Asian Journal of Engineering and Applied Technology
ISSN: 2249-068X (P) Vol. 6 No. 1, 2017, pp.1-9
© The Research Publication, www.trp.org.in
DOI: https://doi.org/10.51983/ajeat-2017.6.1.818

Graphics in Combination Handguns Preparation Classification (Gaps)

P.Senthil
Associate Professor in MCA Computer Science,
Kurinji College of Arts and Science, Tiruchirappalli, Tamil Nadu, India
E-mail: senthilkanapathy@gmail.com.
(Received 14 December 2016; Revised 30 December 2016; Accepted 23 January 2017; Available online 30 January 2017)

***Abstract* - The goal of the article is to present a novel Multimedia Firearms Training Classification. The system was developed in order to compensate for major problems of existing shooting training systems. Designed and implemented solution can be characterized by five major advantages: algorithm for automatic geometric calibration, algorithm of photometric recalibration, firearms hit point detection using thermal imaging camera, IR laser spot tracking algorithm for after action review analysis, implementation of ballistics equations. Combination of the abovementioned advantages in a single multimedia firearms training system creates a comprehensive solution for detecting and tracking of the target point usable for shooting training systems and improving intervention tactics of uniformed services. Introduced algorithms of geometric and photometric recalibration allows using of the economically viable commercially available projectors for systems that require long and intensive use without most of negative impacts on color mapping of existing multi-projector multimedia shooting range systems. The article presents the results of the developed algorithms and their application in real training systems.**
***Keywords:* Firearms shot detection, Geometric recalibration, Photometric recalibration, IR tracking algorithm, Thermography, Ballistics.**

I. INTRODUCTION

There is a need for training systems allowing their users to train operational activities at a relatively low operating cost, and without endangering the health and life. One of the solutions used in industry practice are training simulators for ground and air vehicles. Simulation systems commonly use virtual reality in order to reduce operating costs and enable the training scenarios difficult or impossible to implement in the real training. However, using of virtual reality is associated with making some simplifications related to the representation of the actual training in virtual world. One of the areas in which any simplification can carry the risk of acquisition erroneous practice is shooting and training muscle memory in carrying out operational activities. In this article we present the development of multimedia shooting range solution allowing for the use of the advantages of virtual reality while using real firearms. The proposed multimedia shooting detection system has five major advantages: firearm hit detection using thermal imaging camera, IR laser point tracking algorithm for analysis purpose, implementation of ballistics equations and algorithms of geometric and photometric recalibration).

II. OVERVIEW OF EXISTING SOLUTIONS

Typically, shooting training is conducted at shooting polygon or indoor shooting ranges with the use of firearms and metal or paper shooting targets. Training of this type because of the danger of loss of health or life is conducted only in specially protected areas. This results in limited access and higher cost of operating the solution. For training purposes shooting targets are usually simple images printed on paper, therefore it is difficult to perform realistic training of tactics of intervention using real officer's equipment.

On the market there are solutions that use virtual technology to reduce the significance of this problem. These solutions, however, are characterized by a closed construction prevents their development and general use, covert implementation of algorithms and the use of often outdated equipment due to the long development cycle of these systems. Solutions using virtual technology can be divided into two groups: fully virtual - using only laser replica firearms and systems that are able to detect a hit with firearms in order to interact with the virtual world. In this article we consider only the second group due to the high level of realism.

Based on our review of the existing and applied solutions, there are two main solutions for the detection of hits with the use of firearms: DPCS system from SST GmbH [1] and the system offered by LaserShot for the needs of uniformed services [2]. The DPCS system uses a multi-projector system to project an image of virtual reality on the plane of the screen and the system of illuminators and cameras in order to detect the bullet holes resulting from shots into the plane of the screen with a firearms. Lack of implementation of the algorithm of photometric recalibration forces the manufacturer to use projectors with a lower image presentation parameters and significantly increased cost due to longer stable lifetime of a projector's lamp. The DPCS uses a system of illuminators and cameras in order to detect hits. The system requires a special construction of thescreen and makes it impossible to display the image directly on the ricochets muffler, which greatly complicates the structure and increases the cost of the solution, resulting in difficulty in its common usage. Because of the closed construction of the system and the use of simple video scenarios it is difficult to determine whether the system implements the ballistics equations allowing conducting training for longer distances than 50m.

The system offered by LaserShot for the armed forces consists of a thermal imaging camera with a screen made of special material and calibrated with them projector. Detection of hits in the plane of the screen is done using computer analysis of the video stream from the thermal imaging camera. The use of a special screen with known properties allows thresholding known signature of heat generated by hitting the screen with a bullet. As in the case of system DPCS due to the closed construction of the system and the use of simple video scenarios instead of 3D virtual world it is difficult to determine whether the system implements the ballistics equations allowing conducting training for longer distances than 50m.

It is worth noting that both DPCS system, and the system offered by LaserShot in versions that uses multiple screens does not provide despite using of expensive projectors seamless connection between the images projected on individual screens, which significantly reduces the realism of the training and distracts the participants.

III. SYSTEM ARCHITECTURE

After analysis of the existing solutions, we have identified the following needs and problems to be resolved:

1. Creation of a robust physics engine that implements the ballistic equations and takes into account not only the influence of gravity, but also other important factors such as wind, air resistance, gyroscopic drift etc.,
2. Developing an algorithm that allows photometric recalibration in order to create a high quality system without using projectors with high life-time but often outdated output parameters,
3. Developing an algorithm that allows automatic recalibration of geometric parameters in order to compensate for screen imperfections etc.
4. Enabling the detection of hits directly on the muffler ricocheting instead of the specially developed screen,
5. Implementation of the algorithm of geometric and photometric calibration through the screen in the multi-projector system will be characterized by the so-called seamless connection,
6. Implementation in the system capabilities of continuously tracking the target point in order to collect more advance than the current statistics and in order to allow the possibility of carrying out an exhaustive review after performed action.

