Model of Firearms Simulator Based on o Serious Game ond Sensor Technology

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Abstract: *The purpose of this paper is to describe a new approach for building a firearms simulator that is based on a Serious game – Virtual battle space 2 (VBS2) and motion sensor technology used in Army of Republic of Macedonia (ARM). Motion sensor technology is used to create representative weapon movement signals and transfer them to the VBS2 API in order to create realistic weapon movement.*
This paper major focus is to give a possible solutions for overcoming the problem with the transfer of the signals from the sensors to the computer, so that everything is going to be rightly represented in the virtual 3D engine of VBS2. It also compares this model and the similar models that are in use in NATO allies, and describe challenges and our plans for future work.

Keywords: Serious games, VBS2, Simulations, Inertial sensors, education, training.

1. Introduction

Military training had made a big progress from the time of the first war training techniques that were used in the Prussian armies.
In ARM the acquisition and implementation of these new technologies, combined with the models made from our own research and capacities will raise the quality of training and education.
The concept that we plan to use for combined training is represented in **Figure 1**, we will tailor the use rate of the steps, by our own demands, but without exclusion to one or more of these three steps.

Figure 1: Three steps military training concept

Motion detection is not a new idea. Security systems, medical systems and other systems apply a variety of ways of so called "external" detection of movement. This method of motion detection is accomplished using a variety of sensors (infrared, electromagnetic, radar, laser and video sensors)

that are placed outside the object of interest. As a result, this method of detection is sensitive to external influences and disturbances.
Today very attractive is the so called “internal” way of detecting motion. This method is accomplished by sensors placed on a rigid object, usually in the center of mass of the object of interest. They perform measurements of applied force and moments acting on that object, so with further processing of measurements, motion of the object is detected. Inertial sensors (gyroscopes and accelerometers) are most commonly used sensors for the internal method of motion detection.

2. Related work

For the scope of this paper we will represent and compare only a few top rated firearms simulation systems.
a) VBS2 module – Tactical weapons simulator It is a tailor-made software solution for virtual firing ranges or virtual convoy training solutions.
It has a realistic and configurable ballistic for the weapons used in range or convoy training.
The simulated scene is projected on to a large screen, which the shooter aims at. When the trigger is pulled a pulse of laser light is send at the screen. This light is detected by a camera, which compares the position of this point from each edge of the screen to calculate where the shot would hit [2],[3].
b) VirTra 100 MIL is the higher standard among single-screen small arms training simulators. Marksmanship mode supports up to 4 individual firing lanes at one time with full ballistics and qualification courseware.
The system is extremely compact and can even share space with a standard classroom or squeeze into almost any existing facility.
c) Meggitt Training Systems, support both individual and collective training in the use of a variety of weapons types throughout the full spectrum of military operations. Individual training consists of Marksmanship and Judgmental training.

- Marksmanship individual marksmanship, crew served weapons training and sustainment training for both.
- Judgmental training includes target discrimination, force escalation/de-escalation, and individual leadership imperatives.
- A single system supports five individual firing lanes and can be networked together with additional systems for up to 15 individual firing lanes.

All of the presented systems use lasers that are placed near the weapon muzzle, and they use the lasers for determination of bullet hits.
These systems are too expensive, and have a general problem with: lasers sensors and laser detection camera.
Laser tracking is accurate, but also costly and difficult to implement and maintain.
Laser detection camera is making problems when the environmental light is changed, and has a driver compatibility problem with Windows.

3. Serious games

There are a lot of definitions for serious games. We have chosen few of them that are most appropriate for us:

- “Serious games are games that use the artistic medium of games to deliver a message, to teach a lesson, or to provide an experience”,
- “Serious game: a mental contest, played with a computer in accordance with special rules that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives.”,
- “Serious Game; a computer or video game used for military purposed (training, visualization, experimentation, education.)”.

As **Figure 2** shows, serious games have more than just story, art, and software - they involve pedagogy: activities that educate or instruct, there by imparting knowledge or skill.

