

# Preservation and Protection of Cultural Heritage through Digital Security System

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**Abstract.** The preservation and protection of cultural heritage is of special importance nowadays. With the development of technologies, violation methods became more sophisticated. This requires taking stronger security measures for protection of museum items. The aim of the present paper is to present a design of digital security system for museum exhibits based on a microcontroller combined with sensors of different functions and principles of operation.

**Keywords:** Sensor Systems, Museum Security, Exhibits Protection.

## 1 Introduction

The development of museums requires presenting wide range of exhibits of totally different characteristics, some of them priceless originals, to wide range of people. With the development of technologies, violation methods became more sophisticated and innovative in the use of various technical appliances. The security systems in museums must comply with the following basic requirements:

- Allow the exhibit to be presented as fully as possible to the visitors;
- The system implemented must offer maximum security for the exhibit;
- The elements of the system must have no influence on the structure of the guarded item.

The more variants of violation are considered and worked out during the stage of system design, the reliable it will be. Combination of different variants of violation leads to increased security of the end product. Every particular assignment tailored to the specifics of the guarded item and the conditions in the particular museum poses different challenges to the developers.

Modern times are characterized by rapid development of microprocessor technology and sensor systems (Wilmschurst, 2007). Both the total number of devices offered and the spectra of their capabilities and performance algorithms (Traneva, Tranev, Stoenchev, & Atanassov, 2018) and application range (Ball, 2002), become wider, including in the systems for protection of cultural and historic valuables (Burke & Liston, 2005).

The aim of the present paper is to present a design of a sensor system for protection of museum exhibits based on a microcontroller and combining multiple sensors of different functions and principles of operation. The state of the system is shown by acoustic and light indication.

## 2 Realization and Results

The following requirements must be met by the development of security systems for museum exhibits:

- Together with measures for securing the surrounding area and museum building, special measures should be taken for the protection of single items or groups of items of great value;
- The system should be realized as subsystem of the existing one in the museum.

For the designing of sensor systems for protection of exhibits, freedom should be granted to the developers with respect to concrete design solutions but the following principles should be obeyed: subtleness, reliability, resistance to intrusion, functionality.

In the system designed for protection of particular exhibit:

- The security measures should not impose restrictions to the full and objective presentation of the item to the visitors;
- The components used and their mounting must not allow their deliberate or unintentional damage, removal or disabling the system;
- The electric power supply of protection modules should be design so as to be invisible to the visitors and there must be backup power supply. On failure of power supply (main or backup), it must be indicated at the Center for monitoring and reception of alarm signals;
- The glass partitions of the showcases and their locking locks and mechanisms meet the requirements of the standards and minimum security classes in relation to the specified physical protection classes;
- The system must generate intrusion signals when extraordinary conditions are sensed (change of air pressure, illumination, fire) in the areas around the exhibit;
- The alarm conditions must generate both acoustic and light indication.;

By the design of a sensor system, it is assumed that the protected items are part of the museum exhibition and are located in one of the museum halls which is designed built according to requirements of the regulations. A security system is implemented in the museum which consists of the following subsystems (Muhtadi, Amin, & Tabassum, 2012):

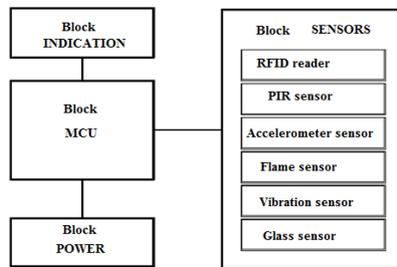
- Alarm system against intrusion and assault;
- Video surveillance;
- Access control;
- Perimeter protection;
- Technical means of control;
- Center for monitoring and reception of alarm signals.

Security lighting and back-up power supplies are set up.

In addition to the existing security system in the museum, it is suggested to add a subsystem for protection of item or group of items of great value, which includes:

- safe glass showcase;
- lock for the glass showcase;
- indication for vibrations sensed within the showcase;
- indication for any movement sensed around the exhibit;
- protection against movement of the exhibit itself;
- indication for disruption of showcase integrity;
- fire alarm signalization;
- signalization for opened cover of the showcase where the item is placed.

