DOI: https://doi.org/10.30837/csitic52021231821

Security system development for “Smart House”

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Abstract. *The best minds of humanity are constantly developing new technologies to improve human life and provide comfort. Comfort has always been one of the engines of progress, forcing human thought to invent more and more new devices to make their lives easier. One such invention was “Smart House” system.*

Keywords: *Smart House, Arduino, security system, microcontroller, Fritzing, sensors, actuators, development*

V. Introduction and Problem statement

The problem of ensuring the safety of property, whether it is various premises, residential, private and multi-apartment buildings, remains a considerable task of the modern world. Electronic fire alarm systems are one of the main components of fire prevention or minimization. Security alarms are used to detect unauthorized intrusion into the protected object, as well as such devices generate and transmit various alerts, provide control of sound and light alarms.

“Smart house” is an intelligent system that integrates electrical appliances with a control line. This makes it possible to control several devices simultaneously with just one control display. The complex of sensors continuously monitors the work of all equipment and, thanks to the interaction of all systems, makes it possible to reduce maintenance costs and increase safety, reliability and comfort [1].

“Intelligence” in this system means the ability to recognize certain situations and respond to them in any way (the degree of this ability can be different, including very high).

The concept of intelligent building includes the following provisions:

- Creation of an integrated system of management with the ability to ensure the integrated work of all engineering systems of the building: lighting, heating, ventilation, air conditioning, water supply, access control and many others.
- Disposal of all staff and transfer of control and decision-making functions to the subsystems of the integrated building management system. The “intelligence” of the building is embedded in these subsystems – the way how it will react to changes of the parameters of the system sensors and other events such as emergencies.
- Implementation of the mechanism of immediate disconnection and transfer, if necessary, to the control of any subsystem of the intelligent building. At the same time, the user must be provided with the convenient access to control and display of all subsystems and parts of the "intelligent building".
- Ensuring the correct work of individual subsystems in case of failure of the overall control system or other parts of the system.
- Presence in the building of the applied communication environment for connection to it of devices and modules of systems. And the possibility of using as a communication medium in the control system of different types of physical channels: low-current lines, power lines, radio channel.

In order to turn an ordinary house into an intellectual one, the following elements are needed:

- Sensors (sensors and controls) – wall panels and switches, sensors of physical quantities (temperature, humidity, etc.), thermostats, motion and presence sensors, timers. They are responsible for recording certain external events, the occurrence of which should cause a certain reaction of the system. For example, the sensor detects an increase in temperature and sends a control command over the network to turn on the air conditioner;
- Actuators – dimmers, relay modules, blinds, heating radiators, etc. They change their state (on/off, open/closed) according to the commands coming from the sensors, thus controlling various electrical equipment;
- System devices – power supplies, controllers, interface and logic modules, bus connections, etc. They are installed in a separate electrical cabinet and provide the ability to build and operate the network of a smart house as a whole [2, 3].

Let’s identify the properties that need to be implemented in the security system that will be developed, based on the needs of most consumers. Let's make a list of functions that need to be implemented in a “Smart House”:

- possibility of independent assembly and installation;
- ease of use;
- monitoring the condition of the apartment;
- determination of penetration;
- possibility of modification for specific needs;
- detection of fire, water leakage, gas leakage;
- analysis of data from sensors;
- active response to signals from sensors;
- adding and changing a set of sensors [4].

According to the complexity of installing and managing existing security systems, it is necessary to develop a user-friendly security system. All information from the sensors will be processed by the microcontroller and presented to the user in a normal and understandable way.

VI. PROBLEM SOLUTION AND RESULTS

Based on all the requirements for the security system, it was decided to develop a security system based on the Arduino microcontroller. Arduino Mega was chosen for the developing system, for the reason that this board has a large number of analog and digital inputs. Therefore, if necessary, it is possible to scale the system by adding sensors and expansion cards. This will allow more flexible design of the system for specific needs.

