HausZero

We, HausZero, come with a vision to provide a new way of life. A way to make home smarter, more efficiency, more environmentally friendly, more potential for the future. As a human, we make mistake every day, being unaware about small stuffs, not know that those careless behaviors will cause a big consequence later not only to yourself but also to the earth.

HausZero does not want to blame human's imperfection. Instead, HausZero comes in a game to compensate and fill up this gap, this is an original mission of an engineer from the beginning.

HausZero provide a full set of sensors for the house including motion sensor to see if there is activities going on in some area, if not then this area should not be consuming any resource like light, TV, etc. and also be used for security in case owner or nobody is not supposed to be at home but there is some activities going on, that might means a break-in or unpleasant things going on, in this case, the owner will be alerted as soon as those unwanted activities happen to stop any kind of serious damage. Beside that, there are still a lot of application that our sensors keep track for you to avoid hazard like water leakage sensor, gas leakage sensor, temperature sensor, contact sensor, and a center hub which is coordinate with all smart sensor devices in Zigbee orientated communication protocol which is suitable for household usage in case of coverage area, security, energy consumption and speed.

In HausZero's package, one of the most used sensors is the smart motion sensor since it is going to be installed in a lot of corners, nearly all the entrance to each section of the house. That is why HausZero implemented this sensor specifically to reduce the price of the total package, by integrating a traditional motion sensor which cannot communicate to the host, to a Zigbee compatible communication module, along with battery, voltage regulator, buzzer, and other necessary stuff to make this smart motion sensor works together with the rest of Zigbee network and can be implemented easily without any technician.

HausZero aims to improve residential life quality together with more environmentally friendly solution, HausZero calculated the energy like gas, electricity, water that consumer could save using HausZero's solution based on Eurostat which is a huge amount wastes that can be saved.

HausZero is not going to stop here. This is the beginning of our journey. HausZero is just born and will continually grow along side with the earth with more solutions, more products, more services. Our missions are to make what should have been done to be done in the right way. HausZero are more than welcome for any idea and opportunities to glow, as HausZero still need a lot of lesson, a real-world experience, a companions.

Operation Principle

The main idea of this challenge is to make a smart home while ensuring security and low energy consumption. The whole structure of the smart home is made using Zigbee. The main reason behind this decision was that Zigbee has a good security protocol to work with all the devices ensuring proper encryption, using mesh topology we can create an expandable network and most of all, it is low energy consuming that the others.

Types of Devices used:

- Zigbee router (custom made motion sensor)
- Zigbee coordinator (Raspberry Pi based)
- Zigbee end point devices
- Zigbee Smart sockets
- Zigbee module integrated Bulbs

Types of sensors:

- Water Leakage Sensor (Zigbee end point)
- Contact sensor (Zigbee end point)
- Temperature Sensor (Zigbee end point)
- Gas Leakage Sensor (Zigbee end point)
- Smart motion sensor (Zigbee router)
- Hub (Zigbee coordinator)

