The field shooting simulator new development

Juris Kiploks (*Leading researcher, Riga Technical University),* Maris Knoks (*Chairman of the Board Geostar Ltd*.), Janis Vjaters (*Reserarcher, Geostar Ltd*.)

Abstract – Article deals with new development of the field shooting simulator based entertainment needs. It contains shooting simulators short historical overview and short review of existing laser shooting simulation market products equipment deficiencies and requirements for development of new shooting simulator. The new kind of shooting simulator technical solution is proposed with block diagram and description and its advantages and disadvantages are discussed.

***Keywords* – SIMULATOR, entertainment, field shooting simulator, laser, video camera.**

I. Description of the problem

Soldiers and law enforcement officers daily life consists of different tactical tasks trainings and performance improvement in specific situations, including with light (personal) weapons in the field. However the uses of real ammunition in daily trainings are relatively expensive, but also very dangerous. Therefore for the daily trainings with weapons the different weapons simulators are used, eg, field tactical simulators. One of the best known is the Cubic Corporation (USA) shooting simulator produced under the acronym MILES (Multiple Integrated Laser Engagement Systems) [1], [2]. At present, in many training and drilling documentation for these training systems the abbreviation TESS (Tactical Engagement Simulation system) [3] is used. The MILES system was created for the US army at last century 70-ies [4]. This system is used in 23 countries around the world [5] at present. MILES facility generally consists of the kit with casting (moulage) of small arms equipped with a laser emitter, hit sensors, control unit and GPS (Global Positioning System) signal receiver (option).

Parallel to the military simulators for shooting drilling the entertainment industry shooting simulators had developed with armed conflict imitation as an integral part of this kind of market ingredient. Many people choose to participate in tactical games with weapons use imitations in the field as an active rest and recreation. For this the use of military simulation systems is not acceptable and the security issues during the games have a special importance. The use of laser beam proved to be the most appropriate for these "toys". These games got a special name LASER TAG (*TAG* is a playground game that involve one or more players chasing other players in an attempt to "tag" or touch them, their usually with hands) [6].

George Carter III inspired by movie "Star Wars" created game "Photon" for a market in 1977 - a prototype for all modern Lasertag games (see Fig.1). The game kit contains light-sensitive sensor and weapon equipped with an IR (infrared) spectrum radiation beam emitter (see Fig. 2). "Photon" is considered to be the first of this kind of games played in the field. For security reasons players are advised not to shoot in a distance closer than 5 m and the use goggles.

Fig.1. George Carter III (center) with his game Photon players in the background

Fig.2. Game Photon Set

The entertainment industry is starting with new market products of this type from this moment. For example the South Bend Toys company started production the game Star Trek Phaser in 1979 with set of 2 guns equipped with light emitters and light sensors (receivers) (see Fig 3). The game was developed with additional special function: near miss indication. Hits were evaluated by the sensor detecting radiant power. A similar feature was introduced in the MILES system. In all modern gaming systems the hits are calculated programmatically by pseudo-random probability method [7].

The term "Lazer Tag" introduced by Worlds-of-Wonders company in the year 1988 - 1989 starting production of the game sets with the same name (see. Fig. 4).

Fig.3. Game Star Trek Set.

Later with a slight modification: "z" substitution by "s", this name was applied to all products using the game "Photon" technical and organizational principles. [8]

Fig.4. Game Lazer-Tag Set.

Laser-Tag game was not designed as a civil application of the military technology, but as a new generation kind of sport. The first Photon units had advertising slogan "XXI century sport". The key to this race is the player's physical strength and reaction speed.

Conditionally the Laser-Tag type games can be divided into two main groups - the labyrinths (these games usually take place in specially equipped indoor environment) and free run (field) – the last do not require especially equipped space for playing. Now exist 12 types of games suitable for various types of weapons and their technical capabilities [9].

Since the last century 70-ies this shooting training technologies have developed and acquired their development in both as military and law enforcement shooting skills training and drilling as well as in the entertainment industry.

Over the past years no new principles of tactical field simulator was developed at the same time the modern military practices and technical progress dictates new requirements for rifleman shooting skills training as well as entertainment gaming applications.

II. Existing shooting simulation equipment disadvantages and requirements for development new shooting simulator

The main existing laser shooting simulation equipment disadvantages are:

- IR emitter beam cannot overcome even small obstacles and can be easily blocked, eg. covering up sensor with a thin paper or cloth.
- In the relatively short shooting distances using narrow-angle transmitters the shooting simulation equipment requires to use enough large number of radiation receiver sensor for each game participant equipment kit significantly complicating the game participant's equipment.
- It is hard precisely localize the hit place (in game kit typically is useed standard IR emitters with a beam divergence of 2-4 arc minutes or beam diameter 6-12 cm at 100 m distance). These parameters as well as secure IR emission power limits the actual shooting distances up to 100 m.
- Significantly increasing the IR-emitting power in order to enlarge the hit distance the IR radiation can become dangerous to human visual organs firing with the same weapon at close range placed target. By using these laser devices are practically obliged to use safety goggles, which in reality is cumbersome and bothering in shooting, especially in the field.
- In addition after each laser emitter switching on the laser beam position optical adjustment procedure must be done.
- When optoelectronic sighting devices are used they can easily identify the opponent IR laser beam and accordingly – the location of other players on game place.

