On the need to create a monitoring system for safe gas consumption in multi-apartment residential buildings for a smart city

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Abstract

Smart city is not only the application of a large number of digital and electronic technologies for transforming the life and working environment of the city, it is mainly ensuring the safety of citizens' lives. The security component in the Smart City concept includes issues of safe consumption of electricity, gas and water. To solve the problems that have arisen and ensure the safety of the population, it is necessary to install devices for detecting and fixing gas leaks in apartments, houses and buildings. For several years, the Georgian Technical University (Tbilisi) has been working on the creation of a new, innovative gas leak detector based on the semiconductor sensor of the Japanese company Figaro Engineering and on the creation of a gas control and gas leakage system in residential premises, including for multi-apartment high-rise buildings, which will be an obligatory component (subsystem) of the "Smart Home" and "Smart City". However, it should be noted that the installation of the above devices in individual apartments does not solve the problem of ensuring security for the entire apartment building, since they should be installed in all apartments without exception. It is clear that a gas explosion in high-rise buildings will lead to destruction of neighboring apartments. Therefore, it is necessary to create a monitoring system for safe gas consumption for the entire apartment building.

Keywords: gas leak, semiconductor sensor, detector, identification, solenoid valve.

1. Introduction

At the very beginning of our report, we want to note, that unfortunately our apartments and houses in our beautiful city Tbilisi are still far from being called smart.

However, we can talk about our little experience in this direction. Back in the 70-80s of the last century, we and our friends worked on the creation of devices and systems that can be considered elements of a "smart" home and "smart" city. We simply did not know these terms then.

Here are some examples:
- By order of the Ministry of Internal Affairs of the Republic of Georgia, we developed a television surveillance system on the Tbilisi-Rustavi highway (about 20 km). two surveillance cameras were installed on the track and experimental tests of the system were carried out.
- A project was developed for a control system for the operation of passenger aerial cableways in the city of Tbilisi. At that time, five passenger cable cars operated in

our city. We beat made a control panel with the function of locating the cable car cars.
- Our project of a system for accurate metering and advance payment of electricity consumed by subscribers seems to be very interesting. The system has passed experimental tests in two cities of Georgia.
- We carried out work on automated accounting of working hours using biometric methods of personnel identification. In this direction, the system of conducting biometric elections at the faculties of the educational institution successfully worked.
- A project was developed and systems for automatic switching on and off of lighting in the entrances of multi-apartment residential buildings were manufactured.

Today, all this can be considered as the first experiences of creating separate "smart" devices and "smart" home systems. However, specialists dealing with the problems of smart home and smart city understand that a systematic and integrated approach to the problem is needed.

After such a long preface, we want to move on to our issue - the creation of an air quality monitoring system. And the issue of detecting leakage of dangerous and toxic harmful gases is an obligatory part of a "smart" home.

The importance of detecting (identifying) leaks and accumulation of household and sparkling gases and protecting human safety is clear to everyone. Alarms, detectors, monitoring devices and safety systems are designed for the safety of people in residential apartments and houses.

Various gas identification devices are currently being developed in European countries, the USA, Japan and China. Gas leak detectors and detectors occupy a large place among them. They differ from each other in purpose, functions to be performed, and obviously in price.

The increasing number of accidents in our country in recent years has raised the need to address these issues in order to avoid explosions, fires, poisoning and death. The statistics are very deplorable. For example, in 2014, 2,089 people were poisoned with natural gas in Georgia and in 2015 - 3 356 people. 27 people have been killed by gas in those two years. All this indicates the urgency and necessity of detecting gas leaks and warning people about it. Extensive implementation of gas alarms, detectors and monitoring systems in multi-storey residential buildings can be said to practically solve this problem.

2. Main part
A new microprocessor system (device) for ensuring the safety of gas consumers created by a group of scientists and specialists of the Automation Scientific-Research and Engineering-Technical Center of the Georgian Technical University. The system consists of three main parts (blocks):1. Primary transmitter (semiconductor sensor); 2. Electromagnetic shut-off valve.3. Microprocessor electronic unit;

The technical documentation of the processed system, the test samples of the device have been prepared, the laboratory test of the methane leak detection device has been carried

out, the works for the serial production of the devices for fixing the leakage and accumulation cases of household and exhaust gases in residential apartments have started. Three samples have been prepared to be tested for compliance with international standards, after which it will be possible to obtain the ISO standard.