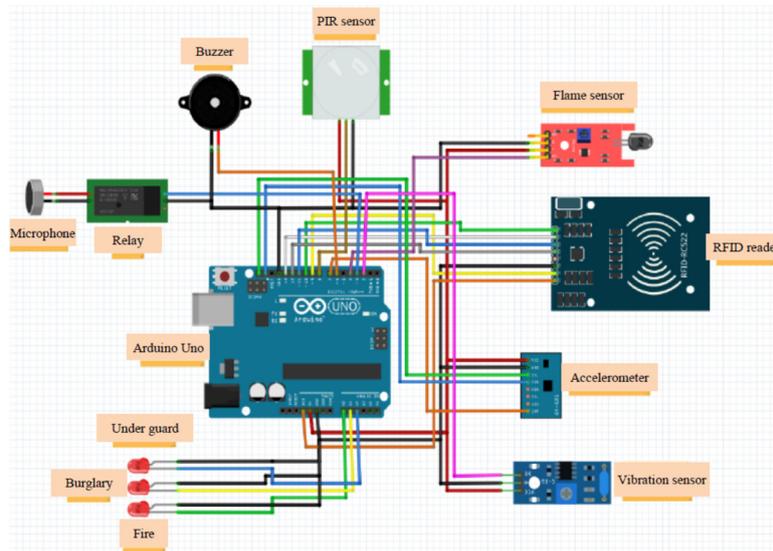
Based on these requirements, the following sensor system block diagram was realized (Fig.1):



**Fig. 1.** Block diagram of the sensor security system

The individual block are realized using the following components (Fig.2):

The main control unit (**Block MCU**) of the sensor system receives and processes the information sent by the sensors and displays it on a display (Warren, Adams, & Molle, 2011). The microcontroller circuit selected is Arduino Uno Rev.3 (Blum, 2012). It can be powered through USP port of a computer or from external source and switching between the two methods of power supply is automatic. The external power source can be DC adapter 7 ÷ 12V or battery.



**Fig. 2.** Full circuitry of the sensor system

According to the requirements of the current system of regulations, the following modules were chosen for Block Sensors of the security system:

- RFID reader – RC522 - the module is based on MFRC522 IC controller of NXP which is one of the cheapest RFID variants currently on the market. It is usually delivered with a label with RFID card and label with keys with 1kb memory and it is designed to generate 13.56 MHz electromagnetic field which is used for communication with the RFID labels (standard labels according to ISO 14443A).
- Motion detector PIR sensor – HC-SR501. The sensor has three output pins VCC, OUT and GND. It has embedded voltage regulator so it can be powered by any direct voltage in the range 4,5 ÷ 12 V.
- Accelerometer and gyroscope – GY-521/MPU-6050. The module is a cut-off circuit for MPU-6050 MEMS which is characterized by 3-axis gyroscope, 3 axis accelerometer, digital movement processor (DMP) and temperature sensor.
- Flame sensor – KY-026. Detects infrared radiation emitted by fire. The module has both digital and analogue outputs and potentiometer for regulation of sensitivity.
- Vibration sensor – SW-420. It is high sensitivity non-directional vibration sensor. When the module is stable, the circuit is switched on and the output will give high level. On appearance of motion or vibration, the circuit breaks for a short period and the output signal will be low.
- Sensor for broken glass – GBD10 – analogue glass break detector. Analyzes the input signal and generates acoustic frequency which can be adjusted to optimize detector performance. Reacts on breaking of the glass and it is sensitive to acoustic signals in the range 2 to 10 kHz.

- Power supply block. The power supply is realized with converter from 220 V to 12V and voltage stabilizer realized by the integral circuit L7812. The controller AndroidUno is powered by DC adapter with working voltage of 12 V. in real-time operation, the back-up power supply is realized by external source – uninterruptable power supply and a battery. The switching in case of failure of the main power supply is automatic.
- Block indication. The light indication of the system is realized by LEDs for the three states of the system – under protection, intrusion, fire. The acoustic signalization is realized by a buzzer with different buzzes for the different states. The full block diagram of the operating algorithm is shown in Fig.3.

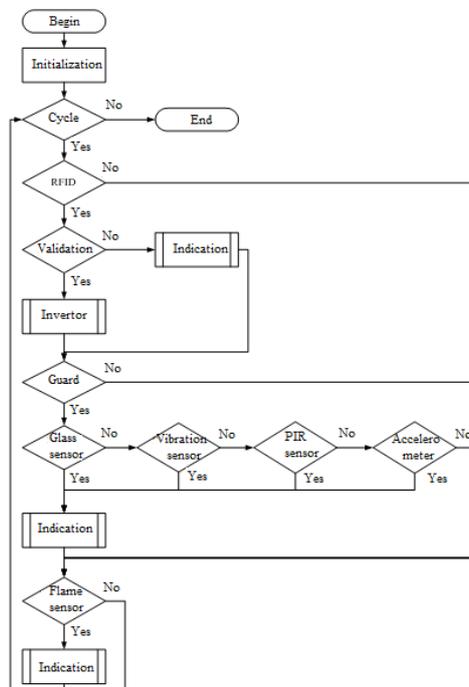


Fig. 3. Operating algorithm of the sensor system

### 3 Conclusions

The project suggested is for practical implementation. The security system developed can be implemented in a museum or for protection of private collections and family valuables. The topic is a problem of the present day and it is imposed by the increasingly frequent cases of encroachment and by the search for newer methods and forms of protection by the development of security systems.

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