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SMART HOME SYSTEM HARDWARE and SOFTWARE DESIGN

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Abstract

The smart home system has been developed since 1980s. Its first application was built in 1984, in Turkey. In these first steps, the focused group was only people without disabilities. Initially, manufacturers tried to create all-in-one systems, yet the final products were all gadget-like and minimalistic. (Energy control units, security systems, light controllers, etc.) Smart homes have various application areas. Controlling central air conditioning in modern high-rise buildings, malls with parameters such as temperature and humidity is an example of real-time programming of these devices. The main idea here is to control the capacity of air conditioning equipment in order to save energy, thus saving money. The goal of our article is to make life easier with the help of computer science. With our knowhow and extra research of available information, by using the software portions and the hardware components, we aim to create a sensor-based smart home system. Basically, the system is getting the data from the sensors placed in different locations in home and transfer it to terminal via Wi-Fi. In the flowchart, the most crucial part is to connect the hardware problem-free. Next thing is to upload the code for these modules to an EEPROM computer to establish connection between devices and to display the information in the terminal screen. The designed system looks like an autonomous computer which can control the air conditioning with the help of various sensors with precision.

AKILLI EV SİSTEMİ DONANIM ve YAZILIM TASARIMI

ÖZ

Akıllı ev sistemi 1980'lerden beri geliştirilmeye devam edilmektedir. Türkiye'de ilk uygulama ise 1984 yılında yapılmıştır. İlk uygulamalarda, sıradan her hangi bir fiziksel engeli

olmayan insanların ev konforu düşünülmüştü. Üreticiler, bir sistemin bütününü entegre etmeyi amaçlamamışlardı. Ancak bireysel olarak kontrol edilebilecek birçok ürün çeşidi ortaya çıktı. (Enerji kontrol ünitesi, güvenlik sistemi, ışık kontrolcüleri… gibi). Literatürde bahsedildiğine göre çok farklı uygulama alanları, tipleri ve kapsamları mevcuttur. Yüksek katlı modern binalarda veya büyük alışveriş merkezlerinde, merkezi havalandırma sistemlerinin sıcaklık ve nem gibi parametre kontrolleri ile ilgili cihazların çalışma zamanlarının programlanması bu örneklerden biridir. Genel kurulum amacı binalarda kullanılan ısıtma soğutma ekipmanlarının kapasite kontrollerini yaparak enerji tasarrufu elde etmektir. Bu makaledeki amaç, insan hayatını kolaylaştırmaktır. Bilgisayar biliminin bununla ilgili kısımlarını kullanmak amaç edinilmiştir. Bu çalışamda, yazılım ve donanım unsurları kullanılıp insan hayatına katkıda bulunacak biçimde sensör temelli basit bir akıllı ev sistemi kurulacaktır. Sistem temelde ev içine farklı ortamlarda konumlandırılan alt bilgisayarlara bağlı ısı, nem ve çeşitli hayati öneme sahip gaz sensörlerinden bilgiler alıp kablosuz bağlantı yardımıyla ana bilgisayara bilgiler gönderip anlık olarak ana bilgisayara bağlı ekran vasıtasıyla bilgiler buradan görüntülenecektir. İş akışında en büyük başlangıç donanım kısmını sorunsuz bağlantılarla bir araya getirebilmektir. Ardından yapılması gereken asıl işlem ise bu modüllere uygun kodları EEPROM'lu min bilgisayarlara yükleyip cihazlar arasında iletişimi sağlayabilmek ve bilgileri doğru bir biçimde anlık olarak ekranda okunur bir biçimde görüntülemektir. Tasarlanan sistem, ilgili sensörler araclığıyla akıllı ev sistemi olarak çalışan otomatik bir bilgisayara benzemektedir.

Keywords: *Smart Home System, Hardware and Software Design, Arduino*

Anahtar Kelimeler: *Akıllı Ev Sistemi, Donanım ve Yazılım Tasarımı, Arduino*

1. INTRODUCTION

Technologic developments goes very fast and one of its application area is smart home. In this article, we develop this system both hardware and software structure. In 2005, scientists designed Arduino microcontroller. There are lots of projects implemented via this controller and this is very popular in electronical and computer science. Using this component decreases costs and increases designing of smart home. We contribute in this implementation area. Our system is secured closed loop home system which save energy and other

things. Designed system controls heat, gas, humidity, lighting and security [1-7]. It makes life easy and comfortable. Smart home also can be controlled with mobile phones and softwares. It can used with personal computer. Figure 1 shows the general structure and functions of smart home.

Figure 1. Application areas of smart home system

Arduino Mega 2560 R3 model is the central control unit of the system. Each electrical sockets can be connected with the system. For example, kettle, iron and other machines can be added easily to the system. In this case, switch on/switch off part must be added on to socket. All the sytem can be defined as automation system.

Arduino is open source microcontroller and its circuit schema is also open for every one. It is quite easy to make an electronical and software applications with it. PIC C is a programming language in order to use it. Necessary components are one type of Arduino (uno, mini, mega, leonardo) controller, USB cable, IDE program and computer.

