Technical Devices for Supervising of a Household via Interned Based on Arduino Microcontroller

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Abstract: The article deals with the interconnection of the Arduino microcontroller with sensors and with an interface which is connected to the Internet. Selected sensors are intended for home usage. We used sensors for measuring of temperature, humidity, light intensity and the status of doors or windows (opened / closed). Microcontroller can be programmed to respond on some triggered events and to run an appropriate action.

Key-Words: Arduino, microcontroller, sensor, Internet, household control

1 Introduction

The basic device to control an intelligent household is a microcontroller, a small complete computer on a single integrated circuit, containing a processor core, a memory and a programmable input and output peripherals. As the first microprocessor, which was ever made, is considered Intel 4004, which was introduced in 1971. This microprocessor needed for its operation other external chips for the functioning of the whole system. As the first microcontroller is considered TMS 1000 from Texas Instruments developed in 1971 and launched on market in 1974. In response to 1000 TMS Intel developed microcontroller 8048, which is the first Intel's microcontroller [1].

2 Arduino

Arduino is an open source hardware. The license allows anyone to improve, build or expand Arduino (licensed under a Creative Commons Attribution Share-Alike 2.5). This licence led to a very popular platform and its extension. The original Arduino and its development environment was founded in 2005 in Italy in the SmartProjects company. A year later this project won an award at the Prix Ars Electronica 2006. In addition to this project several clones were made. These clones usually contain some improvements and are compatible with the Arduino and its development environment. These clones are not allowed to bear the name Arduino, but for example FreeDuino (primarily, a name that anyone can use), Boarduino, Seeduino, Roboduino (intended for design of robots) and others are allowed. The microcontroller belongs to an ATmega family manufactured by a Norway's company Atmel [2].

2.1 Digital Input / Output

Digital input / output works with binary values 0 and 1, in some sources reffered to as Low and High value. Logical 0 corresponds to 0 V and logical 1 corresponds to 5 V. Some older versions of Arduino (for instance one of the Pro or Mini Pro versions) have logical 1 corresponding to 3.3 V.

2.2 Analog input

Analog input of Arduino has a 10 bit analog - digital converter. This gives us a numerical value range from 0 to 1023 [4]. The value 1023 corresponds to 5 V and a value 0 corresponds to 0 V at the analog input. The difference between two values corresponds to 0.0048 V.

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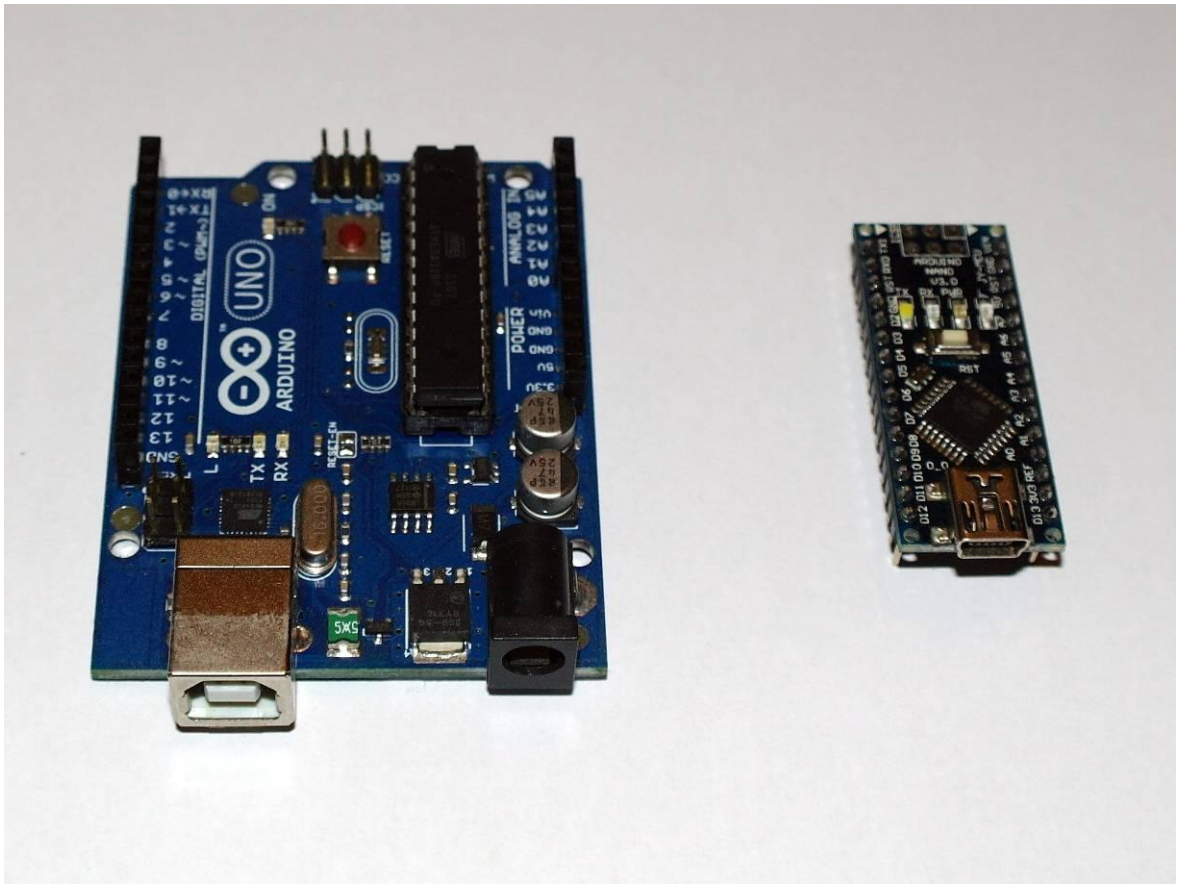

