Technological development: Thermal vision as a phenomenon

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Abstract: *The article deals with technological development, especially with thermal imaging. The authors are convinced, that this technology can progressively and qualitative influence operations of security forces and crisis response teams. The article is divided into 3 main parts, where first chapter generally describes thermal imaging, second chapter deals with current applications and last chapter sets the perspectives for future.*

***Keywords**: CAPABILITIES, EFECTIVENESS, SECURITY, TECHNOLOGICAL DEVELOPMENT, THERMOVISION.*

1. Introduction

Technological trends [1] disruptively influence not only security environment, but also all PMESII [2] areas. New technologies, instruments and procedures have impact on capabilities development and creating of strategies [3]. These strategies are constructed by instruments with their specific characteristics, units and various procedures, influenced by leaders.

One of the phenomenon of nowadays is thermal vision. This kind of technology is not so new and disruptive as itself, but trend of miniaturization push this technology as overall useful and comfortable for single operator. Wide scale of thermal vision applications from low quality devices to very advanced and miniaturized devices offers opportunity to apply this technology.

Thermal vision is based on visualization of difference between temperature of object and surroundings [4]. Generally, it is possible to divide thermal vision into following categories:

- Personal cameras and mobile cameras;
- cameras for recognition and thermal scopes;
- Single thermal cameras and integrated cameras in fused system.

The topic of effectivity from user perspective was several times explored. Simple comparisons, for example [5], favors thermal visions, rather than pure daily optics, daily camera or night vision in worsened conditions. Darkness, fog, snow etc. sets a barrier between target and observer, leveraging using thermal vision. Therefore, based not only on scientific, but firstly on empiric basis is strongly recommended combination of devices, what allows orientation in area.

2. Application in field of security

Security and rescue forces use thermal vision as a fitting asset of response teams.

Police teams by searching areas and objects are identifying lost and hidden individuals and groups. There is visible also fresh body liquids (esp. blood) on the ground and is possible to track escaping individuals.

Fire fighters identify not-visible centers of fire, identify location of victims of fires and also hidden people. Planning and conducting of firefighter’s intervention is more precise and safe.

Medical urgent teams, working in worsened (war) conditions are having the possibility to improvingly identify changes of temperatures and abnormalities in tissues.

The army application is the core topic of this article. Thermal vision systems are installed as sensor part of fixed wings, rotary wings and vehicles. Especially in aircraft are combined with other technologies and the introduced output for operator is integrated picture, which is not visible by separate technologies. ISR units and Special Forces are equipped by reconnaissance and target acquisition devices, using also thermal vision. Not so often are equipped by personal scopes and googles. The combination with other systems allows not integrated picture of surroundings, but by operator distinguished outputs, what can stand for specifics, object or enemies. This advantage sets for protective measures, as anti-thermal vision camouflage [6, 7], what is new trend in field of warfighting function protection. Basically every type of sensor can be thermal and the picture can be transferred into monitoring system as example can be mentioned engineer robots or unmanned aerial vehicles.

Current Ukrainian conflict turned up the impact of thermal vision as a component of maneuvering units. Despite the fact, that these applications were commercial and sometimes low-cost, the tactical advantage was on side of forces using thermal vision. Small local battles of infantry units during night time favorited Ukrainian units, operating with personal thermal vision, night vision and drones with thermal vision. Especially in forests and urban areas was because of technological advantage recognized and impacted an enemy. Clashes between sniping units are also influenced by thermal vision. In fact, who shows body part - does not matter on size, is identified, can be hidden. Impact of using of technology, based on conflict lessons learned, is not only quantitative, but also has strong impact on morale, what is also part of combat potential influencing ratio of strength.

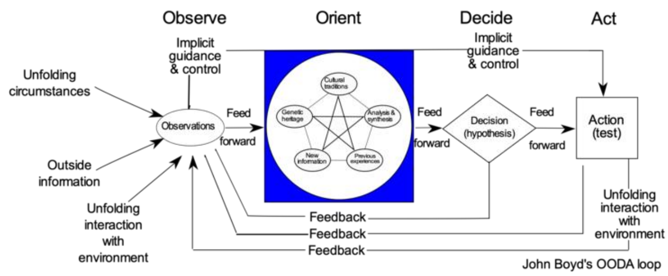
Thermal vision supports military capabilities development and mostly at these of main capabilities areas [8]: Project, Engage, Protect, and Inform.

3. Perspective from operational viewpoint

The miniaturization continues and it is only problem technical development and of time, when will be fusion of technologies integrated onto level of individual soldier. The usage will be wider and more common. Integrated sensors will be part of unmanned systems, sensors and individual soldiers, depending on their needs, for example googles and scopes.

In relation to autonomy, there exists future capacity to link fusion of sensory technologies and algorithms, what enable construction of very precise view of situation and effective support of common operational picture. Adding relation to signal and connection, the picture can be distributed to necessary entities, esp. commanders. This leverage Boyd´s OODA loop at all levels of command and control [9, 10].