The developed system consists of the following hardware components: a projection module comprising two high quality video projectors, computer responsible for the implementation of the algorithms, computer responsible for generating the virtual reality, the module comprising multimodal system: FIR, IR and visible light cameras.

The main goal of the system is the modular design allows configuration of shooting detection on both a single track, and the construction of multi-lane systems (Fig.1).

Fig.1 The system architecture enables modular use of the system: A) A single track, B) Multiple tracks simultaneously

A.Geometric Calibration

The user using simulation system that maps the actual situations can cheaply and without endangering the life and health train operational activities. The basis of operation of the multi-projector systems is to carry out an effective, ensuring consistency of visualization, geometric and photometric calibration of projectors.

During creation of an image projection system using multiple projectors there is a number of challenges with the correct geometric alignment of projectors and photo-metric calibration so that the resulting image is consistent both in terms of geometry and color and luminance [23]. For this purpose the geometric and photometric calibrations is performed. Calibration ensures consistency of geometric visualization composed of images from multiple projectors on the projection screen in terms of geometric means, e.g. the behavior of straight lines along the entire visualization [24].

Transforming the entrance image in this way for the projection of this image falling on the screen of the projection to lie in the earlier designed place is a result of the geometrical calibration. For that purpose, finding the function of such a transformation is needed. The system operator of the image projection can determine such a transformation by hand, changing the geometry of the entrance image and observing changes happening on the screen or perhaps it to be carried out in the automatic way with the feedback in the form of visional information from the camera [23].

Depending on the type of the screen of the projection we can distinguish two with kind of shapes of the screen. The first kind is a screen makes from one or more planar surfaces, a second is a screen of an irregular, unknown shape (Fig. 2). In case of the first type of screens to the calibration it is possible to use linear transformations e.g. homography. In the second case the mapping pixel to pixel is needed.

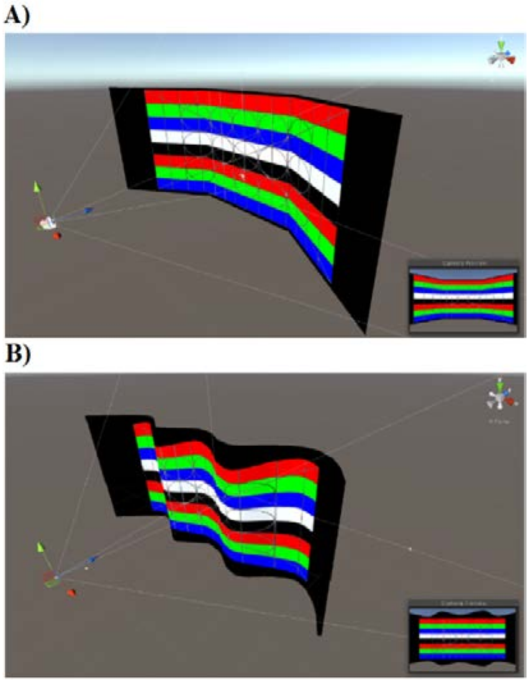

Fig. 2 Screen of the projection consisting of a few plains (left) and screen of an irregular shape (right))

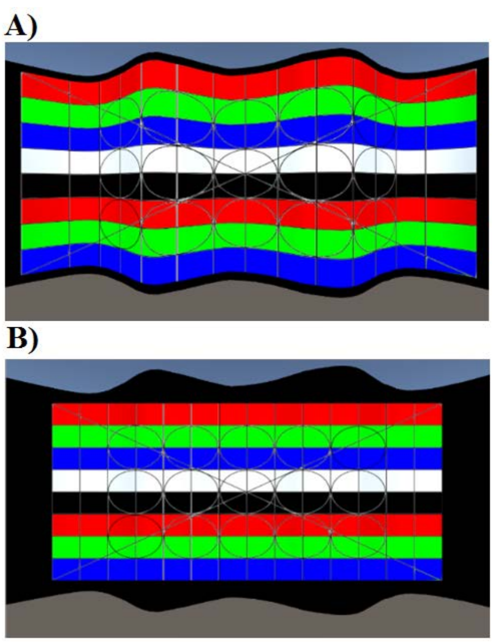

Fig. 3 Two manners of the geometrical calibration at using screens about an irregular shape. First, it is "sticking" of projection to the shape of the screen (left), second it is a calibration of the projection relative to the chosen position of the observer in the space so that shape of the projection comparatively is kept (right)

An irregular shape of the screen results in it, that change position of the observer, requires retransforming the image. Therefore, when we are dealing with screens of irregular shape, we can distinguish two approaches to the geometric calibration (fig. 3).

The first one assumes that visualization is rigidly "glued" to the projection screen. This approach can be compared to the situation at which the wallpaper is located on the screen. The second approach is to calibrate projection system to the desired position of the observer in the space, in such a way that from that location the image is seen correctly.

Photometric calibration provides continuity of brightness levels in the visualization. In this publication the authors present calibration method to calibrate any number of DLP projectors on the screen comprising of any number of planes. Based on tests authors distinguished factors distorting the output visualization, such as offset color black, brighter areas receipt of images from adjacent projectors and developed methods that allow to get a uniform visualization.

