHUYEN DONG !");

} else {

digitalWrite(ALARM\_PIN, LOW);

}

}

currentButtonState = digitalRead(buttonPin);

if (currentButtonState == HIGH && lastButtonState == LOW) {

isLcdOn = !isLcdOn;

if (isLcdOn) {

lcd.clear(); // Xóa màn hình

lcd.setCursor(0, 0);

lcd.print("TAT DEN SANG");

} else {

lcd.clear(); // Xóa màn hình

lcd.setCursor(0, 0);

lcd.print("BAT DEN SANG");

lcd.setCursor(0, 1);

lcd.print(" OFFLINE MODE "); // trang thai ofline

}

delay(200); // Đợi một chút để tránh đọc nút nhấn liên tục

}

lastButtonState = currentButtonState;

if (WiFi.status() != WL\_CONNECTED) {

unsigned long currentMillis = millis();

if (currentMillis - lastAttemptTime > 300000) { // 5 minutes

lastAttemptTime = currentMillis;

Serial.println("Lost WiFi connection. Trying to reconnect...");

connectToWiFiAndFirebase();

}

} else {

int irValue = digitalRead(IR\_SENSOR\_PIN);

int soundValue = analogRead(SOUND\_SENSOR\_PIN);

if (Firebase.ready() && signupOK ) {

if (Firebase.RTDB.setInt(&fbdo, "IRSensor/value",irValue)){

Serial.print("IRSensor: ");

Serial.println(irValue);

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

if (Firebase.RTDB.setInt(&fbdo, "SoundSensor/value", soundValue)){

Serial.print("SoundSensor: ");

Serial.println(soundValue);

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

if (alarmSystemActive != previousAlarmSystemActive) {

if (Firebase.RTDB.setInt(&fbdo, "ButtonState/value", alarmSystemActive)){

Serial.print("ButtonState: ");

Serial.println(alarmSystemActive);

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

previousAlarmSystemActive = alarmSystemActive;

}

if (Firebase.RTDB.getInt(&fbdo, "ButtonState/value")){

alarmSystemActive = fbdo.intData();

Serial.print("Updated ButtonState: ");

Serial.println(alarmSystemActive);

if (alarmSystemActive == 1) {

lcd.clear(); // Clear the LCD screen

lcd.setCursor(0, 0);

lcd.print("BAT DEN SANG"); // Display "BAT CANH BAO" when value is 1

} else {

lcd.clear(); // Clear the LCD screen

lcd.setCursor(0, 0);

lcd.print("TAT DEN SANG"); // Display "TAT CANH BAO" when value is 0

}

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

}

}

Serial.println("\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_");

}

config.token\_status\_callback = tokenStatusCallback;

Firebase.begin(&config, &auth);

Firebase.reconnectWiFi(true);

}

void setup(){

pinMode(IR\_SENSOR\_PIN, INPUT);

pinMode(SOUND\_SENSOR\_PIN, INPUT);

pinMode(ALARM\_PIN, OUTPUT);

pinMode(BUTTON\_PIN, INPUT\_PULLUP);

Serial.begin(115200);

Wire.begin(21,22); //Thiết lập chân kết nối I2C (SDA,SCL);

lcd.init(); // Khởi tạo LCD

lcd.backlight(); //Bật đèn nền

lcd.setCursor(0, 0); // Đặt con trỏ vị trí trái trên cùng của LCD

lcd.print("WELCOME GROUP 2"); // In GIOI THIEU

pinMode(buttonPin, INPUT\_PULLUP); // Đặt chân nút nhấn là INPUT\_PULLUP (nút mở và nối đất)

connectToWiFiAndFirebase();

}

void loop(){

delay(500);

if (digitalRead(BUTTON\_PIN) == LOW) {

alarmSystemActive = !alarmSystemActive;

delay(200);

}

if (alarmSystemActive) {

int irValue = digitalRead(IR\_SENSOR\_PIN);

int soundValue = analogRead(SOUND\_SENSOR\_PIN);

