Virtual Ballistic Projectile Simulation: Detached-Displacement Synthetic Hit Algorithm

Researcher: Dr. Nyagudi Musandu Nyagudi, a cited Military Informatics Expert, Nairobi, KENYA

ORCID:

Contact – email: nyagudim@yahoo.com

Publication Date: 7th/12/2018

Keywords: Augmented Reality, Virtual Reality, Ballistics, Simulator, Simulation, Training Systems, Sniper, Marksman, Gunnery, Bombardier, Artillery, Scoring System, Laser, Digitization, Battle-space, Infantry, etc.

Problem

Marksman skills be they sniper rifle, pistol, etc. are highly perishable skill-sets. Continuous practice serves to awaken otherwise dormant reflexes and perfects targeting accuracy. Over the years with various challenges, e.g. gun-control by dictatorships etc., lack of access to shooting ranges or otherwise practice sessions in limited environments, have hampered many a keen marksman. Many improvised simulation tools add reality issues such as recoil and sound, but none in the open access domain give realistic ballistic challenges in train e.g. on issues such as Kentucky Windage, Ballistic Drop / Gravitational, Cross Winds, etc. The Open Access projectile simulators and those used to train infantry and law enforcement are static with no dynamic challenge in terms of forces acting on a simulated ballistic projectile once it departs from the muzzle. The methodology/algorithm/technique in this paper shall adjust a wide range of Laser simulators, etc [1], [2] to give more realistic training on 7.62mm, 50 cal, and related long-range sniper shot simulators, but with it offers great promise in simulating more interesting projectiles e.g. short range pistol under intense wind conditions; 105mm, 155mm artillery shells; 84mm Carl Gustav, as well as all manner of ballistic projectiles.

Solution – Algorithm

Step 1: A pointing technology is utilized to create an impression on a target

Step 2: Target consumed virtually by a computing system together with impression of pointing technology

Step 3: Trigger is pulled by the marksman using the pointing technology

Step 4: Trigger pull detaches (switches-off) pointing technology from virtual impression of target and pointer

Step 5: Computing system consumes virtual impression of target and pointer position and separates the two

Step 6: Computing system readjusts alignment of virtual impression of the target and pointer position to each other by injecting ballistic characteristics of projectile, gravitational effects, cross-winds, earth's movement, distance from target, flight time of projectile, target movement etc. by way of computing meteorology calculations, ballistic calculations etc.

Step 7: Scoring – Computing system reattaches virtual impression of target to new recalculated pointer position

Step 8: Outcome communicated via suitable interfaces

Step 9: Marksman or Bombardier in training applies corrective targeting calculations and subsequent Measures

Step 10: Step 1 repeated with enhanced skill-sets and higher likelihood of better targeting scores

The Concept

F - Detached Displacement Ballistic Function

P - Original Position of Pointer i.e. final position of pointer if static simulation is used throughout

H – Synthetic Hit Position of Pointer i.e. final virtual position of pointer due to dynamic simulation

$F(P) = H$, where $H \in R$,

N – Negative training effects in real world performance

R – More realistic training outcomes

As $R \to \infty$, $N \to 0$

M – Intended point of target

Initially if the equipment is absolutely perfect and the marksman is perfect then M = P before taking a shot while aiming, but upon taking of the shot there is a relationship between M and P if and only if $R \to \infty$ where $H \in R$.

Notably, the current offerings by way of infantry / marksman training systems are static in nature [3], laser is scored on the basis of static and not dynamically calculated impression i.e. given the short duration time of projectile flights it is assumed that static impressions are sufficient training, but when calculation intense and long-range skills such as those of Bombardiers and Snipers are considered, nothing can be further from the truth. Static projectile simulation for marksman/bombardier training, is actually negative training and negative training shows up in battle-spaces or at competitions as poor performance.

Whereas some advanced existing laser-feedback based simulators read meteorology data and provide an aggregated scoring for projectile trajectory, and others could use various meteorology devices to provide a data-feed for trajectory conditions, their final trajectory calculations are static, this is because they do not simulate conditions like several cross-winds [4], air pressure etc. that could be synthesized for the whole trajectory between the instance of simulated muzzle departure of a projectile and simulated target hit.

The conceptualized system specifically simulates all parameters within the short reality time-window between detached-displacement (simulated muzzle departure) and synthetic target hit (simulated target hit). Additional parameters that could be simulated in the computing platform given sufficient computing resources are those of projectile effect on target e.g. impact or proximity effects and target reaction(or reaction within targeted area) given the simulated hit.

