A Smart House in the Context of Internet of Things

MARIUS RISTEIU[*], REMUS DOBRA[*], MONICA LEBA[*], ANDREEA IONICA[**]
[*]Department of Computer and Electrical Engineering
[**]Department of Management
University of Petrosani
Str.Universitatii, nr.20
ROMANIA
risteiumariusnicolae@yahoo.com, remusdobra@upet.ro, monicaleba@upet.ro, andreeaionica@upet.ro

Abstract: In a smart world characterized by a dynamic evolution of the information technology, the smart house is the place connected to this world and customized to the personal wishes and need. Our smart house consists in eight rooms, each having sensors (like temperature, proximity, light etc) and control devices connected to one central hub. The MatLab-Simulink is used in order to validate the automatic control algorithms.

Key-Words: sensor, control, IoT system, Simulink model

1 Introduction

Internet of things otherwise known as internet of objects refers to network interconnection of daily objects which most often are named smart objects.

Physical connection of objects to the internet makes possible remote access to the sensors to monitor, verify and control any connected smart system.

A smart object is a bit of internet of things, it is actually another name for an embedded system connected to the internet.

Another technology that is moving in this direction is RFID (Radio Frequency Identification) technology. This RFID technology is an extension for barcode which is very common and is found on almost all products we use in everyday life, which requires attaching of an electronic ID tag to the objects so in this mode information about the object can be remotely read.

2 Problem formulation

Smart house project has the starting point in the moment when some appliances from the house have been automated. Nowadays are developed a lot of smart systems inside the house but still can be found new solutions or improved the current solutions. In a smart house the electronic device communicates between them to consume fewer resources to be environment friendly without reducing the comfort.

Smart house system helps very much to resources and costs economy. As an example the temperature control that can offer a different temperature in each room according to owner wishes.

Smart home is a house that uses information technology to monitor the environment, control electric devices and for communication with outer world. Smart home is a complex technology and at the same time it is developing. A smart home automation system has been developed to automatically achieve some activities performed frequently in daily life to obtain more comfortable and easier life environment.

The smart house can monitor and control temperature, humidity, lighting, fire and burglar alarm or other systems inside the house or outside around it. Surveillance system and motion sensors are used to guarantee family safe. The system also has internet connection to monitor and control house equipment from anywhere in the world.

The interesting part of a smart house represents the facts that it can be controlled from a smart phone, tablet or laptop not being necessary a remote controller for each individual device, a single mobile application managing to incorporate all the equipment and the control and monitor can be realized from anywhere.

The appliances are interconnected and allow the communication between them to achieve some activities. These type of house is not just able to be remotely controlled, but it will give warnings for appeared problems, will decide and action with predetermined actions for the real-world cases.

If it is a break entering, the house will alert the owner, the police section and will close all other areas to defend it. If it is a problem to water supply, or with gas supply it will alert the owner and

authorized personnel but in the same time it will interrupt supply for damaged system.

Usually smart house means a varied system of automation subsystems.

These include:

- security system, fire alarm and access system
- water or gas leak detection system
- video surveillance system
- network communication system
- lighting system
- building mechanization (open/close doors and windows, underfloor electric heating etc.)
- Audio Video technique (home cinema, multi-room audio system)
- telemetry - remote tracking system
- IP object monitor – remote control for network system
- GSM monitor – remote information on incidents inside or outside the house
- remote control of electronic devices, actuators and other automation systems

3 Solution

We will consider the example of a house containing eight rooms monitored by sensors of temperature, proximity, light and switch (open/close) sensors. The control of the elements will be achieved based on information collected by the sensors, send it to a central hub and then in a database to be stored and processed. Also, remote control can be made manually by a device connected to the internet.

In figure 1 is presented the block diagram of the proposed smart house.