// Display sensor values on Serial Monitor

Serial.print("IR Value: ");

Serial.print(irValue);

Serial.print("\tSound Value: ");

Serial.println(soundValue);

if (irValue == 1) {

digitalWrite(ALARM\_PIN, HIGH);

lcd.clear();

lcd.setCursor(0, 1); // Set cursor to the beginning of the second line

lcd.print("CO CHUYEN DONG !");

} else {

digitalWrite(ALARM\_PIN, LOW);

}

}

currentButtonState = digitalRead(buttonPin);

if (currentButtonState == HIGH && lastButtonState == LOW) {

isLcdOn = !isLcdOn;

if (isLcdOn) {

lcd.clear(); // Xóa màn hình

lcd.setCursor(0, 0);

lcd.print("TAT DEN SANG");

} else {

lcd.clear(); // Xóa màn hình

lcd.setCursor(0, 0);

lcd.print("BAT DEN SANG");

lcd.setCursor(0, 1);

lcd.print(" OFFLINE MODE "); // trang thai ofline

}

delay(200); // Đợi một chút để tránh đọc nút nhấn liên tục

}

lastButtonState = currentButtonState;

if (WiFi.status() != WL\_CONNECTED) {

unsigned long currentMillis = millis();

if (currentMillis - lastAttemptTime > 300000) { // 5 minutes

lastAttemptTime = currentMillis;

Serial.println("Lost WiFi connection. Trying to reconnect...");

connectToWiFiAndFirebase();

}

} else {

int irValue = digitalRead(IR\_SENSOR\_PIN);

int soundValue = analogRead(SOUND\_SENSOR\_PIN);

if (Firebase.ready() && signupOK ) {

if (Firebase.RTDB.setInt(&fbdo, "IRSensor/value",irValue)){

Serial.print("IRSensor: ");

Serial.println(irValue);

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

if (Firebase.RTDB.setInt(&fbdo, "SoundSensor/value", soundValue)){

Serial.print("SoundSensor: ");

Serial.println(soundValue);

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

if (alarmSystemActive != previousAlarmSystemActive) {

if (Firebase.RTDB.setInt(&fbdo, "ButtonState/value", alarmSystemActive)){

Serial.print("ButtonState: ");

Serial.println(alarmSystemActive);

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

previousAlarmSystemActive = alarmSystemActive;

}

if (Firebase.RTDB.getInt(&fbdo, "ButtonState/value")){

alarmSystemActive = fbdo.intData();

Serial.print("Updated ButtonState: ");

Serial.println(alarmSystemActive);

if (alarmSystemActive == 1) {

lcd.clear(); // Clear the LCD screen

lcd.setCursor(0, 0);

lcd.print("BAT DEN SANG"); // Display "BAT CANH BAO" when value is 1

} else {

lcd.clear(); // Clear the LCD screen

lcd.setCursor(0, 0);

lcd.print("TAT DEN SANG"); // Display "TAT CANH BAO" when value is 0

}

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

}

}

Serial.println("\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_");

}

delay(500);

if (digitalRead(BUTTON\_PIN) == LOW) {

alarmSystemActive = !alarmSystemActive;

delay(200);

}

if (alarmSystemActive) {

int irValue = digitalRead(IR\_SENSOR\_PIN);

int soundValue = analogRead(SOUND\_SENSOR\_PIN);

// Display sensor values on Serial Monitor

Serial.print("IR Value: ");

Serial.print(irValue);

Serial.print("\tSound Value: ");

Serial.println(soundValue);

if (irValue == 1) {

digitalWrite(ALARM\_PIN, HIGH);

lcd.clear();

lcd.setCursor(0, 1); // Set cursor to the beginning of the second line

lcd.print("CO CHUYEN DONG !");

} else {

digitalWrite(ALARM\_PIN, LOW);

