Smart House.

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1. Introduction

The aim of the project was to design and implement a simulation of smart house system. Smart house system is an intelligent house equipped with the variety of smart devices that provide homeowners security, comfort and convenience (J. R. Harper 2003). The simulation consists of the functional breadboard with implemented logic using Arduino and FPGA microcontrollers integrated into the prototype house built using carton. Since the design of the system requires combination of different sensors that were introduced during regular laboratory sessions throughout the course, this project is important in developing skills which would enable students to integrate acquired practical knowledge of using sensors devices to solve the real-world problem.

2. Materials and Methods

a. Arduino board and breadboard.
b. FPGA as an additional power supply.
c. 2 servo motors for automatic garage gate and window opening.
d. 1 VEX Ultrasonic Sonar for recognizing a car as it nears a garage.
e. Light sensor for identifying whether it is night or day outside.
f. Gas sensor for detecting gas leaks and other emissions in the house.
g. Human Body Infrared Sensor (PIR) was used for detecting a human presence at the house. Consequently, it was employed for automatic light and anti-burglary systems.
h. Humidity sensor to measure humidity level outside, which, in turn, indicates the occurrence or absence of rain.
i. 1 Dip Switch 8. One of the switches was used to toggle between automated and manual light systems. The second switch was used to manually turn on and off the light.
j. Speaker for sounding an alarm.
k. LEDs provided the lights in the house.
l. Wires.
m. Resistors to connect the switch, sensors and LEDs.
n. 1 Carton box to build the house.

3. Results

Our initial concept was to create a smart house that would drastically increase the quality of life of people living in it. We tried to include in our smart house as much sensors as possible.

3.2. Schematic illustration of the Smart House

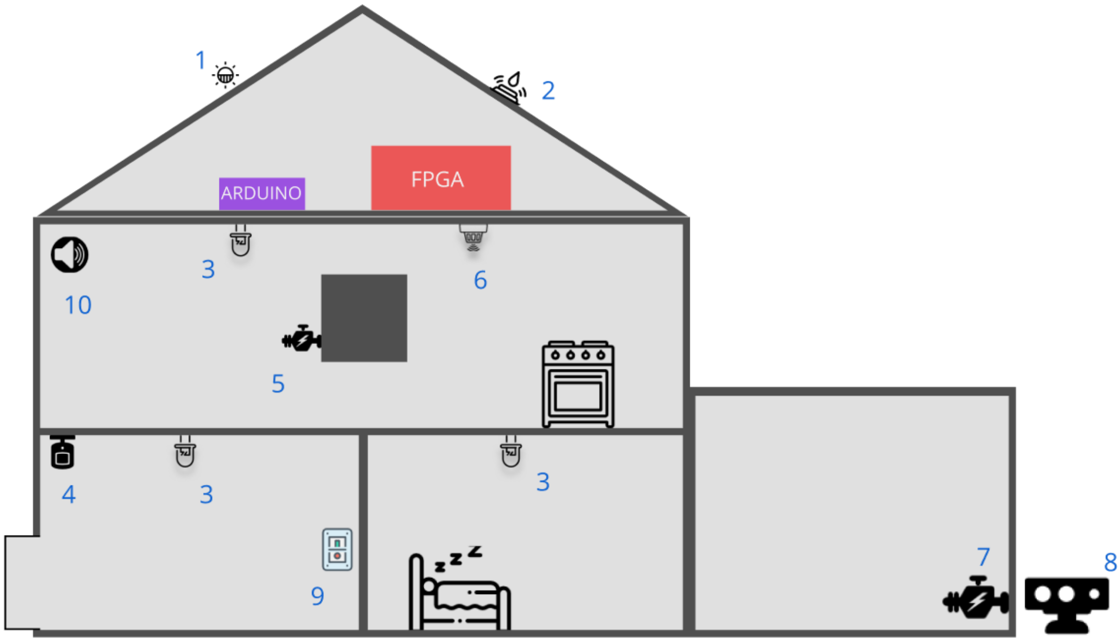

Figure 1. Schematic location of sensors and actuators

Table 1. Description of sensors and actuators from the Figure 1.