Today the open (original) weapon sight use becoming more rare and more infrequently it is replaced with the different types of existing optical and optoelectronic sights. Using the optoelectronic sighting devices rifleman does not see a real, but rather electronically processed image (the target). In addition a growing number of military and law enforcement operations, maintenance of public order events and hunting occur at a dark time of day. This situation stimulates emerging the new generation of optoelectronic sighting devices in market for widespread distribution and availability, which ultimately changes the shooting habits and skills.

The trainings and leisure activities using the small arms (its castings - moulages) in dark time of day become increasingly problematic with using laser transmitters for rifleman shooting simulation in both visible and IR range. The utilization of such emitters momentarily unmasking rifleman location if players are using night vision devices.

In this situation definitely the new vision for the shooting simulator technical solutions must be done that enable:

• High level of accuracy to determine hits in short and long distances.

• Significantly increase the shooting distance (minimum and maximum).

• Not to be dangerous to the rifleman health – that means that there should not be used special glasses to protect rifleman from the harmful laser radiation.

• Possibility to use all day, at the same time without unmasking characteristics.

• It should be simple to use, mechanically durable and would not require special regulations.

III. A new type field shooting simulator technical solution proposal

The technical proposal of new type of field shooting simulator comprise the use of *target coordinates measurements* at the apparatus (weapon) coordinate system at the shot moment thus avoiding the dangerous IR radiant used in entertainment games.

The field shooting simulator consists of non-collimated IR emitter/s (beacon/s) fixed on each game participant (rifleman) helmet/and waistcoat, mounted on the small arms casting (moulage) the telescopic optical system (optical sight) with inserted in the telescopic system focal plane video sensor (video camera) working in the IR emitter/s (beacon/s) spectrum band, GNSS - Global Navigation Satellite System (GPS, GLONASS, Galileo, etc.) signal receiver and communication devices. The telescopic optical system axis is adjust parallel to the weapon's (casting) barrel axis.

The Shooting Simulator works as follows.

Each game participant is equipped with helmet and waistcoat (the first or both) fitted with IS-emitting devices - beacons. Aiming (visually or optically) to the target – the "enemy" rifleman, the opponent's beacons are not be seen not at the daytime nor nighttime. The beacon image is visible in the weapon's telescopic optical system's IS video sensor (IR video camera) in case then the weapon is pointed to the target (with beacon) and the last can be displayed at the video sensor field.

At the shot moment the beacon (opponent's) image is fixed (recorded) on the video cameras IR sensor field, which forms the apparatus coordinate system on the telescopic system focal plane with the origin of this apparatus coordinate system formed by telescopic system axis intersection point with the middle point of video sensor. Beacons image coordinates (relative to the origin of this apparatus coordinate system) in this apparatus coordinate system is a real-at the moment hit coordinates. Each rifleman's GNSS signal receiver generates his position in the geographical coordinates of the selected coordinate system and from these measured coordinates at the shot moment the distance between the riflemen (opponents) can be calculated, giving the scaling factor in the apparatus coordinate system at the shot moment.

Each rifleman communication device transmit these target (hit) image and GNSS coordinates either to the game operator's control center, or to the opponent's weapon controller, which calculates the real hit (or miss).

Beacons IR radiation is visible only in optoelectronic sighting device, working in the radiated IR spectrum band, in case, if it is used. The beacons IR radiation identification can be prevented in this case by placing in the optoelectronic device the spectra cutting optical filters working in the beacon IR spectrum.

VI. The new type field shooting simulator block diagram and description

The new type field shooting simulator block diagram is shown in Figure 5.

The field shooting game simulator is designed for 2 rival teams (team A and B) for different field rivalry games (eg.,