Several variants of the system electrical circuit have been developed. At this stage, a circuit based on a single semiconductor sensor (Figaro sensor TGS and one microcontroller) was selected; three test samples of the system were made using a PIC12F675 type microcontroller.

The proposed new system has several advantages over other existing alarms, detectors and devices:
- Using stabilized current to heat the sensor reduces the degradation rate of the sensor and increases its operating time;
- Two-dimensional measuring circuit ensures high sensitivity of the device to both small and large air pollution;
- The power consumed by a semiconductor sensor is almost 100 times less than the limit value;
- Due to periodic automatic calibrations it is possible to avoid annual periodic verification and calibration.
- Additional automatic periodic calibration eliminates the negative impact of sensor degradation and contamination process, were we will use the outsourcing method. "Outsourcing" generally means using external resources. This term was first used in 1989 to refer to the transfer of any particular activity or function to another company. One of the basic principles of outsourcing can be: "Instruct someone else to do what they do best and cheaply to you." Outsourcing has gained a foothold in almost every field. It is especially widely used in instrumentation as well as in information technology. In order for a new innovative device, device or system to work, we need to place (load) the software product we created in a programmable microcontroller.
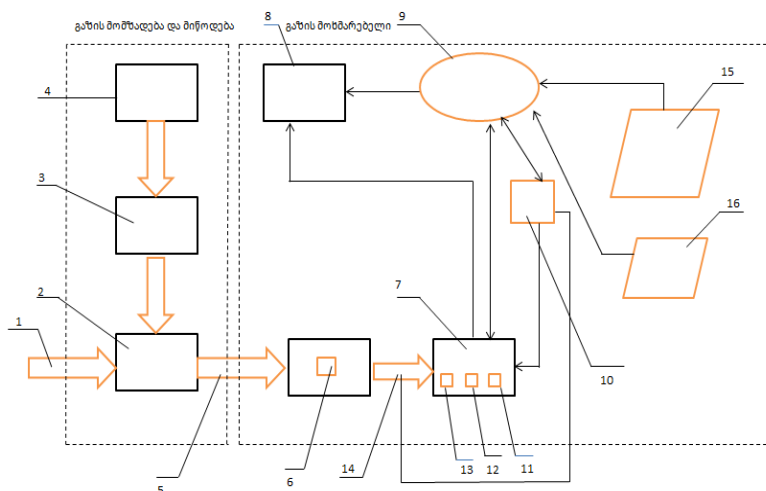

Fig.1. Structure of household gas consumption

1. Main gas, 2. Gas distributor, 3. Odorant; 4. Odorization device; 5. Odorized gas; 6. Gas flow meter; 7. Gas household appliances; 8. Smoke-ventilation ducts; 9. User (resident); 10. Gas detector; 11. Gas stove; 12. Gas heater; 13. Gas heater; 14. Locking electromagnetic valve;
15. Rules for operation of gas installations; 16. Gas consumption rules

After that, the system will be installed, assembled, initialized and final checked. Then another component of the problem will be involved in the work - "certification" (or "metrological certification stand"). The system should be checked for compliance with international standards.

3. Conclusion

Thus, in order to solve the problem, it is necessary to develop and manufacture a special metrological stand, on which the tools made in the first stage will be tested and certified.

Only then should it take place in the trading network of manufactured systems. The stand created by us will be able to test not only natural gas leak detectors, but also other gas control devices and devices. It is also advisable to consider the test of electromagnetic shut-off valves at the same stand.

Particular consideration should be given to the fact that users do not experience discomfort. To fully solve the problem, it is necessary to create a special service that will install tools directly in apartments, houses and buildings, as well as check them at intervals specified by technical conditions. Obviously without this component it is impossible to carry out the "technical services" provided for the performance of all these works.

A specialized service – "Technical Service Center" will be established. These components completely cover the range of issues that need to be addressed in order to avoid accidents, fires, explosions, human injuries and possible casualties caused by gas leaks.

The new system has no competitors in the domestic market of the country; It can also be used in other neighboring countries; The device complies with modern European analogues with basic technical parameters and it is protected by our country's patent.

We hope that very soon our city of Tbilisi can be classified as a "smart" city and it, on a par with Oslo and Singapore, Zurich and Geneva, Helsinki and others, will become a city where you can live and work very comfortably and safely, and residents can be happy.

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