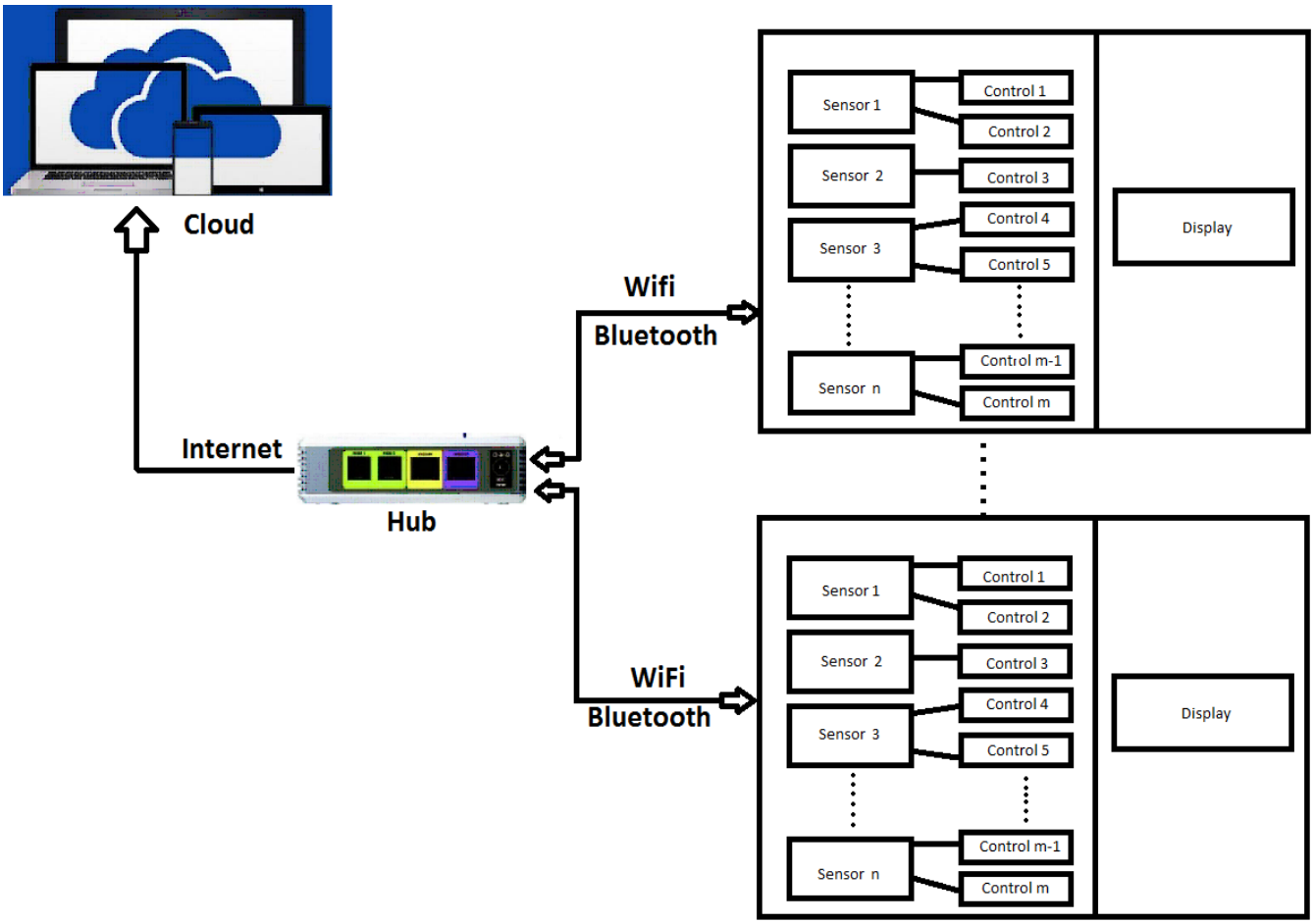

Figure 1. Block diagram of a smart house

As can be seen, for each room in the smart house we considered a number of sensors and controls suited for the purposes of the room. Each sensor is wireless connected to a central hub of the house. If the number of rooms or the surface of the house is too big, there can be considered a hierarchy of hubs connected to a central one.

The central hub is connected to a server that contains a cloud solution to store, update, analyze and process the data received from the sensors.

All the data are stored in a cloud database. By analyzing and processing the collected data from the smart house's sensors and taking into account the automation algorithm implemented in the control application there are sent information to the control devices from each room also through the central hub. This is the automatic part of the smart house. There also is a manual part that involves the house residents.