Workflow

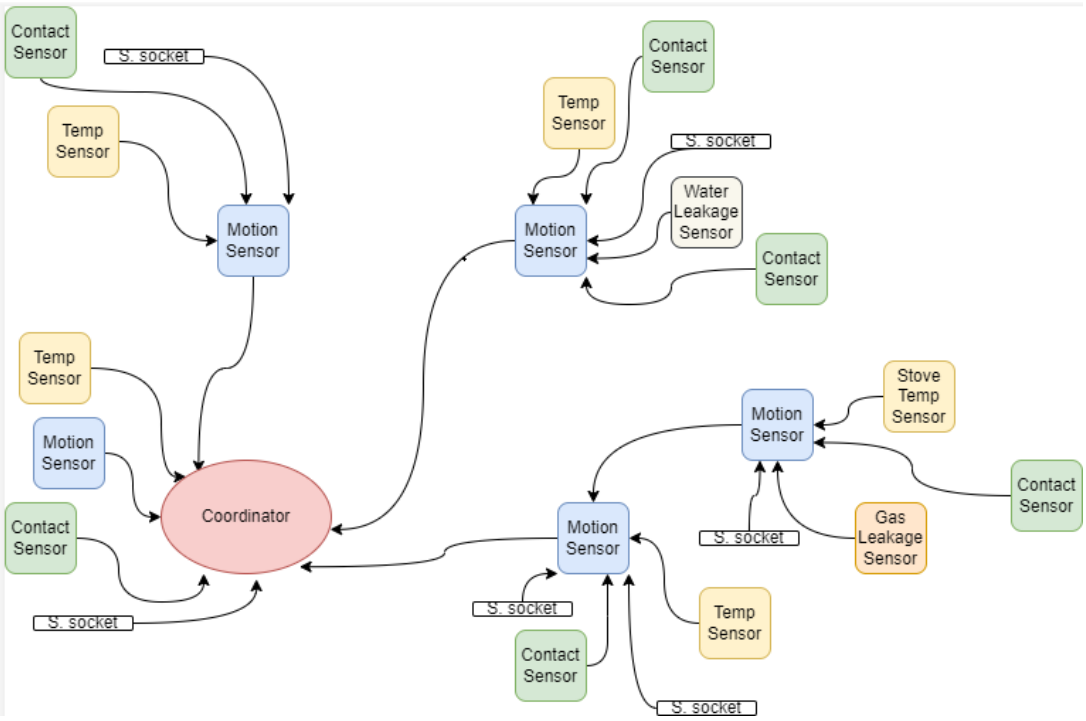
The working principle is simple. All the Zigbee end points are constantly sending data to Zigbee router. And the Zigbee routers are connected to the central hub. In our case, the sensors such as contact, water. Temperature etc. are sending data to the Zigbee router. All the electrical equipment's are connected to the Zigbee smart sockets to track the consumption of energy.

- **Water Leakage Sensor**: The water sensor will be used to keep track of water usage in bathrooms and kitchen.
- **Contact sensor**: Sensor used for keeping track of open window.
- **Temperature sensor**: Sensors to track temperature in rooms. In a special condition, the temperature sensor is used in cooperation with a motion sensor to detect the owner presence in front of the stove to predict possible mishap.

- **Gas Leaking Sensor:** To sense leakage of gas to let the owner know of the situation
- **Smart motion sensor**: Custom made motion sensor used to detect movement around the house to turn on the light. It also doubles as a burglar alarm system when the owner isn't home.