Having detailed information about how the vertices of the output image (texture) are converted to the output image of the projector it is possible to map the entire texture from one quadrangle into another [5]. The aim of the methods is to find bilinear equations opposite to the following:

$$X = a_0 + a_1 U + a_2 V + a_3 UV \quad (1)$$
$$Y = b_0 + b_1 U + b_2 V + b_3 U \quad (2)$$

After transformations, we obtain equations for the coordinates *U* and *V*:

$$U = (X - a_0 - a_2 V)(a_1 + a_3 V) \quad (3)$$

$$V = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A} \quad (4)$$

The geometric calibration challenge is a seamless connection of adjacent projected images [6]. For this purpose the blending of images of the joints, described by transfer function whose argument is the distance from the edge of the pixel image, is used. The output value of the pixel is its actual value multiplied by the value of the function.

$$f(x) = \begin{cases} 0.5\,(2x)^p & for\ \ 0 \le x \le 0.5 \\ 1 - 0.5\,\big(2(1-x)\big)^p & for\ \ 0.5 \le x \le 1 \end{cases} \quad (5)$$

The curvature of the function is controlled by the parameter p Where blending is linear with $p = 1$, the growth of p will increase the degree of curvature of the blending. In the case of image projection systems applies only the function f is no suitable. It is necessary to take account of the gamma function that informs about how the pixel values are mapped to the brightness of the device. The value of gamma G is in the range 1.8 to 2.2 [6]. The blending after taking into account the gamma is as follows:

$$f(x) = \begin{cases} f(x)^{\frac{1}{G}} & for\ \ 0 \le x \le 0.5 \\ f(1-x)^{\frac{1}{G}} & for\ \ 0.5 \le x \le 1 \end{cases} \quad (6)$$

The results of these functions are presented in test chapter of the article.

B. Ballistic Engine

Marksmanship Training Systems includes simulation of bullet trajectory, to make it more realistic. Movement of the projectile and forces acting on the bullet is subject of exterior ballistic that is well described in scientific literature [7],[8]. Based on that mathematical model was created. It describes movement of the bullet as close as possible to reality. These effects have influence on bullet trajectory [7]:

1. Gravity force – causes bullet to fall.
2. Air resistance – causes bullet to decelerate.
3. Wind – causes bullet to change flight direction.
4. Coriolis effect – additional forces acting on bullet because it moves relative to rotating reference frame.
5. Gyroscopic drift – drift caused by rotation of bullet.
6. Magnus effect and Poisson effect – additional forces acting on bullet caused by circular movement of bullet in atmosphere.

Atmosphere parameters like: air temperature, air density, air pressure have impact on all effects that are caused by bullet movement in atmosphere. These effects are: air resistance, wind, Magnus effect, and Poisson effect.

However, gyroscopic drift, Magnus effect and Poisson effect don't have significant impact on bullet trajectory, and Poisson effect can't even be described by mathematical equations. Therefore, not every effect is considered in mathematical model of bullet trajectory that was used for simulation. To simulate projectile movement mathematical model takes into account: gravity force, air resistance, wind, Coriolis effect and changing parameters of atmosphere. These effects have significant impact on bullet trajectory.

To simulate bullet trajectory, specific bullet parameters are required: it's weight, caliber, ballistic coefficient and drag model [8]. Ballistic coefficient is a bullet's parameter that describes it's ability to overcome air resistance during flight. Drag model is a function that describes a relationship between bullet velocity and drag coefficient. Combining ballistic coefficient and drag model together allows to compute drag force acting on projectile. These parameters are often found in ballistic tables provided by ammunition manufacturers.

C. IR Laser Point Tracking

Modern tracking algorithms are focused on complicated objects, which can be described with complex methods. Object tracking survey [9] lists 4 common visual features: color, edges, optical flow and texture. These features are used to build models, create templates and probability densities functions in order to find representation of object. Novel trackers can define and learn about the object not only by initialization but online as well [10]. However, tracking simple laser blob, which is seemingly immutable in real-time even in environment close to laboratory's one becomes difficult task.

The basic reason of problems is fast laser movement. Because of its small dimensions it can move by path of few diameters between two frames. What is more, rapid moves make blob blurred and darker. It means none of features listed above is preserved. Size of blob can get multiplied or divided by few times even every frame. Once area of the blob is too big information about relevant position of the laser is lost and cannot be calculated from just single frame. Last, but not least problem is real–time processing in high resolution. This is important task, because it can increase quality of the tracking. Ability to process frames with high frequency allows usage of faster camera.

We have selected few trackers to compare with our algorithm. Fist of them, FragTrack [11] algorithm divides tracked object to set of fragmented images, where each fragment is represented and identified by histogram. Second algorithm called VTD [12] bases on 2 steps – first is defining object's observation and movement model. Usage of this data can make tracker robust to simultaneous changes of movement and shape. In second step tracking is divided to group of elements, where each one traces single, different type of object change. In order to combine results of elements together it uses Interactive Markov Chain Monte Carlo (IMCMC) method. Locally Orderless Tracking (LOT) [13] method is based on the combination of the image space and object appearance which allows tracking of targets that are deformed. Method adapts its operation to form of the object that is being tracked. If the object is a solid body, then the value of the arrangement coefficient is close to zero and can be used in methods based on spatial alignment such as pattern matching. Otherwise, when the shape of the object is changing, LOT method cannot take advantage of spatial fit and works by matching the histogram.