Fig. 1: Ardunino Uno and Arduino Nano

Technical specifications of Arduino:

	Arduino Uno	Arduino Nano	Arduino Mega 2560
Microcontroller	ATmega328	ATmega168 or ATmega328	ATmega2560
Operating voltage	5V		
Input voltage (recommended)	7-12V		
Input voltage	6-20V		
Digital input / output pin count	14 (6 PWM)		54 (14 PWM)
Analog input pin count	6	8	16
Memory Flash / SRAM / EEPROM	32 KB / 2 KB / 1 KB	16 KB / 1 KB / 512 B or 32 KB / 2 KB / 1 KB	256 KB / 8 KB / 4 KB
Flash – used by the loader	0,5 KB	2 KB	8 KB
Frequency	16 MHz		
Size (mm)	68*53	43*19	101*53

Table 1: Comparison of selected parameters of the current types [3]

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3 An Ethernet card

The Ethernet card for Adruino belongs among the official Arduino Shields. The newer version includes a slot for Digital Security (the SD) memory card. Version without the SD card connected to the Arduino interface uses 4 digital pins, version with the SD card uses 5 pins [3]. These versions of the card use different versions of Ethernet controllers. Newer card version uses Wiznet W5100 controller. But the older version that contains the ENC28J60 controller was used. According to the chosen controllers the appropriate libraries must be used.

Fig. 2: Ethernet card for Arduino Ethernet Shield V1.1

The card does not have default MAC address. The programmer must choose a unique MAC address to a computer network, where the microcontroller is connected.

4 Sensors

Sensor is an operational element forming the input block of measuring chain that is in direct contact with the measured environment. The term sensor is equivalent to the concept of scanner, transducer or detector. The sensitive part of sensor is sometimes referred to the sensory receptor. Sensor as the primary source of information reads observed physical, chemical or biological variable and transforms it into a measured value by using defined principle - mostly to the electric quantity. Furthermore, there are sensors, which transform the non-electrical quantity directly into a digital signal. [5].

Sensors are distinguished by [5]:

- According to the measured value
- According to the physical principle
- According to the sensor's contact with the measured environment
- According to the transformation of the signal
- According to the production technology

Smart sensor is such a sensor, which contains the sensory receptor, processing circuits, signal analysis and unification in a single compact design. [5]

The chosen sensors had been already connected to the Arduino by someone before. There are also available examples, diagrams and source codes, how to use them with the Arduino.