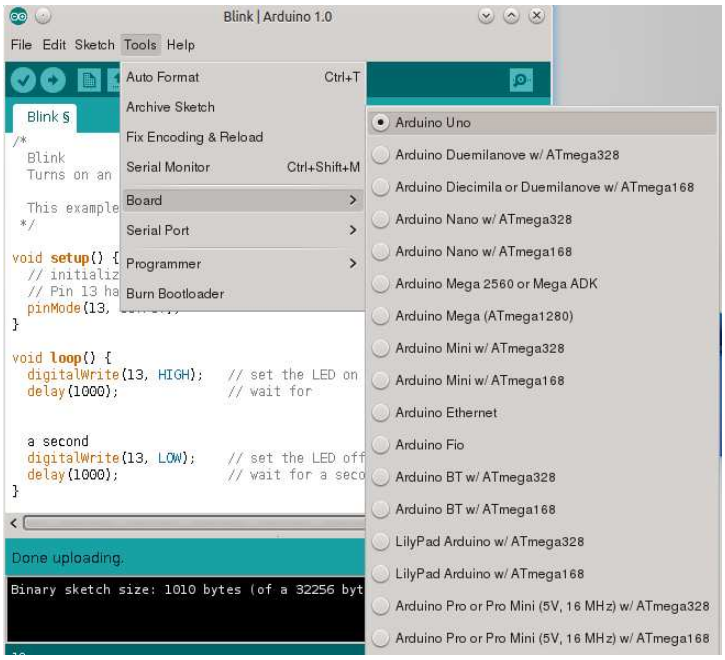

Figure 2. Arduino Model Choice Screen

We firstly choose Arduino port from menu in order to connect it with computer. After that the system has been developed.

2. HARDWARE / SOFTWARE COMPONENTS and THEIR IMPLEMENTATIONS

In this chapter we describe the hardware and software components of smart home system and their implementations. These components are Arduino Nano, Aluminium heatsink, small 5V air conditioned fan, Arduino Mega 2560 R3, 2x16 LCD keypad shield, 2.4 GHz wireless module, IR remote controller, thermal paste, DHT-11 heat and humidity sensor, MQ-2 / MQ-4 / MQ-7 gas

sensors, cables, prototype paltform (802 pointed breadboard) and other equipments. Arduino nano has ARM architecture 15 MHz clock cycled microcontroller. It has compatible with Bluetooth, wi-fi, GSM and USB.

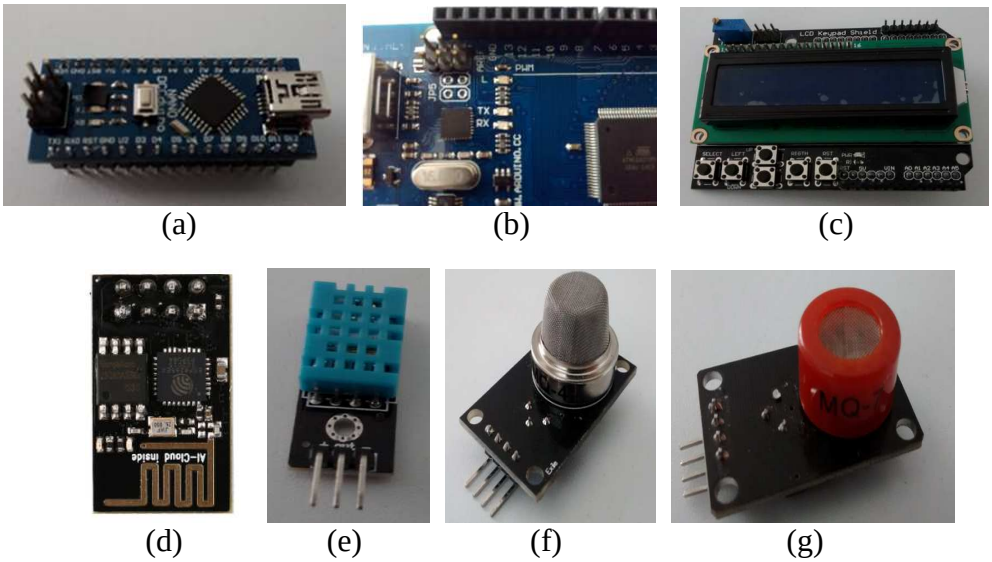

Figure 3. (a) Arduino nano (b) Arduino mega 2560 R3
(c) 2x16 LCD keypad shield (d) 2.4 GHz wireless module
(e) Heat and humidity sensor (f) MQ-4 gas sensor (g) MQ-7 gas sensor