Sensors #	description
1	Light sensor
2	Humidity Sensor
3	LED
4	Infrared sensor
5	Automatic window opening servo motor
6	Gas/Smoke sensor
7	Automatic door opening servo motor
8	Distance sensor
9	Main switch
10	Speaker

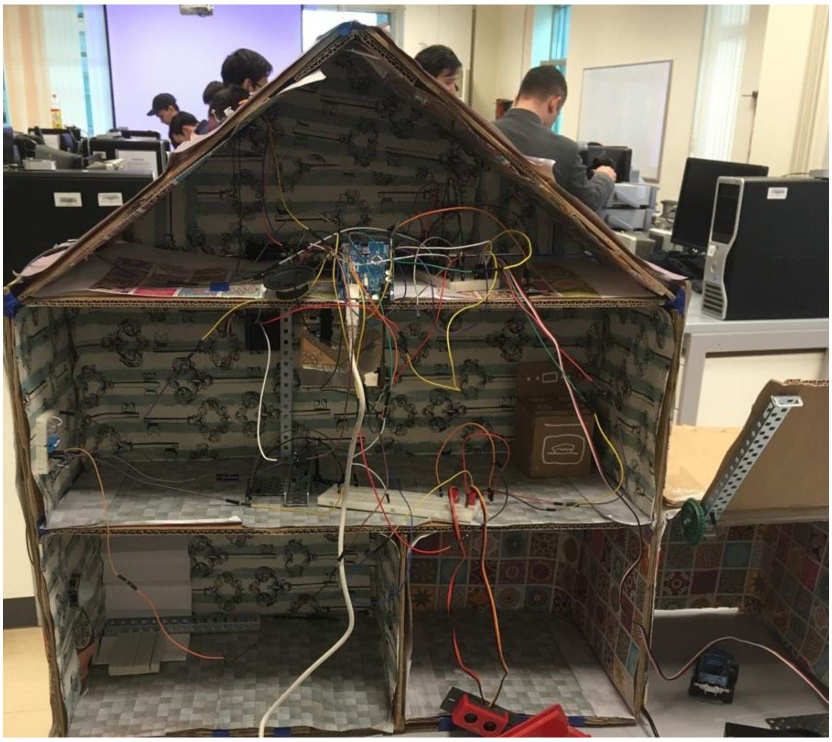

Figure 2. Working prototype

3.3. Description of work.

We designed our house in a such way that FPGA and Arduino are located on the attic in order to minimize the interaction of a final user with internal components of the system. This smart house has a system of automatic lighting. Whenever person enters the room, infrared sensor (4) detects person and toggles on the light (3) if light sensor (1) detected that outside is dark. In addition to this, person can toggle on the light with a manual switch (9) whenever he wants to. This infrared sensor is also used as anti-burglary protection. When the home owners are not at home and infrared sensor detects any movement in the house it will turn on the siren (10) automatically.

As you may know, there are millions of house fires occurs in the world everyday. Possible solution that will prevent these fires could be Gas/Smoke sensor (6). In our house, whenever this sensor detects a smoke or gas it will automatically turn on the siren from the speaker (10) which will help to notice that something is burning.

Our house also has an automated window opening/closing system and garage door opening/closing system. Servomotors (5) that are attached to the window will close and open it according to the weather outside. It works using humidity sensor (2). As you know, whenever rain is coming, humidity of the air increases which leads to the closure of the windows. Automatic garage doors works whenever distance sensor (8) detects an object in front of it. It causes doors to open automatically.

4. Discussion and Conclusions

The goal of our final project was to create a working prototype of a smart house. At the initial stage of our project we wanted to have an FPGA board as the main control unit of our sensory system. Unfortunately, it was quite challenging to make sensors work with our FPGA board, since sensors that we used were made for Arduino board and all the supplemental libraries had to be installed into Arduino software. Therefore, we had to make a transition from FPGA board to Arduino (nevertheless, we attach out tentative FPGA-compatible Verilog code).

We were able to connect light, gas, proximity, infrared sensors, a speaker and two Vex motors to our Arduino board. FPGA acted as an additional power source. One problem that we had was with the humidity sensor as it required completely independent circuit for proper work. We could have done it but we were short on batteries.

By building a working model of smart house we wanted to show that simple arrangement of sensor network can improve lives of many people. By replacing Vex motors with more powerful ones the proposed model can be easily used in a real house environment without any complicated additional configurations.

Student Contributions: Dinmukhammed Baimurza and Askar Kossymzhan were involved in circuit design and implementation. Yegor Chsherbatykh was programming Arduino. Altyn Zhelambayeva and Anel Kassenova were building a smart house prototype and helping to test each sensor. Every team member was actively involved in fixing bugs and circuitry problems we encountered on the way.

References

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