Physical reality could also be provided in a chamber or outdoors, e.g. weather-conditions under which the sniper or bombardier or etc. are operating, e.g. physical real but inert simulation of equipment used, or simulated sensation of winds on a snipers' body to add some more realistic training conditions and eliminate any form of negative training.

Development Challenges

Inevitably, there shall be a development challenge for such a system by way in computing systems both hardware and software, and that of additional delays in displaying simulated reality. With engineering radar systems, circuit/system delays are calculated and/or determined using, Vector Network Analyzers [5] an analogous approach shall have to be deployed in the realm of this proposed systems.

Conclusion

More realistic training solutions can be developed for marksmanship and gunnery, at ever lower costs. The hardware is ubiquitous and can be found off-the-shelf at any supermarket. The primary cost is developing sufficiently fast computer algorithms and selecting the right hardware platforms and software environments. The primary challenge is ability to determine the seemingly infinitesimal time delays in the system that have the effect of increasing the undesired value of Negative Training [5], as well as eliminating undesired computational complexity that may retard otherwise good performance of the simulator.

The premium is that equipment used for training can be hidden in plain sight, as it need not look like the weapon it is emulating but can be measured/engineered in such a way to precisely emulate the feel of the same, large numbers of warfighters can be trained in confined spaces hidden from aerial assets (strikes and/or surveillance) and regime elements. More so with methods such as E2 [6] regimentation, hundreds of thousands could be trained for combat in a heavily policed city without knowledge of a genocidal regime.

Supplemented by free open-source frugal downloadable weapons designs, a whole citizen army could be recruited, trained, equipped and deployed without any immediate need for foreign weapon shipments. With the Genocides of World War 2, Khmer Rouge – Killing fields in Cambodia [7], etc. in mind this is not a bad idea if the broad knowledge of the know-how can deter bad governance.

References

[1] Laabicz *et al*, (2013), "HomeLESS – Home Laser Shooting Simulator", Url: https://homeless-eng.webnode.com/ (accessed on 8th/12/2018 at 8:37 pm Nairobi Time).

[2] Hagara, Ladislav, PhD, LTC, and Lábr, Miroslav, 2LT. (2016), "HomeLESS Shooting Analyzer 0.2", Department of Communication and Information Systems, Faculty of Military Technology, University of Defence, Czech Armed Forces, Czechia. Url: https://www.unob.cz/vyzkum_vyvoj/Documents/vysledky_vyzkumu/2016/SW%20HomeLESS-Shooting-Analyzer-0_2-01.pdf (accessed on 8th/12/2018 at 8:49 pm Nairobi Time)

[3] Hoffmann, Oliver, (2017/2/19th), "Press Release: Rheinmetall's Legatus live simulation – leading technology for realistic modern combat training", Rheinmetall AG, Germany. Url: https://www.rheinmetall-defence.com/media/editor_media/rm_defence/publicrelations/pressemitteilungen/2017/2017_02_19_rheinmetall_idex/englisch/2017-02-19_Rheinmetall_IDEX_15_Legatus_Live_Simulation_en.pdf (accessed on 8th/12/2018 at 9:25 pm Nairobi Time)

[4] Crowe, Devon G. (Inventor), (2010/4/27th), "System and Method for Determining Crosswinds", United States Patent No.: US7,705,971 B2. Assignee: Raytheon Company, USA. Url: https://patentimages.storage.googleapis.com/5f/93/4f/48c5736ad8a3a1/US7705971.pdf (accessed on 8th/12/2018 at 9:39 pm Nairobi Time)

[5] Williams, Jonathan H., (2011/1), "Modular System RF Design "Build Your Own Small Radar System"", 2011 MIT Independent Activities Period (IAP), MIT Lincoln Laboratory, USA page 30

[6] Note - A regimented organization formed by way of hierarchy but members do not know each other apart from their superiors and are still subjected to co-ordinated operations. Ideal regimentation structure for large scale clandestine and/or subversive operations in dictatorships, such that capture and/or torture does not impede tactical operations if well implemented.

[7] Hovind, Kent (Dr.), (2004), **A Critique on Gun Control and its effects which are usually Genocidal**, Url: https://www.youtube.com/watch?v=mcHoCXjvuy0 (accessed on 8th/12/2018 at 10:25 pm Nairobi Time)