4.1 Temperature

To obtain a temperature Dallas DS18B20 sensor was selected. A lot of information and examples how to connect this selected thermometer sensor to the Arduino are available on the Internet. There are available source codes, libraries and examples as well. This sensor is a digital thermometer. Sensor is connected to the only one data pin forming a bus. The bus is marked as 1-Wire by the manufacturer. The connection to the bus allows you to connect multiple sensors or other devices (1-Wire) on a single data pin [6]. Each component has its own unique predefined address. If we need to connect more thermometers to the Arduino, we can use other digital pins to different sensors or cards. The accuracy of this sensor is excellent for household use. This thermometer can be purchased in the Czech Republic.

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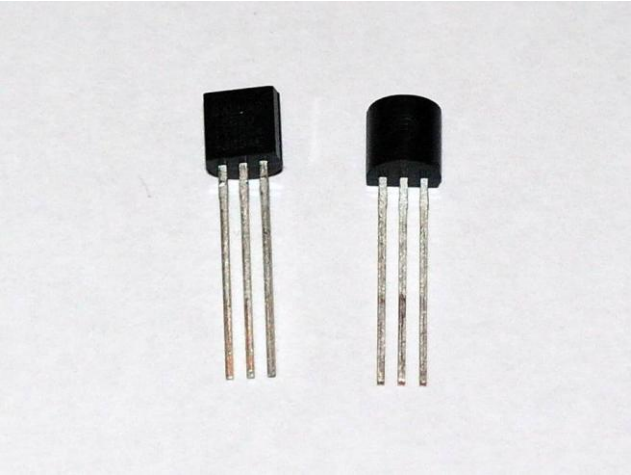

Fig. 3: Digital thermometer DS18B20

Accuracy	+/-0,5°C (at temperatures from – 10°C to +85°C)
Measuring range	from –55°C to +125°C
Accuracy of the output	optional from 9 to12 bits 0,5 °C, 0,25°C, 0,125 °C
Thermometer address	Unique address - 64 bits
Power supply	from 3.0 to 5.5V
Measuring speed	Max. 750ms at 12 bit accuracy of the output
Price in January 2012	2.08 €

Table 2: The Dallas DS18B20 thermometer – parameters [6]

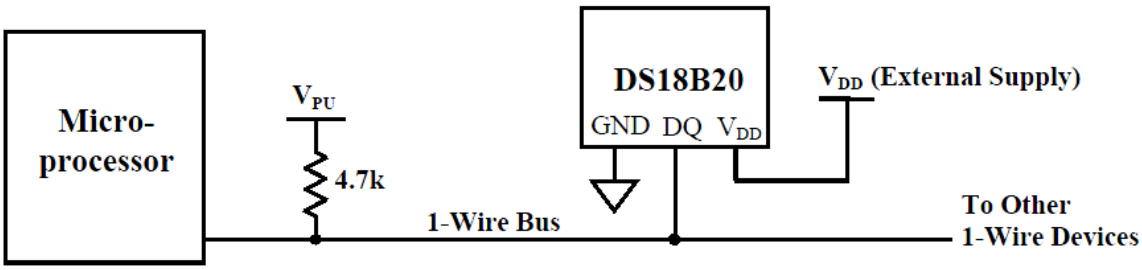

Fig. 4: Diagram of the possible involvement of one or more digital thermometers DS18B20 [6]

Possibilities of using a thermometer:

- Household heating system control
- Supervision of the proper functioning of appliances (air conditioner, boiler heating, refrigerators, freezers)
- Reporting the indoor / outdoor temperature

Fig. 5 The DHT11 hygrometer

4.2 A hygrometer

To determine the humidity the DHT 11 sensor was used. This sensor cannot be purchased in stores in the Czech Republic. However, it can be bought in a global online store such as the eBay. Sensor can measure temperature and humidity at the same time. We can calculate other information from these measured data, for example a dew point.

