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# Prospects for the Development of Control Devices for Small Arms Use within the Framework of the Internet of Things (IoT).

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***Abstract*—This report addresses trends related to the use of microprocessor-based systems as a means of controlling the use of small arms. Experiments have shown that an embedded chip with an autonomous power supply and additional power derived from the conversion of the recoil energy accumulated by a small arms weapon can record the time, number, and interval between shots, as well as geolocation data, with the ability to transmit this information wirelessly.**

***Keywords*— microcontroller-based system, SIM-800C module, GSM (GPS-GPRS) module. MMG – mass-dimension model, Security Service of Ukraine – SBU, FBC – non-lethal weapon**

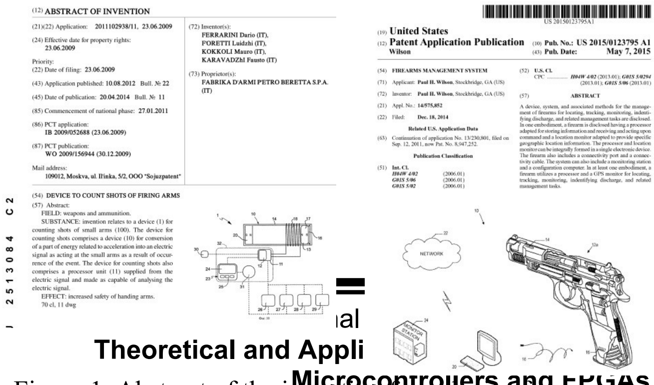
The issue of controlling the unauthorized use

of small arms has become particularly relevant in light of the war between Ukraine and Russia. The issue of legalizing small arms—prompted by a sharp increase in the availability of illegal weapons—is particularly unfeasible in the domestic context without the development of control measures.

This relevance is also highlighted from time to time in the ongoing debates about the legalization of small arms in Ukraine.

Controlling the use of weapons is also relevant for specific tasks carried out by the Security Service of Ukraine (SBU). Modern MEMS technologies, advancements in communications, and the Internet of Things make it possible to address such challenges. This is confirmed by patents and developments that have been underway in the United States and Italy since the mid-2000s.

Figure 1 (left) shows the title of Beretta’s patent for a device to monitor the number of shots fired from a small arms weapon. It proposes a method for powering a microprocessor-based device (the MSP430 chip is recommended) by harnessing the recoil energy of both automatic and semi-automatic firearms, as well as conventional rifles.


(12) ABSTRACT OF INVENTION

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(54) DEVICE TO COUNT SHOTS OF FIRING ARMS

(57) Abstract:
FIELD: weapons and ammunition.
SUBSTANCE: invention relates to a device (1) for counting shots of small arms (100). The device for counting shots comprises a device (10) for conversion of a part of energy related to acceleration into an electric signal as acting at the small arms as a result of occurrence of the event. The device for counting shots also comprises a processor unit (11) supplied from the electric signal and made as capable of analysing the electric signal.
EFFECT: increased safety of handing arms.
70 cl, 11 dwg

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(54) FIREARMS MANAGEMENT SYSTEM

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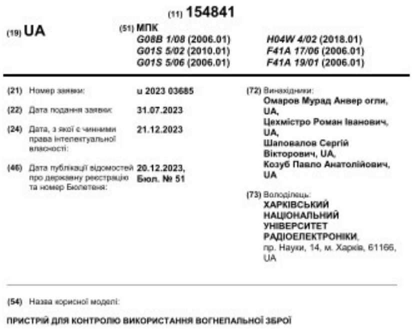
(57) ABSTRACT

A device, system, and associated methods for the management of firearms for locating, tracking, monitoring, indentifying discharge, and related management tasks are disclosed. In one embodiment, a firearm is disclosed having a processor adapted for storing information and receiving and acting upon command and a location monitor adapted to provide specific geographic location information. The processor and location monitor can be integrally formed in a single electronic device. The firearm also includes a connectivity port and a connectivity cable. The system can also include a monitoring station and a configuration computer. In at least one embodiment, a firearm utilizes a processor and a GPS monitor for locating, tracking, monitoring, indentifying discharge, and related management tasks.