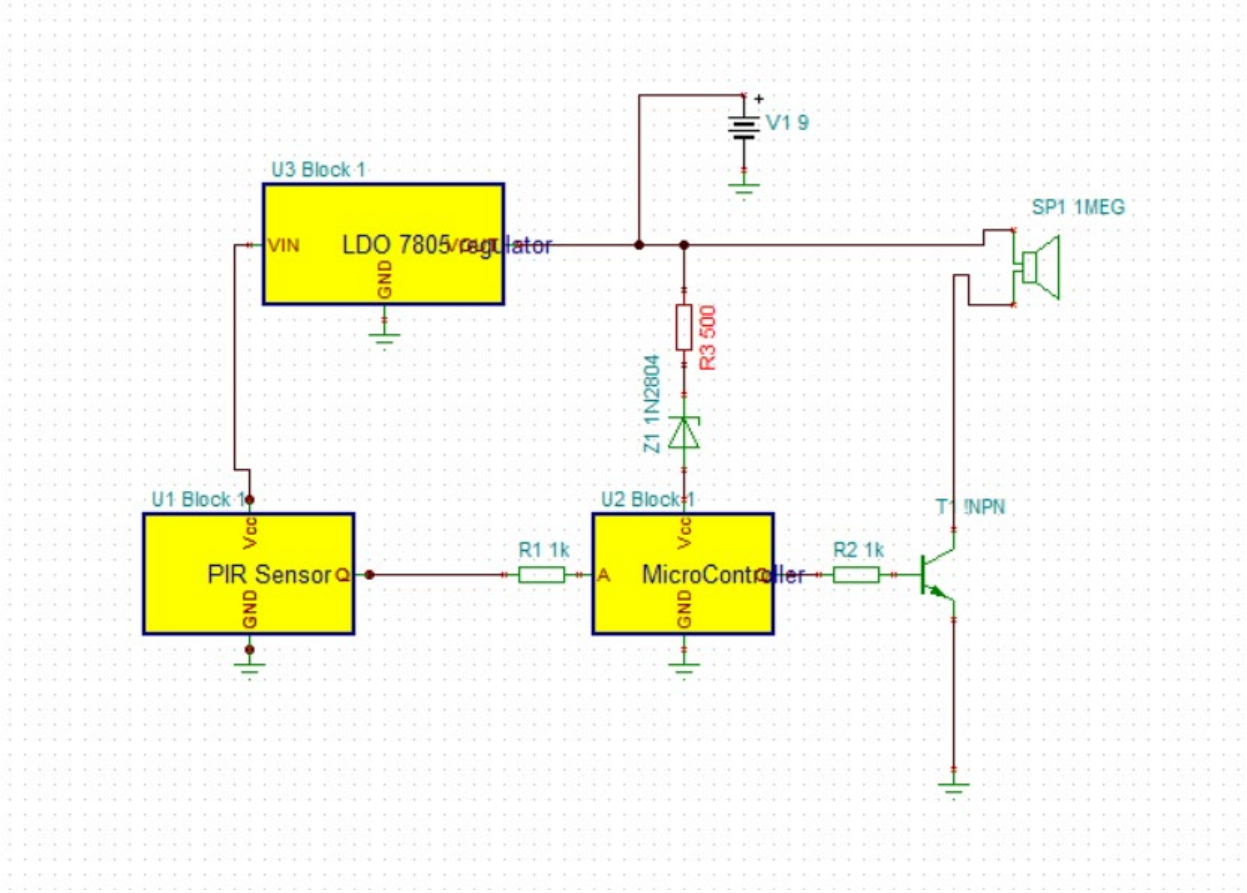
Water and gas leakage sensors detect leakage of water and/or gas to notify the user of possible leakage. Whereas temperature and contact sensor are mainly used to keep tabs on temperature usage and opened windows respectively.

Sensing Network



Custom Made Smart Motion Sensor

To ensure security and energy saving, we have created a custom motion sensor. The motion sensor will be able to detect movement in a particular room. The sensor works constantly with the zigbee coordinator to get input on the security status set by the homeowner.



Whenever the homeowner goes out, he/she sets a pincode to let the zigbee know. This triggers a key and is sent to the PIR sensor microcontroller. The communication with the microcontroller happens through Zigbee 3.0 protocol. For this specific purpose we have used STM32WB5MMG model of microcontroller. The reason behind using this microcontroller is that:

- it is very low energy consuming
- It has a built-in antenna to communicate with the coordinator
- Works well with Zigbee 3.0 protocol
- Cheap

The scenarios can be divided into two parts.