Measuring range of the hygrometer	20%～90%
Temperature measurement range	0～+50℃

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Accuracy of the hygrometer	±5.0%
Accuracy of the thermometer	±2.0°C
Accuracy of the output	8 bits 1°C
Power supply	3.0-5.5V
Measuring speed	<5s
Price in December 2011	3 GBP – (3.6 €) including postage

Table 3: DHT 11 hygrometer and thermometer - parameters [7]

Possibilities of using a hygrometer:

- Reporting the indoor / outdoor moisture
- Prevention of the dried air or mold in the household

The ideal humidity in your home should be between 45 and 60%. If the values are higher, the possibility of forming a mold rises. At lower values, the risk of drying out the mucous membranes of the airways increases and other health problems could emerge [7].

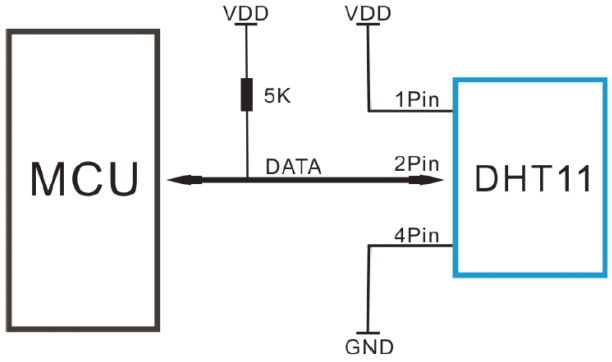

Fig. 6: Connection of the DHT11 sensor [7]

4.3 Light intensity

Sensor for the detection of intensity of light in the room can be created from a photoresistor. Light is a form of electromagnetic radiation with a wavelength of 380-780 nm [5]. The photoresistor is connected to the Arduino's analog input. Arduino has a 10 bit analog digital converter. This provides us with 1024 different values.

Resistance at light 10 lux - 2850 K	50 – 150 kΩ
Resistance in darkness	2 MΩ
Maximum power dissipation	175 mW
Price in November 2011	0.72 €

Table 4: The VT83N4 photoresistor

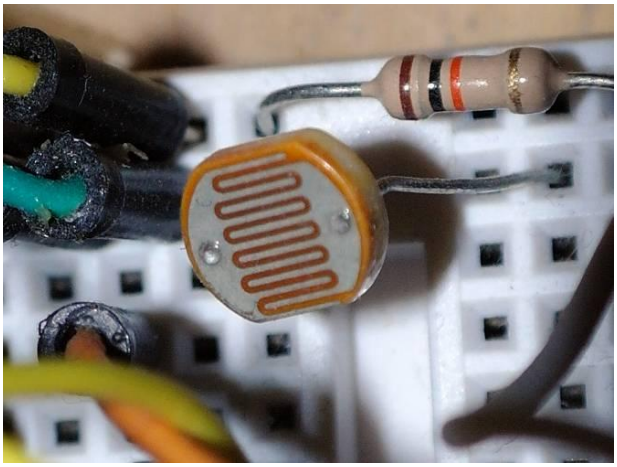

Fig. 7: A photoresistor for light detection

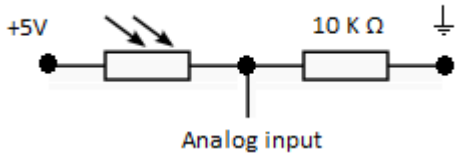

Fig. 8: Connection of the photoresistor to Arduino

Possibilities of using the light sensor:

- Checking if the lights are turned off after leaving home
- Automatic light regulation in a room based on natural light

4.4 Open / closed door or window

For the detection of open / closed doors or windows, we can use a magnetic door switch. This switch can be connected to a digital or an analog pin. If the switch is connected to the analog pin, we must determine the open / closed border value. This value cannot be close to the boundary values, because it may be interfered.

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Fig. 9: Magnetic door swtich

Size	27.4 x 7.8 mm
The maximum voltage / current	100V / 500 mA
Active gap between the counterparts	15 mm
Price in January 2012	1.72 €

Table. 5: Magnetic door switch

Possibilities of use of magnetic window / door switch:

- Control of acces to the room / apartment
- Checking if the windows are closed / opened
- Checking if the apliances are closed / opened

4 Conclusion

In this article the examples of individual sensors for measuring temperature, humidity, light intensity and the status of doors or windows (opened / closed) were described. The article has also dealt with a microcontroller that can be programmed to react to events (which are generated by sensors described above) and to cause a corresponding action.

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