Our algorithm RLPT is feature based tracker. In order to determine whenever found blob is laser's point or noise we use two features: color and area of the blob. Both of them must match predefined, parameterized thresholds. Tracking processing for every frame works in two different modes: regional or global search of blob. In regional mode search is performed only in boundaries around previous laser's position. In case of fast blob's movement it starts to estimate position of the laser using the blob's velocity and contour. If regional search fails or position of any laser in previous frame is unknown the global search is made. It scans whole frame for blob, which can be possibly the laser's one. Algorithms returns new position of the laser as centroid of the blob or flag that the laser does not exist if none blob has been found. All the details of the algorithm are presented in the article [14].

D. Photometric and Geometric Recalibration

The first stage recalibration of color is the detection of light area of each projector relative to the screen. This is done by displaying green image for each projector, which is then thresholded in order to detect an area of the projector (Fig. 4). It is assumed that before the camera was calibrated [20].

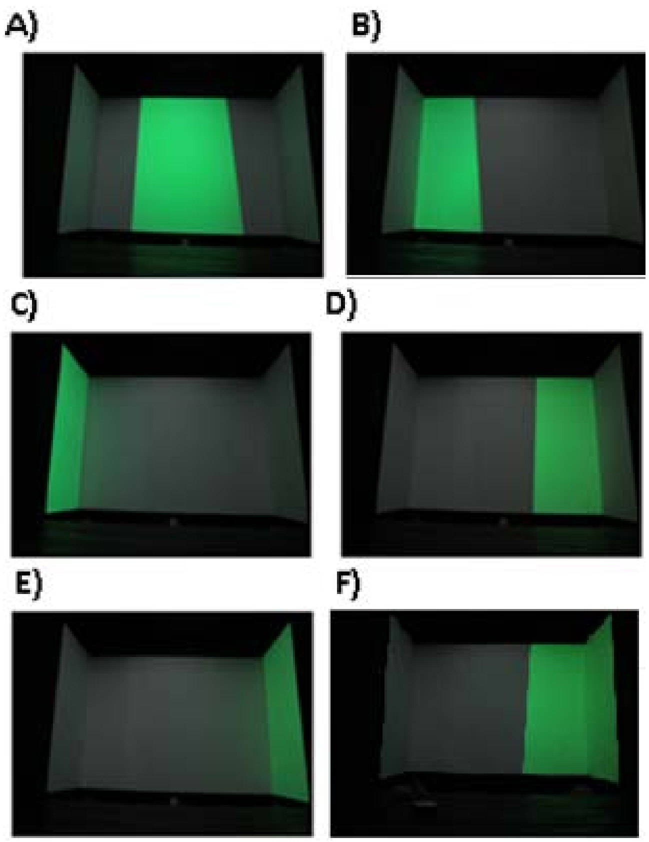

Fig. 4 A)-F) Steps of an algorithm of automatic detection of an area of each projector in the multi-projector system

The screen detection presented in fig. 4 would be sufficient if the screen surface would be flat. However, in reality, most of the screens are not perfectly straight. Please note the imperfections near the center of the screen (fig. 5a). Therefore, it is required to determine the shape of the screen. One of the possible methods to determine the shape of the screen is to visualize horizontal and vertical stripes (fig. 5b) and detect their intersections.

In order to compensate for its imperfections it is required not only to detect intersections of the displayed lines but to detect points at the border of previously thresholded screen area per projector as well (fig 5c). After those steps it is possible to automatically compute homographies required to compensate for projection screen imperfections.

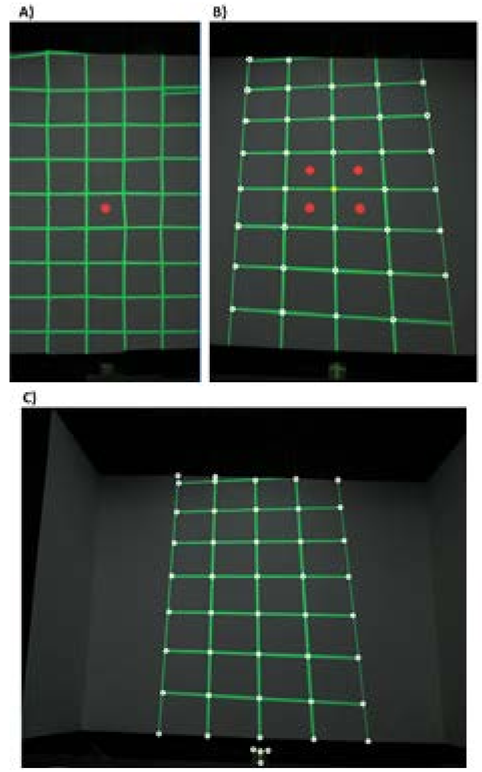

Fig.5 A) Screen imperfections visualization using horizontal and vertical straight lines in virtual reality, B) detection of lines intersections, C) detection of line’s endpoints

Photometric color recalibration algorithm for multi-projector system proceeds in the following steps:

1. Automatically detect the screen and compensate for its imperfections.
2. Determination of the transfer function projectors and their reversal [16].
3. Balancing the white point for each projector individually [15], the effect of actions are gains for the different channels that are common to all the pixels of the projector.
4. Transforming gamut for each pixel [15], the result is a map that the pixel be-longing to the common parts reduces the brightness.
5. Filtration using morphological opening, the structuring element has a square shape with a side length equal to 10% of the root of the sum of pixels of histogram multiplied by the width of the histogram.
6. Reducing the brightness of each pixel [15], [16], resulting in two maps - gains and redeployment of black.
7. Smoothing brightness for each pixel [15] The result is another map of gains.