}

}

currentButtonState = digitalRead(buttonPin);

if (currentButtonState == HIGH && lastButtonState == LOW) {

isLcdOn = !isLcdOn;

if (isLcdOn) {

lcd.clear(); // Xóa màn hình

lcd.setCursor(0, 0);

lcd.print("TAT DEN SANG");

} else {

lcd.clear(); // Xóa màn hình

lcd.setCursor(0, 0);

lcd.print("BAT DEN SANG");

lcd.setCursor(0, 1);

lcd.print(" OFFLINE MODE "); // trang thai ofline

}

delay(200); // Đợi một chút để tránh đọc nút nhấn liên tục

}

lastButtonState = currentButtonState;

if (WiFi.status() != WL\_CONNECTED) {

unsigned long currentMillis = millis();

if (currentMillis - lastAttemptTime > 300000) { // 5 minutes

lastAttemptTime = currentMillis;

Serial.println("Lost WiFi connection. Trying to reconnect...");

connectToWiFiAndFirebase();

}

} else {

int irValue = digitalRead(IR\_SENSOR\_PIN);

int soundValue = analogRead(SOUND\_SENSOR\_PIN);

if (Firebase.ready() && signupOK ) {

if (Firebase.RTDB.setInt(&fbdo, "IRSensor/value",irValue)){

Serial.print("IRSensor: ");

Serial.println(irValue);

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

if (Firebase.RTDB.setInt(&fbdo, "SoundSensor/value", soundValue)){

Serial.print("SoundSensor: ");

Serial.println(soundValue);

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

if (alarmSystemActive != previousAlarmSystemActive) {

if (Firebase.RTDB.setInt(&fbdo, "ButtonState/value", alarmSystemActive)){

Serial.print("ButtonState: ");

Serial.println(alarmSystemActive);

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

previousAlarmSystemActive = alarmSystemActive;

}

if (Firebase.RTDB.getInt(&fbdo, "ButtonState/value")){

alarmSystemActive = fbdo.intData();

Serial.print("Updated ButtonState: ");

Serial.println(alarmSystemActive);

if (alarmSystemActive == 1) {

lcd.clear(); // Clear the LCD screen

lcd.setCursor(0, 0);

lcd.print("BAT DEN SANG"); // Display "BAT CANH BAO" when value is 1

} else {

lcd.clear(); // Clear the LCD screen

lcd.setCursor(0, 0);

lcd.print("TAT DEN SANG"); // Display "TAT CANH BAO" when value is 0

}

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

}

}

Serial.println("\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_");

}

}

currentButtonState = digitalRead(buttonPin);

if (currentButtonState == HIGH && lastButtonState == LOW) {

isLcdOn = !isLcdOn;

if (isLcdOn) {

lcd.clear(); // Xóa màn hình

lcd.setCursor(0, 0);

lcd.print("TAT DEN SANG");

} else {

lcd.clear(); // Xóa màn hình

lcd.setCursor(0, 0);

lcd.print("BAT DEN SANG");

lcd.setCursor(0, 1);

lcd.print(" OFFLINE MODE "); // trang thai ofline

}

delay(200); // Đợi một chút để tránh đọc nút nhấn liên tục

}

lastButtonState = currentButtonState;

if (WiFi.status() != WL\_CONNECTED) {

unsigned long currentMillis = millis();

if (currentMillis - lastAttemptTime > 300000) { // 5 minutes

lastAttemptTime = currentMillis;

Serial.println("Lost WiFi connection. Trying to reconnect...");

connectToWiFiAndFirebase();

}

} else {

int irValue = digitalRead(IR\_SENSOR\_PIN);

int soundValue = analogRead(SOUND\_SENSOR\_PIN);

if (Firebase.ready() && signupOK ) {

if (Firebase.RTDB.setInt(&fbdo, "IRSensor/value",irValue)){

Serial.print("IRSensor: ");

Serial.println(irValue);

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

if (Firebase.RTDB.setInt(&fbdo, "SoundSensor/value", soundValue)){

Serial.print("SoundSensor: ");