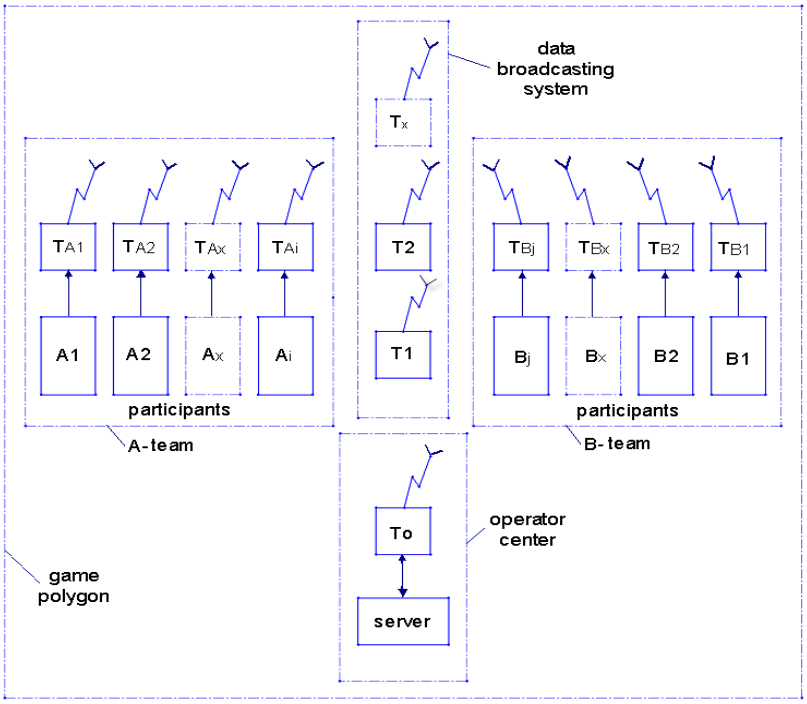

Figure 5. The new type field shooting simulator block diagram

hide and seek) including shooting options. Number of participants (Ai and Bi) in each team is limited only by available amount of the participant's equipment kits, eg., from one participant to, eg., 32 and data network overlay field options. Mandatory equipment kit elements - each game participant is provided with his wireless data transmission unit (TAx, TBx) and each game participant is equipped with its own special small arms casting (moulage) and additional

equipment outfit (helmet/and waistcoat). Each game participant is monitored and controlled from the game (shooting simulator) operator center by wireless data broadcasting system, which can be expanded by data broadcasting repeaters (eg., Tx), whose number is selected according the need of a reliable radio communication coverage from the operator to each game participant. Operator center is equipped with a wireless data broadcasting device (T0), to satisfy data interchange with each participant of the game, and server with control and management software, including geographic information systems, able to monitor and control each game participant in the field in real geographical environment and in real time.

V. The new type field shooting simulator advantages and disadvantages

The above-mentioned new type of field shooting simulator advantages compared to the known products are following:

- Substantially larger range of executable games and tasks to be performed. Possible each game participant individual control and management (employing the game operator) in the real geographical environment and close to real time.
- There is no need for specially arranged game polygon – the shooting simulator can not pose a threat to its environment, and the surrounding people. It may be used in the urban and rural areas.
- Significantly more secure: no hazardous radiation (laser) is used, the protective goggles against IR laser radiation should not be used.
- Can be operated around the clock while be sufficiently masked.
- The hits can be determined with high accuracy at near and far shooting distances.
- Significantly increased maximum firing distance, compared to known systems.
- Easy to use and does not require special regulations.
- Simply adapted to new generation of optoelectronic sighting devices.

The most significant disadvantages of the proposed new type of shooting simulator is the electronic management and control system complexity compared to laser shooting simulators.

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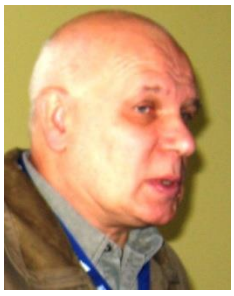
Dr. Juris Kiploks, are leading researcher of Institute of Industrial Electronics and Electrical Engineering of Riga Technical university (RTU),. Education: Riga Technical University, Doctor degree (2011, RTU) in Computerized control of Electrical Technologies, Master degree (2006, RTU) Since 1994 to 2010 service in Latvian NAF. From 2010 to now – work at the Department of Industrial electronics and electrical technologies of RTU. Address: Azenes 12/1, LV1048, Riga. Phone +371 8310044, e-mail : jkiploks@yahoo.com

Maris Knoks (Chairman of the Board, GeoStar Ltd., www.geostar.lv). Experience in geodetic equipment, optics, electronics, fine mechanics and project management. Education: Riga Technical University, Master’s degree (2011, Riga Technical University - RTU) in Radioelectronics, Graduated RTU in 1989 with fifth-level professional qualification of radio engineer. Postal address: Marupes street 20, Riga, LV-1002, Phone : + 371 67615233, +371 29163309 , E-mail : info@geostar.lv



Jānis Vjaters, Consultant in optoelectronics, optics and mechanics. Education: Ms.Phys., 1993, University of Latvia (UL). Graduated LU in 1972 Faculty of Physics and Mathematics. From 1970 to 2010 working in projects of optoelectrical and mechanical systems in University of Latvia and other organizations. From 2005 to 2010 had worked with projects of shooting simulation systems for MOD of Latvia and other organizations.Address: Marupes street 20, Riga, LV-1002, Phone +371 29488543, e-mail: slr_jv@latnet.lv

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