IV. TESTS AND RESULTS

The developed algorithms were implemented in software and tested quantitatively and qualitatively. Selected results are shown below. Tests were performed both in simulation and in reality conditions. They were present at all stages of calibration to verify the correctness of the implementation of the methods and the evaluation results. Simulation tests were performed in simulation engine, which enables the deployment of virtual projectors and virtual projection screen, built by the user and in Matlab. They allowed for the preliminary examination of the accuracy of methods used. The tests were performed on the prepared actual image projection system consisting of three DLP projectors and the screen made up of three perpendicular walls. (Fig. 6).

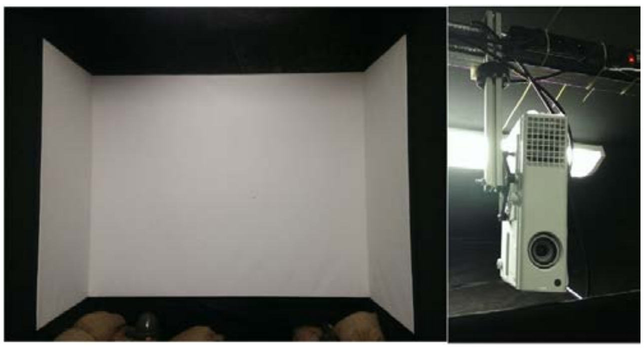

Fig.6 A) The tested system of image projection. Screen and one with 3 DLP projectors

A. Photometric Recalibration

The effects of the selected steps of photometric recalibration algorithm are illustrated in Fig.7.

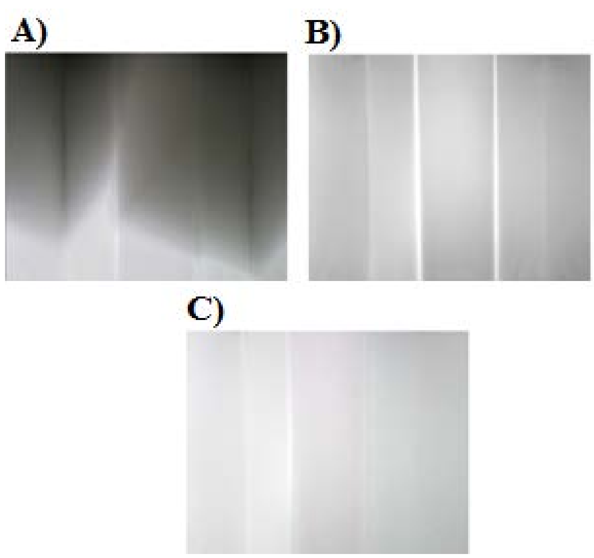

Fig.7 The result of the selected steps of photometric recalibration algorithm. A) the result of step 3, B) the result of step 4, C) the result of step 6

Results of implementation of all the steps of the proposed algorithm are shown in Fig.8.

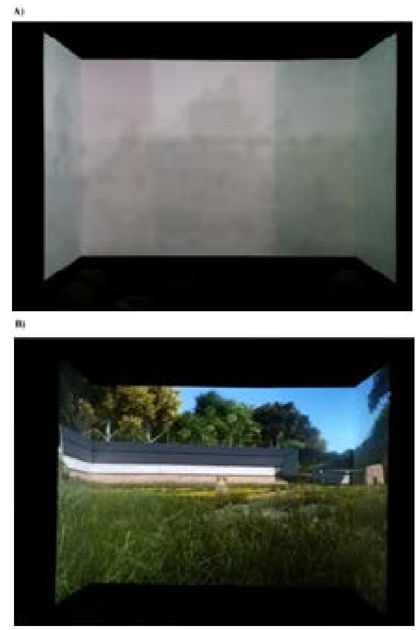

Fig.8 The result of implemented photometric recalibration algorithm. A) Before use, B) after use

B. Hit Point Detection

The developed and implemented based on the authors' experience with the friends-foe recognition systems [19], [22], hit detection algorithm using video analysis of a stream from thermal imaging camera has undergone extensive testing in quantitative and qualitative terms. The input data for the algorithm is the video stream from the thermal imaging camera (fig. 9). 3D visualization of the first and last frame of the sample sequence recorded during shooting 5 test shots is shown in Fig. 10.

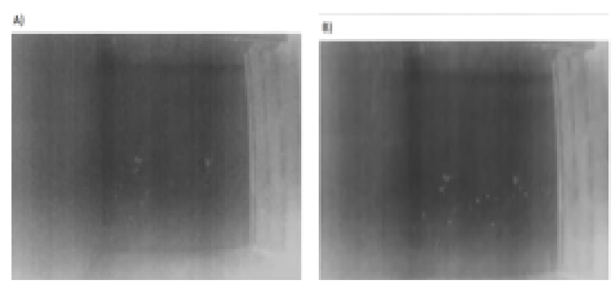

Fig.9 The first and last frame of the sample sequence recorded using a thermal imaging camera while 5 shots were fired. a) first, b) last

During the tests it was found experimentally possible to detect hits into firearm ricochets muffler:

a. In different places of the plane of the screen,
b. In the same place of the plane of the screen,
c. Single shots,
d. Series (up to 600 rounds per minute),
e. Detection of shots from a handguns,
f. Detection of shots from rifles,
g. Detection of ASG shots using BB above 2g.