Serial.println(soundValue);

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

if (alarmSystemActive != previousAlarmSystemActive) {

if (Firebase.RTDB.setInt(&fbdo, "ButtonState/value", alarmSystemActive)){

Serial.print("ButtonState: ");

Serial.println(alarmSystemActive);

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

previousAlarmSystemActive = alarmSystemActive;

}

if (Firebase.RTDB.getInt(&fbdo, "ButtonState/value")){

alarmSystemActive = fbdo.intData();

Serial.print("Updated ButtonState: ");

Serial.println(alarmSystemActive);

if (alarmSystemActive == 1) {

lcd.clear(); // Clear the LCD screen

lcd.setCursor(0, 0);

lcd.print("BAT DEN SANG"); // Display "BAT CANH BAO" when value is 1

} else {

lcd.clear(); // Clear the LCD screen

lcd.setCursor(0, 0);

lcd.print("TAT DEN SANG"); // Display "TAT CANH BAO" when value is 0

}

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

}

}

Serial.println("\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_");

}

Serial.println("Lost WiFi connection. Trying to reconnect...");

connectToWiFiAndFirebase();

}

} else {

int irValue = digitalRead(IR\_SENSOR\_PIN);

int soundValue = analogRead(SOUND\_SENSOR\_PIN);

if (Firebase.ready() && signupOK ) {

if (Firebase.RTDB.setInt(&fbdo, "IRSensor/value",irValue)){

Serial.print("IRSensor: ");

Serial.println(irValue);

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

if (Firebase.RTDB.setInt(&fbdo, "SoundSensor/value", soundValue)){

Serial.print("SoundSensor: ");

Serial.println(soundValue);

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

if (alarmSystemActive != previousAlarmSystemActive) {

if (Firebase.RTDB.setInt(&fbdo, "ButtonState/value", alarmSystemActive)){

Serial.print("ButtonState: ");

Serial.println(alarmSystemActive);

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

previousAlarmSystemActive = alarmSystemActive;

}

if (Firebase.RTDB.getInt(&fbdo, "ButtonState/value")){

alarmSystemActive = fbdo.intData();

Serial.print("Updated ButtonState: ");

Serial.println(alarmSystemActive);

if (alarmSystemActive == 1) {

lcd.clear(); // Clear the LCD screen

lcd.setCursor(0, 0);

lcd.print("BAT DEN SANG"); // Display "BAT CANH BAO" when value is 1

} else {

lcd.clear(); // Clear the LCD screen

lcd.setCursor(0, 0);

lcd.print("TAT DEN SANG"); // Display "TAT CANH BAO" when value is 0

}

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

}

}

Serial.println("\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_");

}

if (alarmSystemActive != previousAlarmSystemActive) {

if (Firebase.RTDB.setInt(&fbdo, "ButtonState/value", alarmSystemActive)){

Serial.print("ButtonState: ");

Serial.println(alarmSystemActive);

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

previousAlarmSystemActive = alarmSystemActive;

}

if (Firebase.RTDB.getInt(&fbdo, "ButtonState/value")){

alarmSystemActive = fbdo.intData();

Serial.print("Updated ButtonState: ");

Serial.println(alarmSystemActive);

if (alarmSystemActive == 1) {

lcd.clear(); // Clear the LCD screen

lcd.setCursor(0, 0);

lcd.print("BAT DEN SANG"); // Display "BAT CANH BAO" when value is 1

} else {

lcd.clear(); // Clear the LCD screen

lcd.setCursor(0, 0);

lcd.print("TAT DEN SANG"); // Display "TAT CANH BAO" when value is 0

}

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

}

}

Serial.println("\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_");

}

G"); // Display "TAT CANH BAO" when value is 0

}

}

else {

Serial.println("FAILED");

Serial.println("REASON: " + fbdo.errorReason());

}

}

}

Serial.println("\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_");

}