The system will consist of the Arduino board and several sensors. The gas and smoke sensor will be installed in the kitchen, next to the stove, the motion sensor in the hall, the opening sensor on the front door, and the water sensor in the bathroom. All sensors are connected to a board that will read data from them. When the motion sensor is activated, the relay is activated and the light in the room is switched on, when the smoke or gas sensor is activated, the relay is activated and the fan or the hood is switched on.

The Arduino Mega is powered by connecting a cable to a PC, after which all sensors begin to monitor the environment.

The gas and smoke sensor monitors the gas concentration in the air. If the concentration exceeds the gassiness threshold, the sensor is activated and sends a signal to the piezoelectric emitter, which will make an audible signal. The signal is also fed to the relay, which is responsible for turning on the fan. If the gas concentration drops, the relay switches off the fan.

The water sensor should be placed on the floor in the bathroom. In order for it to work, the flooding of the room must exceed the threshold set in the software implementation. When water enters the “touch” board, the sensor is triggered and the signal is fed to the piezoelectric emitter. The system operates in constant monitoring mode, only some sensors have a standby mode.

When the motion sensor is triggered, the signal is sent to a relay that is responsible for turning on the light.

In order for the door sensor not to work constantly when the door is opened, it is planned to make it with a separate mode on/off. If the magnet isn't adjacent to the reed switch, the door is considered to be open - the sensor is triggered and sends a signal to the piezoelectric emitter to make an audible signal. If this sensor is switched off, the program won't be processed and no signals will be sent.

For clarity, the assembly of the scheme was performed in a special design application called Fritzing.

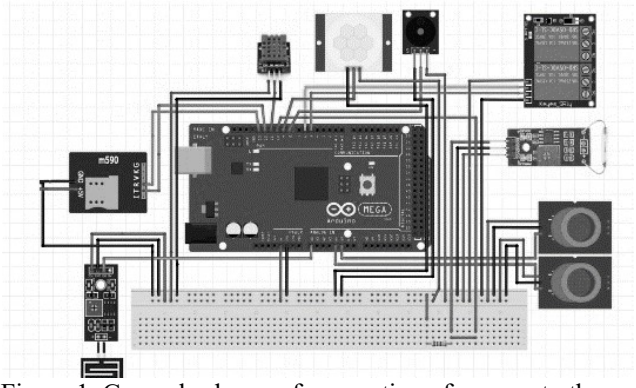

Figure 1. General scheme of connection of sensors to the microcontroller

To understand the logic of the security system, we will develop programs that process the readings of signals from sensors and perform actions. The final housing security system will consist of such small programs. House security programming will take place in a special Arduino IDE programming environment.

The process of programming the board consists of two stages: writing a sketch program and loading the sketch into the controller using a special button in the programming environment. The sketch is downloaded and recorded in a special area of the controller's memory and starts automatically each time the board is turned on [5].

The program for Arduino contains two identical functions: void setup() and void loop(). At the beginning of the code are declared constants and ports that will be used continuously. The void setup() section specifies commands that are executed once. The void loop() section contains commands that are executed as long as the Arduino board is enabled. The microcontroller starts execution from the first command, arrives at the end and immediately goes to the beginning to repeat the same sequence. And so an infinite number of times as long as the board is powered [6].

The developed system detects unauthorized access and malfunctions in the supply systems of the house, in particular: fire, gas leak and flooding. The microcontroller in this system acts as a bus master and is responsible for initiating communication.

VII. CONCLUSIONS

The resulting house security system based on a microcontroller and sensors that differs favorably from competitors in cost, scalability, ease of installation.

As a result, the developed security system – easy to install, configure and operate, has a low cost. and most importantly very flexible, which allows you to modify at the lowest cost for almost any task of ensuring the security of facilities. The Arduino platform is actively evolving, and a large number of analog and digital sensors are currently available to measure a wide variety of performance.

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