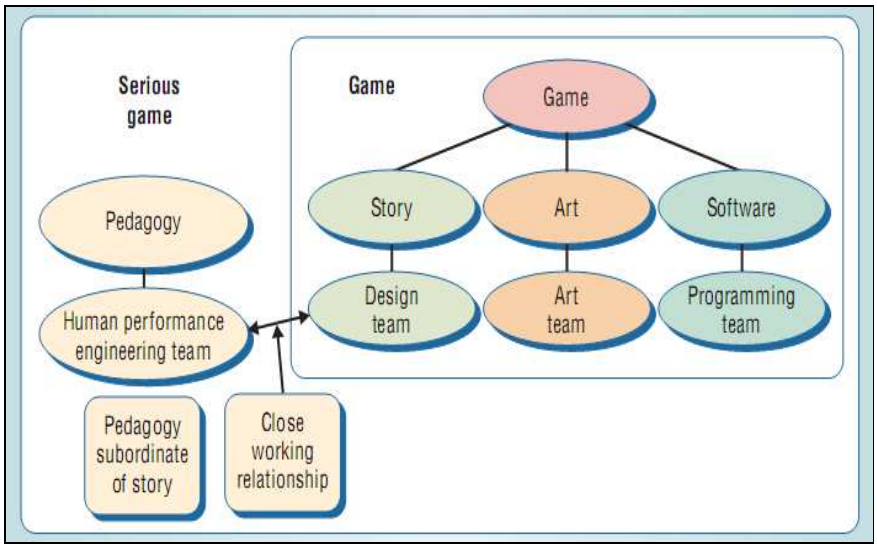

Figure 2: Difference between games and serious games

Successful serious Games balance three components: *Play, Meaning and Reality.*
The lack of either of these components renders a Serious Game useless. The *play* component makes the game more satisfying to play. The *meaning* components relates to the enhancement of the skills of the professional. Finally the *reality* part aims to allow the professionals to be able to apply the newly developed skills in their jobs.

4. **Proposed model**

In the next paragraph we will discuss the problem of interaction with VBS2, how we will overcome that problem, the functional parts of the model and its workflow.

4.1. Issues and challenges

The most important part of the Model of firearms simulator is the connection to VBS2. Other parts of the system will be useless without the ability to control VBS2. The goal of our model of firearms simulator is to be able to do the targets aiming in VBS2 like as it would be in real life.
There are two standard ways to control VBS2. The first one VBS2's API FUSION that enables other programs to interact with VBS2.
The other one is through DirectInput, which is an API (Application Programming Interface) for developers to collect user inputs from keyboards, mousses, joysticks, and other game controllers.
Fusion is an API built by SimCentric which is an add-on module to VBS2. The purpose of Fusion is to enable developers to control VBS2 from outside of the simulation. The Fusion API is a collection of C++ classes that enables developers to create, modify, and get information from objects in VBS2. Fusion is released in stages, v1.0 released in May 2009 and v2.0 in April 2010
DirectInput is an Microsoft API which enables developers to gather inputs from different input devices (mouse, keyboard, joystick or other game controllers) without knowing the properties of the device beforehand. DirectInput also handles output for force feedback and haptic devices. When a developer needs input from same device they uses DirectInput to enumerate all attached devices to the computer. The Developer can then choose device to use and fetch the capabilities of that device. The device describes itself in a standardized way which enables a developer to develop applications that are compatible with a wide range of input devices.
For our module we will use the DirectInput, because it can fetch the capabilities and inputs from our sensors and enumerate them to the VBS2.
VBS2, as almost all other windows games supports DirectInput which are a widely used industry standard for input devices.

4.2. The concept of the model

For the purpose of this model we plan to use an automatic rifle AK47, on which we will mount the Atomic IMU on the muzzle. The IMU will measure the accelerations and angular rates that occur during the movements of the rifle. This information will be sent to i386 Drive micro-processing system through RS232 Serial port. This part will be responsible for processing the measurements from the

IMU, detection of movements and will send them via DirectInput (PS/2) communication to the desktop computer. Here we need to develop algorithms for capturing the motion of the rifle. They will be characterized by high speed and precision. The plan is to develop the algorithms throughout experiments where the movements of the rifle will be performed in all possible positions. As mentioned previously these detected movements will be sent to the desktop computer through DirectInput.
Then the movements of the user rifle will be shown on the screen in real time. The plan is to place two contact sensors on the rifle. The first sensor is going to be placed near the trigger and is going to give signal when the trigger is pressed. Second contact sensor is going to be placed on the magazine catch, so when reloading of the magazine appears it will generate a signal that we are going to enumerate as a magazine reloading.
Motion sensors are relatively cheap compared with the laser sensors. They have very high degree of accuracy. One of the main advantages of this model is the absence of detection camera.
In this way the loop is closed and the user will have a feeling that is a part of the simulation and scenario that is displayed. This editor mode from VBS2 will allow development of various "realistic" scenarios such as: all types of shooting ranges, combat in urban areas, deserts, mountains, forests, etc.
The concept of the model of firearms simulator is shown in **Figure 3.**