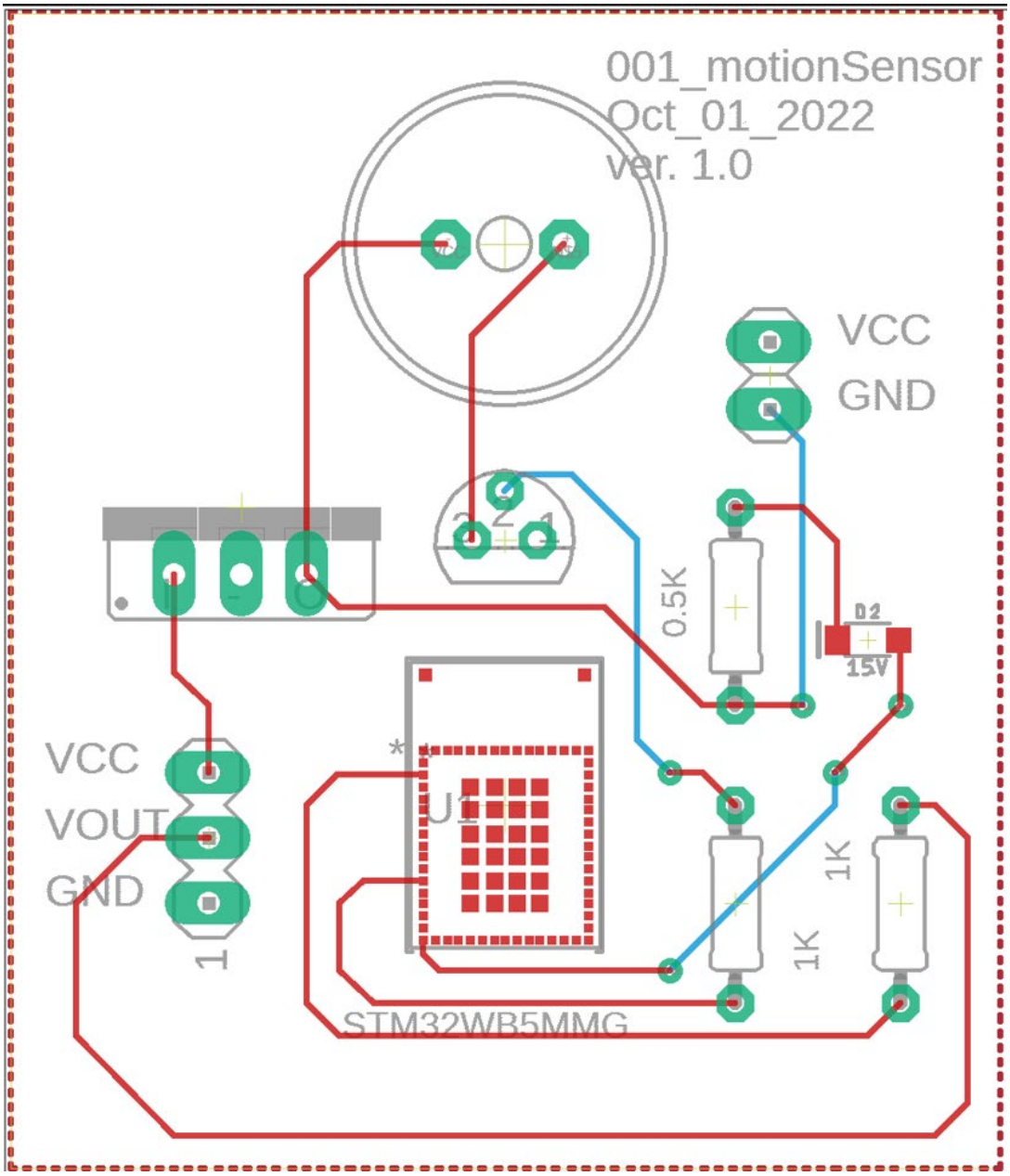
1) The owner is not home and there is movement. In this case, the alarm will go off and all the lights will turn on.
2) The owner is home. In that case, the alarm will not go off and the lights will turn on for the owner.