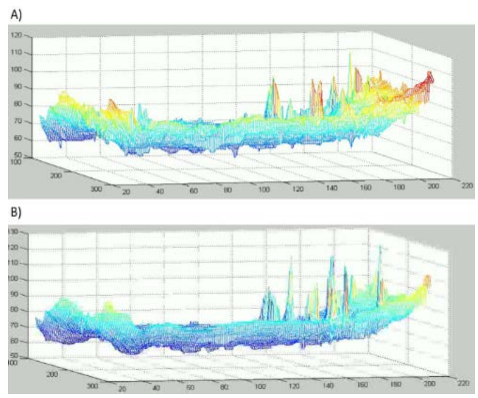

Fig.10 - 3D visualization of the first and last frame of the sample sequence recorded using a thermal imaging camera while 5 shots were fired. A) first, B) last

The result of the implemented algorithm is illustrated in Fig.11.

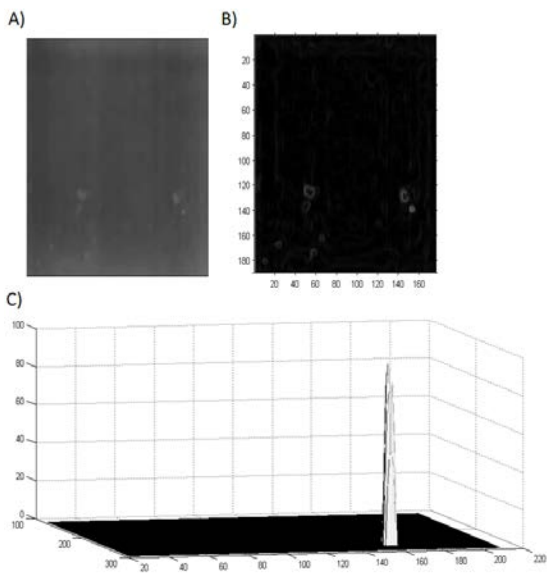

Fig. 11 3D The results of implemented algorithm of a gun's bullet hit into firearms ricochets muffler. A) before processing, B) after processing using the dynamic model of the background, C) 3D visualization of the frame sequence with detected hit point

C. Laser Point Tracking

Our test data for IR laser point tracking includes three recordings, which we named as Easy, Medium and Hard. All of them contains two moving lasers' blobs. In Easy test lasers' blobs move slowly and never blur. In Medium test lasers move with average speed and blur occasionally. In Hard test they move dynamically, they are blurred through majority of record and finally they disappear for few frames: fig. 12, fig. 13, fig. 14, fig. 15. Database of reference positions and areas for each frame has been made manually, so it can be used for analysis of algorithm.

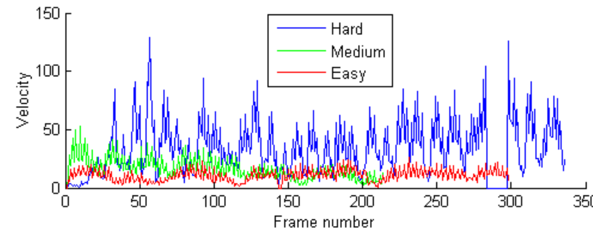

Fig.12 Comparison of velocity of the blob in particular tests

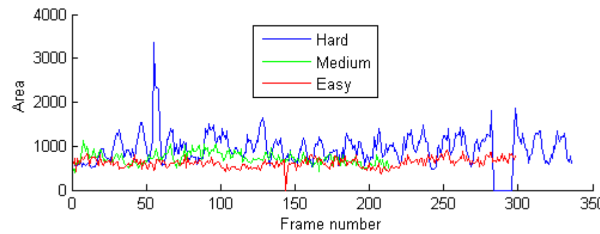

Fig.13 Comparison of the area of the blob in particular test

Fig.14 Comparison of the static blob (left image) and its thresholded bitmask (right image)

Fig.15 Comparison of the blurred blob (left image) and its threshold bitmask (right image)

We have tested proposed Laser Point Tracker (LPT) on three test records described earlier. We have compared results with three other trackers: LOT, FragTrack and VTD. Tests were run on default parameters on implementations published by their authors.

Quality factor q was calculated as follows:

$$q = \begin{cases} 2\,\frac{(A \cap B)}{(A+B)}; A > 0, B > 0 \\ 0; A = 0, B > 0 \\ 1; A = 0, B = 0 \end{cases} \qquad (7)$$

where A is blob area in reference data, B is blob area returned by tracker. It represents how identical are these areas. Values vary from 0 to 1. Area value is equal to 0, when no blob was found on frame.

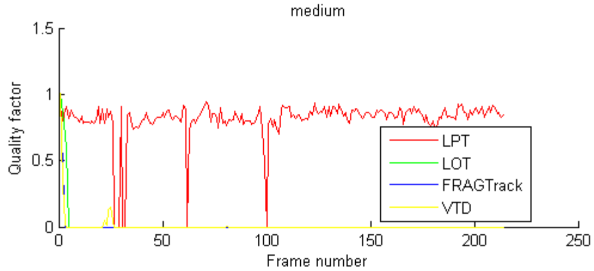

Fig.16 Quality factor for different trackers over time for Medium sequence

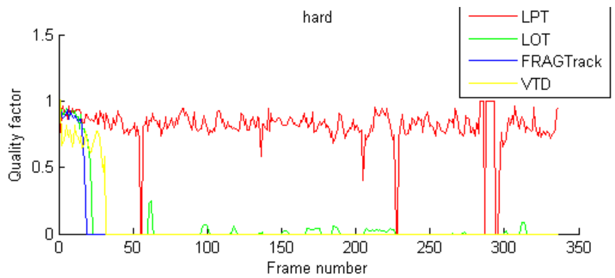

Fig.17 Quality factor for different trackers over time for Hard sequence

Proposed algorithm LPT is able to track laser's point almost constantly regardless the sequence (fig. 16, fig. 17). Even if it loses laser for few frames it is able to find it again. This is the biggest advantage that it has over other trackers. High speed and strong blur in Hard test were successfully LOT and VTD were able to follow laser in Easy test. However, once the blob stated to blur in Medium test both of them have got stuck. Unfortunately static laser's blob wasn't complicated enough to get properly recognized by FragTrack.