Figure 1. Abstract of the invention for a device for counting shots fired from small arms, 2009 (right: Italy, Beretta), 2014 (left: USA) .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(54) Назва корисної моделі:

ПРИСТРІЙ ДЛЯ КОНТРОЛЮ ВИКОРИСТАННЯ ВОГНЕПАЛЬНОЇ ЗБРОЇ

Figure 2. Utility model patent—a further proposal for improving the system for controlling and monitoring the use of small arms, Kharkiv National University of Radio Electronics (KNURE), Kharkiv, 2023.

The company also proposed the ability to collect and store geolocation data in the controller’s EEPROM memory. Further data retrieval is possible through the use of GPS technology and data reading via Bluetooth.

The patent, a page of which is shown in Figure 1 (on the right), discloses a system and related methods for controlling a firearm to determine the location, track, monitor, and identify shots, and to perform related control tasks.

One embodiment (Figure 1, left, 2014) describes a firearm equipped with a processor capable of storing information, receiving and executing commands, and a location monitor capable of providing specific information about geographic location. The processor and location monitor may be integrated into a single electronic device. The firearm also includes a connection port and a connection cable. The system may also include a monitoring station and a configuration computer. In at least one embodiment, the firearm uses the processor and a GPS monitor to determine location, track, monitor, identifying shots and performing related control tasks.

## I. Main parts

A device (as described in the utility model in Figure 2) for monitoring the use of firearms, consisting of a navigation unit and a transceiver unit, characterized in that it additionally includes a microcontroller connected to the output of the navigation unit and the input of the transceiver unit. [1]. The primary purpose of the device is to coordinate the operation of both the navigation unit and the transceiver unit during the use of a firearm; and a unit for converting the mechanical energy of the bolt recoil into electrical energy has also been installed in the firearm's receiver; the output of this unit is connected to the input of the electrical energy storage unit, which provides power and ensures the operation of the device as a whole, whereby the power supply for the entire device can serve as either an auxiliary or a backup source.

To confirm the practical feasibility of the provisions set forth in the utility model shown in Fig. 2, bench tests were conducted on cooled and full-scale samples of multi-round (magazine-fed) firearms. Capsule charges and light-and-noise blank charges were used, all of which were legally acquired and accompanied by the appropriate commercial documents (certificates) in accordance with Ukrainian law.

Only the use of legal blank flash-and-noise charges (cartridges) allows us to use the test bench to study the accumulation of firearm recoil energy in a legally permissible manner; however, we have not conducted such studies at this time.

It was also relevant for activating a microprocessor-based device equipped with a GSM (GPRS, LBS) module and a GPS module with a ceramic antenna.

Testing showed that once the GPS module (e.g., NEO-6M) had had some time to establish a connection with the satellites, the recording of geolocation data into the microcontroller's (microprocessor's) non-volatile memory would occur without any significant time delays.

If a GSM (GPRS, LBS) module, such as the SIM800C, was present and a connection to the mobile network was established, geodata was transmitted to the programmed mobile operator number(s) [1–5].

According to the utility model patent shown in Figure 2, the test was conducted in clear weather with a GPS geolocation signal from a satellite received in advance; the GSM signal was also configured to communicate with the operator associated with the corresponding SIM card.

The time required to fire four rounds (flash-and-noise cartridges) in a single, continuous, single-round mode was less than 20 seconds. This time is sufficient to establish a GSM connection and transmit geolocation data using the technology, with a fully charged 18660-type Li-ion battery (3.7–4.2 V), in both open terrain and urban environments. As studies have shown, this may be sufficient to obtain data in response to a request from the AT—GPRS data protocol commands regarding the location of the shot—however, this technology has an error margin of up to 150 meters (in urban areas). This margin of error is unavoidable because the geodata is derived directly from information received from the nearest base station towers and recalculated using triangulation and other algorithms.

LBS (Location-Based Services) technology can be used, which calculates a device's location relative to cell towers or Wi-Fi networks. LBS relies on cell tower identifiers (Cell ID) or access point identifiers. It is not suitable for use outside urban areas, where the margin of error can reach tens of meters.

Accuracy of up to 10 meters in determining geodata can only be achieved with GPS technology, though this may take additional time (especially in cloudy weather).

For example, a typical NEO-6M module has an additional power supply on the board that is charged via an external power source. This may present some inconveniences related to the separate chip, its power supply, and the need for a GPS antenna.