They can monitor the smart house on any internet connected device, like laptop, smartphone etc. Also, according to the information received they can manually send control information to the smart house.

In figure 2 there is presented a case study for a smart house consisting in eight rooms, each having both sensors and control devices connected to one central hub.

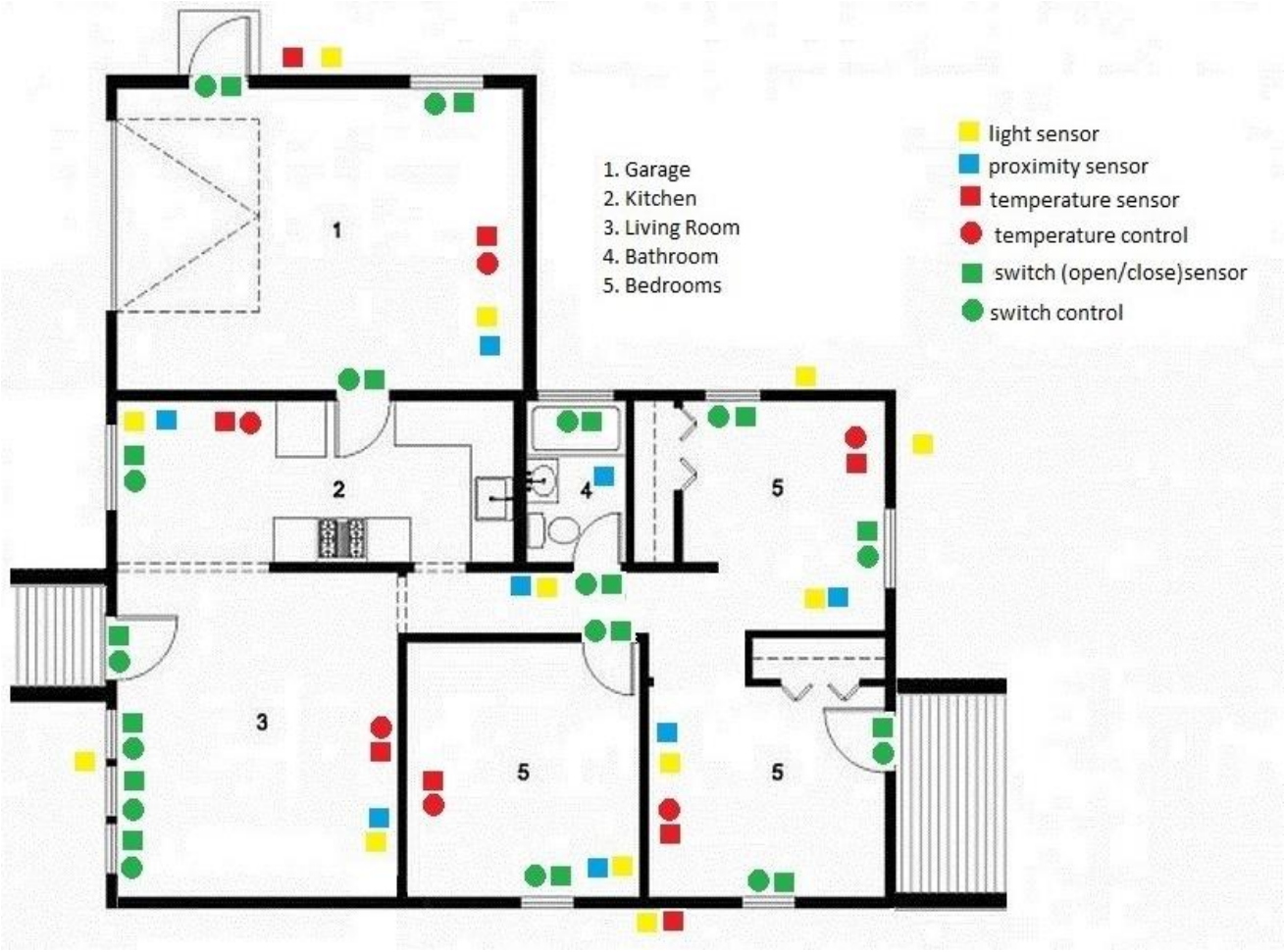

Figure 2. Blueprint of the smart house

We present in this case study the use of light sensors, temperature sensors, switch sensors and proximity sensors and of considered only switch type control devices for doors, windows, light and temperature control.