D. Ballistic Engine

For testing purposes we ran simulation for three different bullets:

1. Parabellum 9x19mm,
2. Winchester .308,
3. BMG .50.

Simulation results were compared to ballistic chart data provided by ammunition producers. Simulation initial conditions were set to match sight calibration from ballistic charts. Sight calibration is act of adjusting firearm sight to hit center of the target at fixed distance.

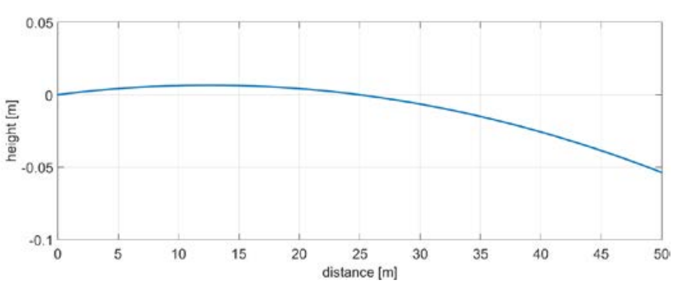

Fig.18 Results of simulation for Parabellum 9x19mm at a distance of 50 meters. Sight was calibrated for 25m

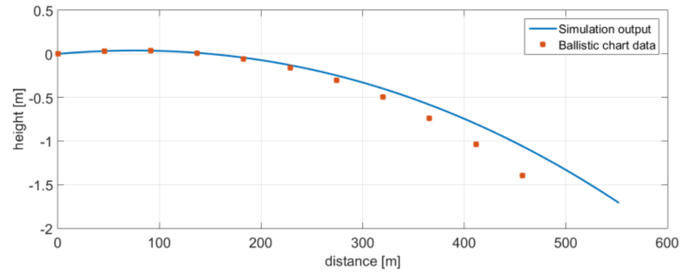

Fig.19 Results of simulation for Winchester .308 bullet compared to ballistic chart data

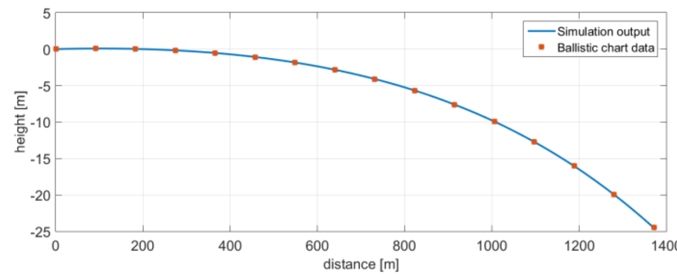

Fig.20 Results of simulation for BMG .50 bullet compared to ballistic chart data

Results of simulations are shown on figures 18, 19, 20. The results shows that simulation outcome is very close to ballistic charts data. This leads to conclusion that used mathematic model of projectile movement describes well real bullet trajectory.

Fig. 21 The real life application of the described concept of multimedia shooting detection system for shooting training system

V. SUMMARY AND CONCLUSIONS

The article results confirm the possibility of practical application of these algorithms to solve current problems occurring in the industry. Implemented algorithms of geometric and photometric recalibration allow a significant reduction of negative impacts of exploitation of projectors. The complexity of the presented solution is a new quality among existing training shooting systems, which in most cases have been developed over a decade ago and continues to benefit from technology developed back then. Presented algorithm of a gun's bullet hit detection using thermal imaging was able to successfully detect shots and allowed detection of both single shots and in a series of up to 600 rounds per minute. The acquired results meets the expectations for the shooting training requirements of majority of the uniformed services. The results of the implementation of ballistics equations in the engine were compared with actual shooting tests and ballistic tables. The level of compliance at distances exceeding 400m allows the use of developed computational engine to simulate the marksman training. In summary, the concept, development and results of the multimedia shooting detection system are promising and allow for practical application in the real training systems, e.g. for uniformed services shooting training. It is worth noting that the use of virtual training systems positively affects the motivation to exercise and the acquired in the simulator skills are possible to use in real life [17], [18], [21] (fig. 21).

REFERENCES

[1] Majumder, Aditi, Duy-Quoc Lai, and Mahdi Abbaspour Tehrani. "A multi-projector display system of arbitrary shape, size and resolution." ACM SIGGRAPH 2015 Emerging Technologies. ACM, 2015.

[2] Sajadi, Behzad, and Aditi Majumder. "Markerless view-independent registration of multiple distorted projectors on extruded surfaces using an uncalibrated camera." Visualization and Computer Graphics, IEEE Transactions on 15.6 (2009): 1307-1316.

[3] Bhasker, Ezekiel, Ray Juang, and Aditi Majumder. "Registration techniques for using imperfect and par tially calibrated devices in planar multi-projector displays." Visualization and Computer Graphics, IEEE Transactions on 13.6 (2007): 1368-1375.

[4] Sajadi, Behzad, et al. "Color seamlessness in multi-projector displays using constrained gamut morphing." Visualization and Computer Graphics, IEEE Transactions on 15.6 (2009): 1317-1326.

[5] J. Gacek: Balistyka zewnętrzna Cz. 1, Modelowanie zjawisk balistyki zewnętrznej i dynamiki lotu, Warszawa, 1997

[6] B. Litz: Applied Ballistics for Long Range Shooting : Understanding the elements and application of external ballistics for successful long range target shooting and Hunting,

[7] Yilmaz, Alper, Omar Javed, and Mubarak Shah. "Object tracking: A survey."Acm computing surveys (CSUR) 38.4 (2006): 13.

