

UNIVERSITÀ DEGLI STUDI DI PALERMO

EMBEDDED SYSTEMS

Door Alarm System on Raspberry Pi 4

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1 Introduction

The project is a Door Alarm System. The System is able to monitor the open or closed status of a door using a hall sensor to detect the presence of a magnet; if the latter is far from the sensor, it is emitted a sound alert with a buzzer. Using two LEDs and a LCD display 16x2 the status of the door is shown. In addition there is a button that can be used to turn off the alarm when the door is closed.

In the following sections is described in detail the hardware and the software used to implement the project.

2 Hardware

2.1 Raspberry PI 4

The chosen target for this project is the Raspberry Pi 4 Model B, a single board computer developed by the Raspberry Pi Foundation and realeased in 2019. The tech specs include:

- Broadcom BCM2711, Quad core Cortex-A72 (ARM v8) 64-bit SoC @ 1.5Ghz
- 1GB, 2GB, 4GB, or 8GB LPDDR4-3200 SDRAM (depending on model)
- 2.4 GHz and 5.0 Ghz 802.11ac wireless
- Gigabit Ethernet
- Bluetooth 5.0, BLE
- 2 USB 3.0 ports, 2 USB 2.0 ports
- Raspberry Pi standard 40 pin GPIO header
- 2 micro-HDMI ports (up to 4kp60 supported)
- 2-lane MIPI DSI display port
- 2-lane MIPI CSI camera port
- 4-pole stereo audio and composite video port
- H.265 (4kp60 decode), H.264 (1080p60 decode, 1080p30 encode)
- OpenGL ES 3.1, Vulkan 1.0
- Micro-SD card slot for loading operating system and data storage
- 5V DC via USB-C connector (minimum 3A)
- 5V DC via GPIO header (minimum 3A)
- Power over Ethernet (PoE) enabled (requires separate PoE HAT)
- Operating temperature 0 - 50 °C ambient

2.2 KY-003 Hall sensor

The KY-003 hall sensor allow to detect a magnetic field. When the magnetic field at the Hall sensor exceeds the operate point threshold (BOP) the output of the device switches low. When the magnetic field is reduced to below the realease point threshold (BRP) the device output switches high. BOP and BRP may vary respectively from 1 mT to 33 mT and from 5 mT to 35 mT at operating temperature $T = 25^{\circ} \text{C}$ depending on the sensor model. This sensor is used to trigger the alarm when the magnetic field detected by the sensor is below the realease point threshold.

2.3 LCD 1602

The LCD 1602 is a liquid crystal display that can display 16x02 characters at the same time. This module provides a 16 pin interface and a I2C interface. It is used to show the door status (open or closed).

2.4 KY-012 Buzzer

The KY-012 Buzzer is an active piezoelectric buzzer, it generates a sound of approximately 2.5kHz when input signal (S) is high. The Buzzer is activated when the Hall sensor detect a magnetic field below the BOP

2.5 LEDs

When the Hall sensor detects a megnetic field that exceeds the BOP the green LED is on and the red LED is off. When the Hall sensor detects a megnetic field below the BOP the green LED is off and the red LED is on.

2.6 Button

The button is used to turn off the buzzer.

2.7 Resistors

2.8 FT232-AZ USB to TTL serial UART adapter

The FT232-AZ USB to TTL serial UART adapter is used to connect the PC used during the development of the project to the target in order to send and receive data between the PC and the Raspberry Pi 4. The PC is connected through a USB port, the target is connected through GPIO pins according to the following table.

GPIO #	Function	UART adapter
14 (Tx)	Output	Rx
15 (Rx)	Input	Tx
Ground	Ground	Ground

2.9 GPIO wiring diagram

The following table is the GPIO wiring diagram.

GPIO #	Function	Connection
2	SDA	LCD
3	SCL	LCD
6	Output	Buzzer
16	Output	Green LED
25	Input	Button
26	Output	Red LED
27	Input	Hall sensor
5V	Power	Breadboard
3V3	Power	Breadboard
Ground	Ground	Breadboard

3 Software