Arduino mega 2560 R3 is our main computer which conduct the system and it has 16 MHz processor. There is USB point, 9V input on it, three LEDs and on/reset modules. 2x16 LCD keypad shield has buttons with matrix screen. Each row has 5x8 pixels. ASCII characters can be shownd and used on this screen part. 2.4 GHz wireless module works with 3.3 V. They have also antenna version. For home system development we have MQ-4 and MQ-7 gas

sensors. They detect CNG/LPG gas and carbonmonoxyde gas, respectively. These components can be seen from Figure 3. After opening the Arduino IDE, the libraries and definitions has been stored in to system. After adding libraries we defined the variables. These can be seen from Figure 4.

```
#include <LiquidCrystal.h> //lcd ekran kütüphanesini dahil ediyoruz
#include <dht11.h> // dht11 kütüphanesini ekliyoruz.
#define DHT11PIN 52 // DHT11PIN olarak Dijital 52'yi belirliyoruz.
dht11 DHT;              //Sıcaklık sensör tanımlama
LiquidCrystal lcd(8, 9, 4, 5, 6, 7);
```

```
void setup() {
  lcd.begin(16, 2); //lcd ekran başlangıcı
  lcd.createChar(0, newChar); //bar karakterini oluşturma
  pinMode(trig, OUTPUT);   //mesafe ölçmek için çıkış yapan ses dalga pini
  pinMode(echo, INPUT);    //mesafe ölçer için giriş yapan ses dalga pini
  pinMode(backlight,OUTPUT);//arka plan ışığının çıkış birimi olduğunu gösteriyoruz
  digitalWrite(backlight,HIGH);//arka plan ışığını başlangıçta aktif  ediyoruz
  menuAcilis();  //açılış menüsünü çağırıyoruz
  clearPrintTitle();     //üst satırı belirliyoruz
  }
```

Figure 4. Libraries, definitions and setup function

We define main menu with keypad. The screen is 16x2 matrix and x variable has been used for this. After that up, down, right and left keys defined for the system. Menu content also can be seen from user to control the smart home. We code the system and start the dynamical test phase.

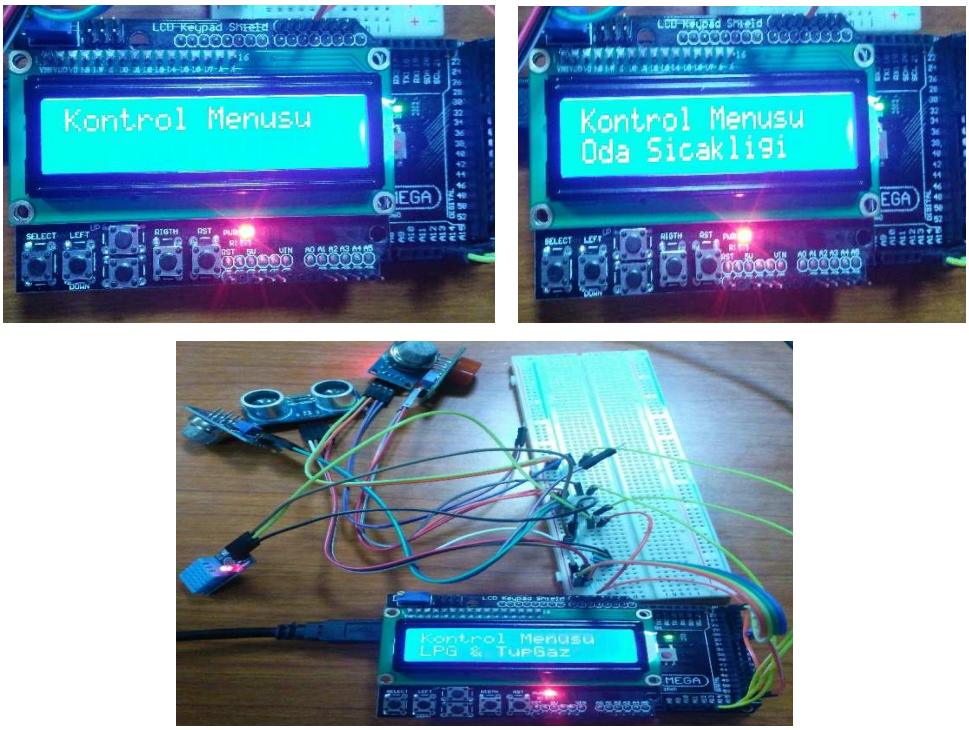

Figure 5. Smart home system

Smart home system illustrated in Figure 5. All hardware parts and software developments, coding phase has been completed in order to use it. We complete the design of the system with many parts.

5. CONCLUSION

Arduino microcontroller is one of the most popular card in a few years in order to design several electronic, robotic and software based system. It is easy to use, practical and compatible with many different hardwares. Lots of

applications developed by the scientists and they make life easier. Arduino developed in several years and there are several types of them available for the experiments. Entegrated systems also can be constructed with it. Connection can be made not only with cable but also wireless. Because of its many advantages we use it to design smart home system. These systems make life more comfortable, easier and economic. Because, controlling part of the home save energy. Especially, security, electrical machines, gas controlling, heat, humidity, lightining and automatic climate system main acquisitions from the systems. Mobile phones also can be used to control the smart home system.

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