Picture1: *Boyd´s OODA loop*



Source: The OODA Loop and the Half-Beat

4. Way outs for applied research

In Czech army, there is not breaded thermal imaging in structure of manoeuvre units (meaning combat units of army, not reconnaissance or SF/SOF). The authors are convinced, that this kind of technology can, in case of correct amount and training, influence combat effectiveness of manoeuvre units. For this reasons they prepared set of experiments, answering following questions, correlating on low-tactical level:

- How can thermal vision influence deployment of combat units?
- Which tactical activities are proper to support with thermal imaging and why?
- How will increase combat potential and capability to engage?
- How are the principles of using thermal vision and how to protect against enemy using this technology?

Firstly data we measured and evaluated, using imager InfiRay Eye II E6Pro V3 for short distances. During the data measuring were focused results and also approach of trainees. Firstly dataset of results is following:

- Up to 200 m is possibility to detect, recognise and identify all details of person. Is possible to recognise basic sign of friend or foe.
- For detection, it is possible to use it for opened area observation up to 1000 m.
- Commercial application are also for applying for infantry units.
- In tree lines and bushes, there is not capacity to recognise man (soldier) and animal. So the imager only “warns”, that in area finds something.
- The eyes of observer can be defocused, in combat environment it can cause inability to shoot, for decades of seconds.
- From individual perspective, creates overview esp., during night, conducting reconnaissance and defence activities (mostly static). Knowledge of surrounding, makes soldier more informed and oriented, capable to decide for appropriate action.
- The light from rear lens is visible in night vision. It is important to equip imager for military use by automatic switch off when drawing from eye.

Next measurement will be focused on dynamic tactical activities and also using ARCHER TBX 8 on middle and longer distances. Using live simulators (SAAB) will be measured difference of effectiveness of units equipped and not-equipped by thermal vision.

All the hard data will be transformed to constructive simulator Masa Sword and compared from perspective of capabilities on battalion level, what can generate change of combat potential.

5. Conclusion

Thermal vision can influence results of battle in all phases of OODA, based on empirical knowledge, current subjective experience from operations and also primarily results from measurements. Manoeuvre units worldwide, are underestimated by equipping with this kind of materiel, which can be crucial for fulfilling the task and surviving on the battlefield.

References

1. STO. Science & Technology Trends 2020-2040: Exploring the S&T Edge. In: Www.nato.int [online]. Brussels, 2020 [cit. 2022-09-10]. Dostupné z: https://www.nato.int/nato_static_fl2014/assets/pdf/2020/4/pdf/190422-ST_Tech_Trends_Report_2020-2040.pdfA. Mecke, I. Lee, J.R. Baker jr., M.M. Banaszak Holl, B.G. Orr, Eur. Phys. J. E 14, 7 (2004)
2. STOJAR, Richard. Bezpečnostní prostředí: sektorová analýza a implikace pro ozbrojené síly ČR 2021. Brno: Univerzita obrany, 2022. ISBN 978-80-7582-459-2.
3. PROCHÁZKA, Josef a Pavel NEČAS. Přístupy k tvorbě bezpečnostních a obranných stratégií. Banská Bystrica: Univerzita Mateja Bela v Banskej Bystrici, Fakulta politických vied a medzinárodných vzťahov, 2020. Fakulta politických vied a medzinárodných vzťahov. ISBN 978-80-557-1656-5.
4. BALÁŽ, Teodor, VU, Duc Hieu. INFRARED SIMULATION OF STATIC PERFORMANCE OF THERMAL CAMERA SYSTEM. In: 22nd International Scientific Conference ARMAMENT AND TECHNICS OF LAND FORCES 2016. Liptovský Mikuláš, SR: Academy of the Armed forces of Gen. M. R. Štefánik, Liptovský Mikuláš, 2016, s. 193-201. ISBN 978-80-8040-537-3.
5. MORAVEC, Tomáš. Historie a současnost prostředků pro pozorování za ztížených podmínek a jejich využití u bezpečnostních složek. Praha, 2022. Bakalářská práce. AMBIS.
6. NATO STO. About the NATO Science and Technology Organization (STO). Sto.nato.int [online]. 2022, 2022 [cit. 2022-09-10]. Dostupné z: https://www.sto.nato.int/Pages/default.aspx
7. RACEK, František, BALÁŽ, Teodor, KREJČÍ, Jaroslav, JOBÁNEK, Adam. Evaluation of validity of observer test for testing of camouflage patterns. In: Target and Background Signatures IV. Bellingham, Washington, USA: Society of Photo-Optical Instrumentation Engineers (SPIE), 2018. ISSN 0277-786X. ISBN 978-1-5106-2172-5. doi:10.1117/12.2325101
8. THE LONG TERM PERSPECTIVE FOR DEFENCE 2035. In: Army.cz [online]. Prague, 2019 [cit. 2022-10-25]. Dostupné z: https://www.army.cz/assets/en/ministry-of-defence/basic-documents/dv-2035-aj.pdf
9. BOYD, Cameron, Robert COLLIER, Daniel SKINNER, et al. Characterisation of Combat Identification Technologies. https://shoalgroup.com/wp-content/uploads/2017/06/Boyd-et-al-2005-Characterisation-of-Combat-Identification-Technologies-IEEE-2005.pdf, 2005.
10. The OODA Loop and the Half-Beat. In: Thestrategybridge.org [online]. 2020 [cit. 2022-10-26]. Dostupné z: https://thestrategybridge.org/the-bridge/2020/3/17/the-ooda-loop-and-the-half-beat