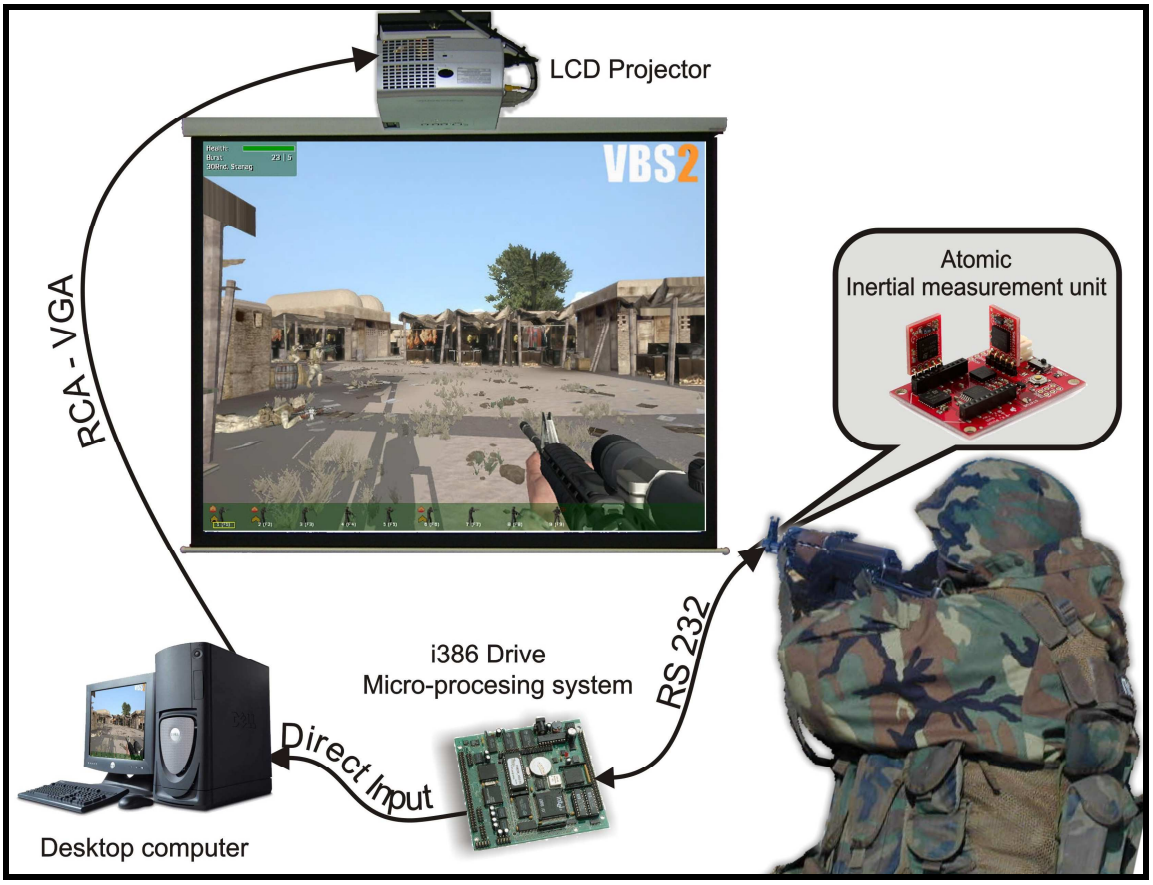

Figure 3: Concept of the model of firearms simulator

6. In conclusion

With our firearms simulator based on a serious game and sensor technology we are traying to enhance the ongoing process for implementing new technologies in training and education in Military academy and in ARM.
Our model compared with other gives: high degree of accuracy, it cost less and doesn't use detection cameras.

Establishing communication of exchanging information from sensors to VBS2 will fulfill basic condition for the future work in order to place wireless sensors on the user gear, to simulate the movement of the user in VBS2 and enemy return fire with electric impulses. Furthermore, cooperating with the Faculty of Electrical Engineering and Information Technologies - Skopje, we plan to build a pneumatic system that will simulate the recoil of the riffle.

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