[8] Wu, Yi, Jongwoo Lim, and Ming-Hsuan Yang. "Online object tracking: A benchmark." Proceedings of the IEEE conference on computer vision and pattern recognition. 2013.

[9] Yang, Fan, Huchuan Lu, and Yen-Wei Chen. "Bag of features tracking." Pattern Recognition (ICPR), 2010 20th International Conference on. IEEE, 2010.

[10] Kwon, Junseok, and Kyoung Mu Lee. "Visual tracking decomposition." Computer Vision and Pattern Recognition (CVPR), 2010 IEEE Conference on. IEEE, 2010.

[11] Oron, Shaul, et al. "Locally orderless tracking." International Journal of Computer Vision 111.2 (2015): 213-228.

[12] Ryt, Artur, et al. "Real-time laser point tracking." Computer Vision and Graphics. Springer International Publishing, 2014. 542-551.

[13] Color Seamlessness in Multi-Projector Displays Using Constrained Gamut Morphing, Behzad Sajadi, Student Member, IEEE, Maxim Lazarov, Aditi Majumder, Member, IEEE, and M. Gopi

[14] Perceptual photometric seamlessness in tiled projection-based displays, A. Majumder and R. Stevens.

[15] Bhagat, Kaushal Kumar, Wei-Kai Liou, and Chun-Yen Chang. "A cost-effective interactive 3D virtual reality system applied to military live firing training." Virtual Reality 20.2 (2016): 127-140.

[16] Sobel D., Kwiatkowski J., Ryt A., Domzal M., Jedrasiak K., Janik L., Nawrat A., The System for Augmented Reality Motion Measurements Visualization, vol. 33, Studies in Systems, Decision and Control, pp. 189-200, Springer International Publishing, ISBN: 978-3-319-21117-6, 2015.

[17] Wilk P., Targiel T., Sobel D., Kwiatkowski J., Jedrasiak K., Nawrat A., The Concept of an Active Thermal Camouflage for Friend-Foe Identification System, Innovative Simulation Systems, vol. 33, Studies in Systems, Decision and Control, pp. 67-76, Springer International Publishing, ISBN: 978-3-319-21117-6, 2015.

[18] Sobel D., Jedrasiak K., Daniec K., Wrona J., Jurgaś P, Nawrat AM, Camera Calibration for Tracked Vehicles Augmented Reality Applications, Innovative Control Systems for Tracked Vehicle Platforms, vol. 2, pp. 147-162, ISBN (Print) 978-3-319-04623-5, ISBN (Online) 978-3-319-04624-2, 2014.

[19] Demski, P., Grzejszczak, T., Jedrasiak, K., Mikulski, M., Automatic Targeting Sentry Turret for Distributed Systems, Vision Based Systems for UAV Applications, ISBN: 978-3-319-00368-9, pp. 47-55, Springer-Verlag, 2013.

[20] Jędrasiak K., Nawrat A., The Comparison of Capabilities of Low Light Camera, Thermal Imaging Camera and Depth Map Camera for Night Time Surveillance Applications, Advanced Technologies for Intelligent Systems of National Border Security, Ed. by A. Nawrat, K. Simek, A. Świerniak. Berlin : Springer, Studies in Computational Intelligence ; vol. 440 1860-949X, ISBN 978-364-231-664-7, pp. 117-128, 2012.

[21] Bhasker, Ezekiel, Ray Juang, and Aditi Majumder. "Registration techniques for using imperfect and par tially calibrated devices in planar multi-projector displays." Visualization and Computer Graphics, IEEE Transactions on 13.6 (2007): 1368-1375.

[22] P.Senthil,Enhanced of Image Mining Techniques the Classification Brain Tumor Accuracy.International Journal of Computer Science and Mobile Computing, © 2016, IJCSMC All Rights Reserved,DOI:5.5/TMI.2016.V5I5201632, ISSN 2320–088X,Volume.5 Issue.5, May- 2016,page.110-116.

[23] Prof P.Senthil,Medicine Neural Networks Control Mind of Memory in Image Processing (Men-Net-Mind),International Journal of Modern Computer Science (IJMCS) ISSN: 2320-7868 (Online),Volume 4, Issue 2, April, 2016

[24] Prof P.Senthil,Discovery of Image Mining used Brain Tumor using Improve Accuracy and Time (ANGIOGRAPHY),International Journal of Modern Computer Science and Applications (IJMCSA) ISSN: 2321-2632 (Online),Volume No.-4, Issue No.-3, May, 2016.

[25] Prof P.Senthil,Brain Tumors Frequency Image Mining Used Detection Time Technique in Medical Images,International Journal of Modern Electronics and Communication Engineering (IJMECE) ISSN: 2321-2152,Volume No.-4, Issue No.-3, May, 2016.

[26] Prof P.Senthil, Image Mining Using Attribute Supported Brain Tumor Synthesis by DWT (MRI Relevance), International Journal of Modern Computer Science and Applications (IJMCSA) ISSN: 2321-2632 (Online) Volume No. 4, Issue No. 3, June, 2016.

[27] P.Senthil Image Mining Automata Based Seeded Tumor C-Taxonomy Algorithm for Segmentation of Brain Tumors on MR Images (BITA), Asian Journal of Computer Science and Technology ,ISSN: 2249-0701 Vol. 5 No. 1, 2016, pp.10-16,© The Research.Publication, www.trp.org.in.