Workflow

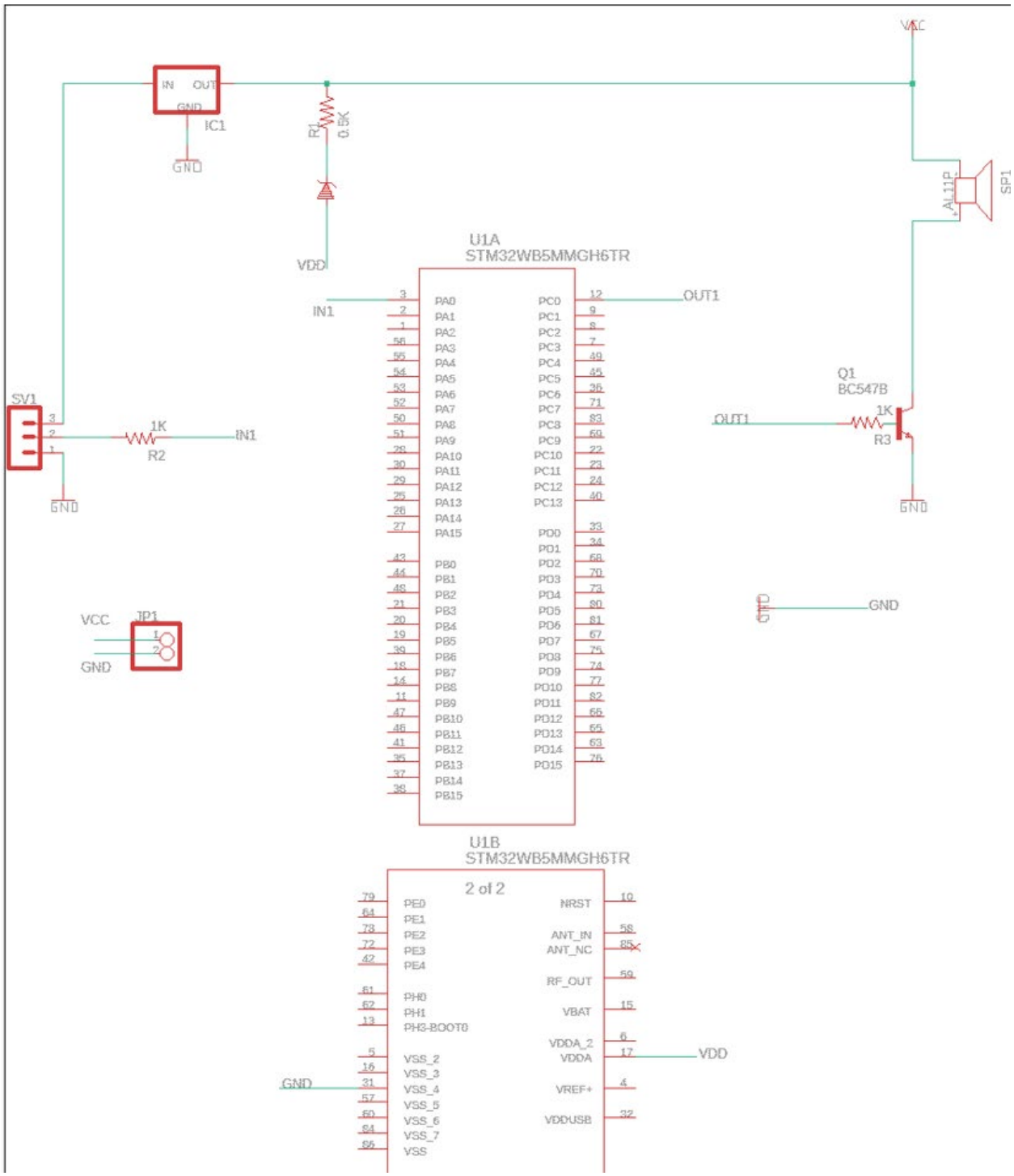
The PIR senses the movement and triggers a high voltage. After that It goes to the microcontroller. According to the security key, the microcontroller decides whether to turn on or not turn on the alarms. If the security key is high (owner is not home), the transistor pulls up and alarm goes off. Otherwise, no. For power supply we use a 9V battery. The battery is mainly used for the sound alarm system. And on the other hand, we need 5V supply for the PIR sensor. Due to this reason, we use a voltage regulator to turn the 9V to 5V.

The sensor is connected to the Zigbee module integrated smart bulb. So, the microcontroller integrated custom motion sensor can communicate with the bulb to turn it on in case of high output from the PIR sensor. Unless until the PIR sensor detects something, the microcontroller and the whole system stays in sleep mode saving energy consumption.

Schematic and layout (Custom motion sensor)



(A) PCB Layout



(B) Schematic

The inputs and outputs of the microcontroller have been configured using software.

Calculated Saving

saved

	Compact Fluorescent	Incandescent	LED
Time of non use\ Power (W)	40	60	15
number of lamps	5	5	5
average waste hours/week	12	12	12
Cost/month (€)	240	360	90
Cost/year (€)	2880	4320	1080
average for all types/year			

euro/kWh (for above average) 0.1

installation

	Price (€)	Number of pieces	
water sensor - MCLH -07	7.5	1	7.5
Gas sensor - ER-ZCG-QG	17	1	17
SMART MOTION SENSOR	30	4	120
Motion sensor	11	1	11
Taya temperature Sensor	8	5	40
Contact sensor - TS0203	8	4	32
raspberry pi + zigbee transever	60	1	60
			288

average price of heating bill (EuroStat)	160
percent saved by closing the door and windows	25%
saved by thermal system/year	480