However, modern technologies can make such devices (GPS trackers) extremely compact, as shown in Figure 3.

The microprocessor module's response to the results of the model's mechanisms was implemented using sensors with specific purposes and configurations.

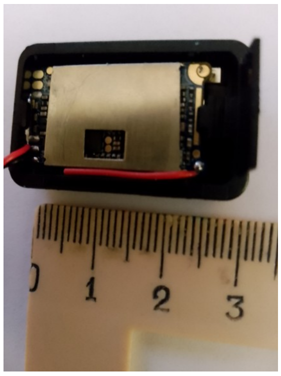

Figure 3 A typical modern geolocation tracker that supports a SIM card

It clearly shows that the time between four unevenly spaced shots (single-shot mode) was 11.174 seconds and provides information on the latitude and longitude of the firing location. The latitude and longitude data were sent via SMS to the mobile operator's number, whose SIM card is located in the communication module (an example would be the sim800C).

Figure 5 clearly demonstrates the result of transmitting geolocation data to a mobile phone in real time.

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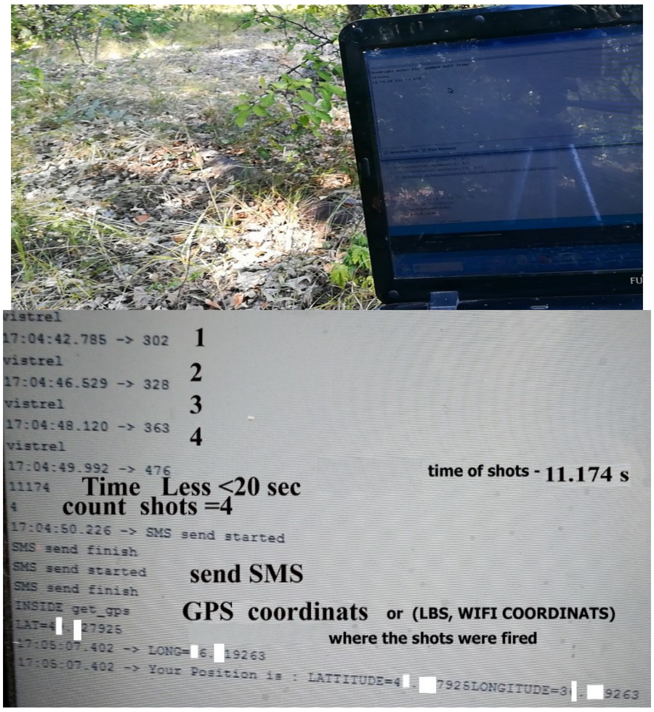


Figure 4. Video clip of an experiment in which information about the shots fired is monitored by transmitting data via an RS-232 interface from a microprocessor module—integrated with GPS (GSM) modules—connected to the weapon to a PC.

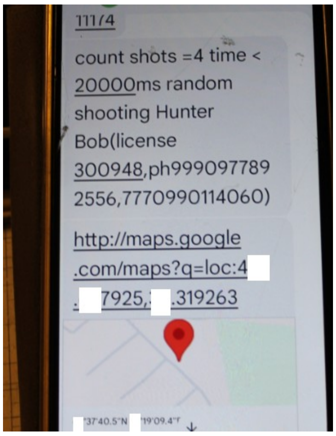


Figure 5. Receiving an SMS message on a smartphone regarding the rate of fire and total firing time (11.174 sec.) as well as geolocation data on the weapon's location.

## .IV. CONCLUSIONS

The results of the experiment conducted on the developed test bench make it possible to verify the operation of an electronic microprocessor-based device—which incorporates a wireless communication module and has the capability to store data in EEPROM—and to assess its potential for integration with a weapon prototype.

With further refinement, this integration allows for monitoring the use of the weapon and, in the long term, preventing its unauthorized use.

This experiment was not intended to determine the effect of the actual number and frequency of shots on the guaranteed activation time of the shot-recording device or the wireless transmission of geolocation data in the absence of an autonomous power supply.

However, it clearly demonstrated the ability to obtain data both in real time and during scheduled weapon inspections (by reading data from EPROM memory). This provides a basis for the development of similar technology as a component of the Internet of Things.

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