Next we present an example of source code for controlling the ambient temperature using a temperature sensor and using a "setvalue" read from a local display or smart device and considering a hysteresis also adjustable by local or remote settings.

```
#include <SPI.h>
 const int SSPin=53;

void setup()
{
 pinMode (SSPin, OUTPUT);
 pinMode(7,OUTPUT);
 SPI.begin();
 Serial.begin(9600);
}

void loop()
{
 digitalWrite(SSPin, LOW);
```

```
 byte oct1 = SPI.transfer(0x00);
 byte oct2 = SPI.transfer(0x00);
 digitalWrite(SSPin, HIGH);
 int val=oct1<<8 |oct2;
  if (val & 0x1)
{
    Serial.println (2000);
}
else
{
    val&=0xfffc;
    float temp = val / 16.0;
    Serial.println(temp);
    int PVM = 0.40 * temp + setvalue;
    if( PVM > 50)
{
     analogWrite(7,PVM);
     Serial.println(2001);
}
else
{
     digitalWrite(7,LOW);
     Serial.println(1999);
}
}
 delay(200);
}
```

For the light system of the smart house we present in figure 3 the MatLab-Simulink model and simulation considering as input elements a light sensor inside the room, a light sensor outside the house and switch sensors for the current state of the windows/curtains of the room and as output a control device that opens/closes the room windows and/or the curtains and a control device for the inside light system.

We considered the following control logic for this case:

- For the curtains:
  - if the time is passed a present value (e.g. 9 in the evening) we send a close control signal for the curtains;
  - if the time is passed a present value (e.g. 7 in the morning) we send an open control signal for the curtains;
  - in the interval between the morning and evening preset times, if the light sensor from the outside of the house shows an intense light (over a preset threshold) we send a close control signal for the curtains and if this light sensor shows a dimming of the outside light intensity (below a preset threshold) we send an open control signal for the curtains;
- For the light system:
  - by comparing the values read from the inside and outside light sensors we send control signal for the inside light system, e.g. dim the inside light if the outside light is higher than the inside.

We presented this case study, considering the temperature control system is similar to the light control system.

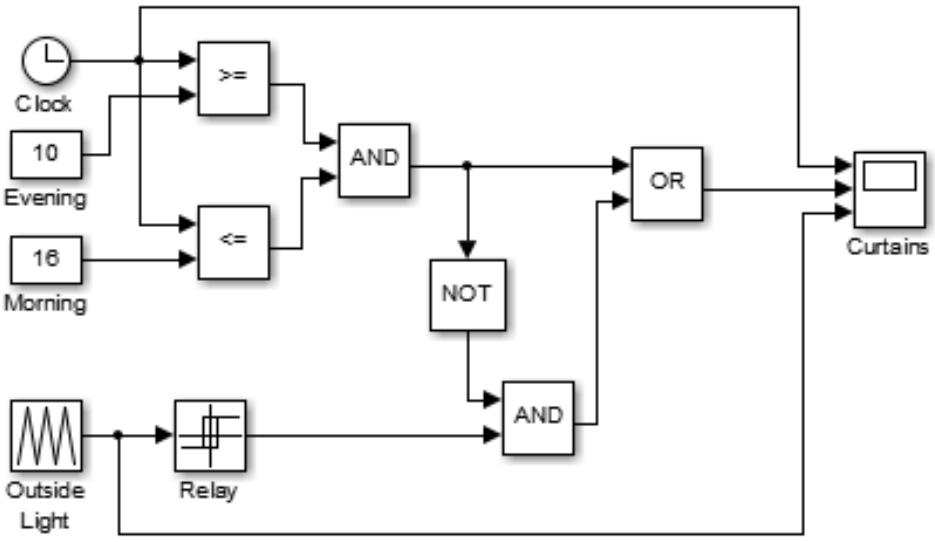

Figure 3. MatLab Simulink model

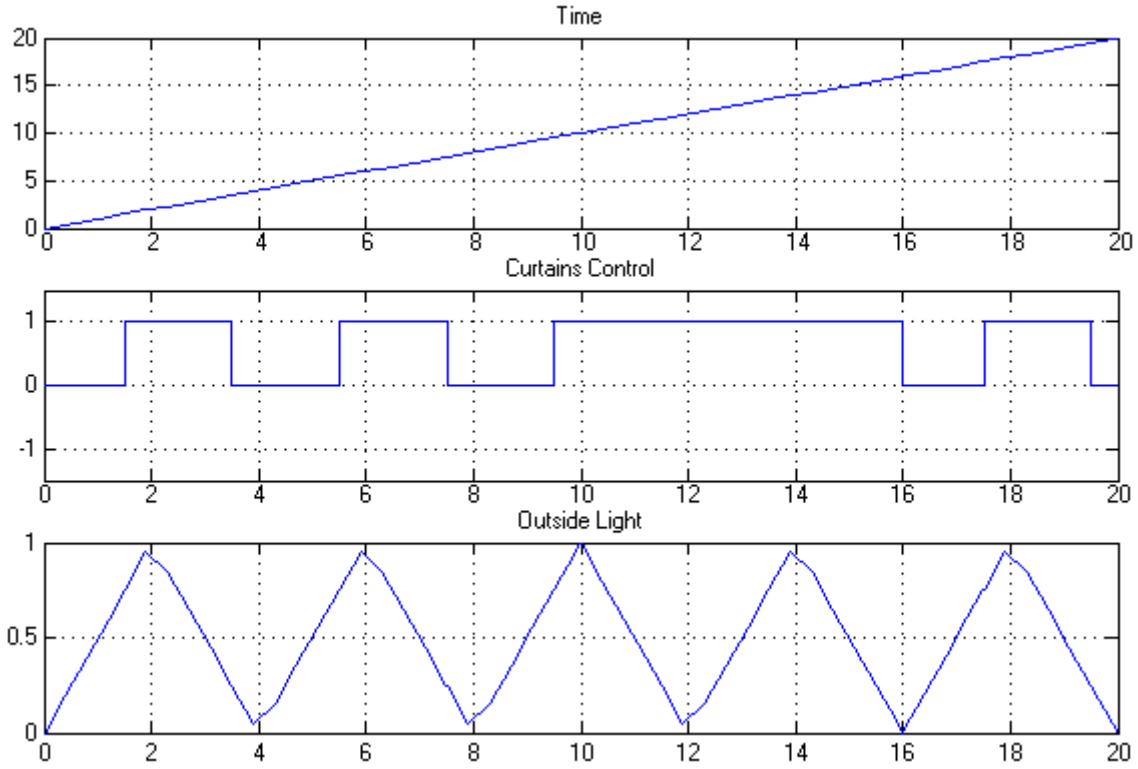

Figure 4. MatLab Simulink simulation results

4 Conclusions

The smart house represents the future of our homes that is building in the present. The paper proposes a system that can be easily adapted to any configuration of a house, by a modular construction principle, with all the components connected to a central hub. The modular principle also allows an easy upgrade of the proposed smart house configuration. The simulation was achieved in order to prove the viability of the automatic control principles implemented in the control algorithms developed for the smart house.

References

[1] Arshdeep Bahga Vijai Madisetti, Internet of Things, VPT, 2015, ISBN 978-0996025515
[2] Michael Miller, The internet of things, Que Publishing, 2015, ISBN 978-0789754004
[3] John Boxall, Arduino Workshop - a hands–on introduction, No Starch Press, 2013, ISBN 978-1593274481
[4] Fraden Jacob, Handbook of modern sensors, Springer; 4th ed., 2010, ISBN 978-1441964656
[5] Hermann Kopetz, Internet of Things in Real-Time Systems, Springer, 2011, pp 307-323, ISBN 978-1-4419-8236-0