Infantry tactical level combat training monitor system using ICT technology

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ABSTRACT
Traditionally, the monitoring, adjusting, and evaluating of combat training in the Vietnamese army are conducted without any support equipment. The commander can only observe directly, memorize and shorthand to evaluate the training process, so learning from experience encounters certain difficulties. From that practical need, we develop an infantry division combat training monitor system based on information and communication technology (ICT). In the proposed system, various types of sensors were connected to collect several information from the battlefield. The data is analyzed to provide multiple points of view about combat training in real-time as well as after the practice. Thereby, the system not only helps commanders to build training plans based on 2D digital maps, monitor the training progress of infantry detachments through sensors, but also view the review, evaluate, review, draw experience after each exercise, help officers and soldiers recognize advantages and disadvantages, easily overcome, improve the quality of training and learning.

Keywords: *ICT, video surveillance, combat training*

1. INTRODUCTION

The blooming of advanced technologies, such as Artificial Intelligence (AI), Internet of Things (IoT), is affecting almost every area. Scientific advances bring remarkable efficiency in fields such as agriculture, industry, and commerce. Not outside that trend, military training problems are also interested. In the field of national security and defense, the militaries of developed countries have long paid great attention to the application of the achievements of modern science to modernize and improve the strength of their armies. In training, too, militaries of developed countries have researched, manufactured, and put into use many types of combat training equipment systems, especially tactical training. There are roughly divided into two groups: Tactical training in a virtual environment; Tactical training in the field (using real soldiers) [1-3].

The systems that support tactical training in the virtual environment are conducted entirely on computer systems. The participating forces are all virtual objects. In the military of developed countries, in-field systems to support tactical training are implemented through the application of modern equipment such as navigation equipment, communication to improve efficiency combat results, minimizing casualties [4, 5]. Today, to enhance the effectiveness and quality of tactical training, these support systems also pay great attention to research and integration of electronic sensors, communication, and information technology equipment for the training to be as close as possible to actual combat, tactical training. This will bring the highest efficiency on tactical thinking for soldiers.

Virtual reality systems in military training can be classified into three levels of virtualization:

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Vision level, mixed-reality level, on-field level. At vision level, soldiers can take the training on a fully computerized system with or without VR equipment like VR glass. Those systems are usually used for map reading and land navigation, or combat theory study. In this system, trainees work with computer screens, interact mostly via standard input devices. Due to the limited interaction between humans and computers, the trainees can not develop motor combat skills. At the mixed-reality level, there is a combination of computer systems, emulated military equipment, emulated weapons in an indoor environment. The addition of devices such as motion base, laser firearms, or emulated vehicles will help soldiers become familiar with real armament. At the on-field level, soldiers will practice on open battle with simulation armament. Trainer or commander can monitor the activities of trainees via navigation equipment in real-time. This system provides the most realistic experience for trainees as well as a comprehensive view for the battle commander. In advance, a control system can be added for the reconfiguration of participant teams. The monitoring and controlling in a large area of the battlefield is a challenge for communication [6-9].

To meet the requirements of combat training, we propose a combat training monitor system that is include emulated weapons, navigation, sensors, video surveillance, digital map. An IoT-based communication is in charge of gathering battle's status as well as transferring control signals to all objects on the field. Via our training system, the trainees can practice on the closest condition of a real battlefield. And the trainer or commander can precisely manage and evaluate the quality of the tactic practice as well as the ability of subordinate officers.

In the following part of the paper, we continue to discuss the combat training monitor system. Section II describes preliminary problems related to monitoring technologies, IoT technology in military applications. We will present the solution for the combat training monitor system in section 3. The integration and testing of the proposed system will be shown in section 4.

2. PRELIMINARY

2.1. Monitoring technology

For monitoring, navigation technology is most popularly used that collect the position of objects on the field. The innovation of satellite navigation systems like GPS, GLONASS, or Galileo increases the accuracy up to within 30 centimeters (GPS receivers that use the L5 band). For intuitiveness, the result of the navigation system is visualized on a digital map (2D or 3D) that provides a vivid view for the user. Furthermore, model monitoring systems do contain not only navigation but also surveillance. This information is obtained by various sensors such as visible or infrared cameras, SAR, and MTI radar. These sensors are placed on a variety of platforms such as planes, helicopters, and drones [10]. When apply on a training battlefield, the sensors can be set up at fixed positions in the field infrastructure or as wearable devices. Unlikely simple information of position, surveillance data allows the trainer to observe movements, actions of trainees on the battle. The big volume of data from a wide variety of devices is a challenge for communication, processing, and UI design.

2.2. IoT technology in military applications

The Internet of Things has strong military applications, connecting ships, planes, tanks, drones, soldiers, and operating bases in a cohesive network that increases situational awareness, risk assessment, and response time [11]. It will also produce a huge amount of data. The various types of equipment on the field require a communication system that supports securely and instantly transmit data over large areas as well as satisfy the requirements of military standards. On the Internet of Military Things (IoMT) or Internet of Battlefield Things (IoBT), the sensing and computing devices worn by soldiers and embedded in their combat suits,

helmets, weapons systems, and other equipment are capable of acquiring a variety of static and dynamic biometrics such as their face, iris, periocular space, fingerprints, heart rate, gait, gestures, and facial expressions. For the training battlefield, an IoMT can be made up of portable devices which carry belong to soldiers or on vehicles, and several types of equipment for training. All of the devices communicate with different requirements about bandwidth, report frequency, protocol, channel. This is also an issue for designing a communication system.

2.3. Requirements of combat training

Currently, common difficulties, which encountered in the practice of combat training, include:

- The complex terrain hinders the observation of the training process of the soldiers. In fact, the observation of trainees is still done manually with the naked eye or binoculars from high positions. The large training area, complex terrain (many obstacles) are factors that greatly affect the tracking.
- Night combat training is also important and a challenge for monitoring and evaluation, especially in military reconnaissance subject.
- The lack of recorded training data also affects the quality of the review process. Practitioners cannot directly see their mistakes during practice.

Based on the above difficulties, we decide that there are three main requirements for the combat training monitor system at the infantry division range:

- Monitor the formations, maneuvers, and synergies of the forces during tactical training.
- Monitor the actions of soldiers on the field at key positions such as the position of the door opening, in front of the bridgehead block-house, the machine gun emplacement...
- Oversaw tactical training from platoon level to battalion level, day and night.

3. INFANTRY DIVISION COMBAT TRAINING MONITOR SYSTEM

3.1. Overview

To overcome the above difficulties, we have researched and built a support system to monitor the combat training at the divisional level. Figure 1 shows the functional block diagram of the proposed system where data from the sensor, navigator, and camera is transferred to the control center via wireless networks. The data is processed, visualized, and stored in a database. Through a software system, commanders or trainers can build or reconfigure training programs.

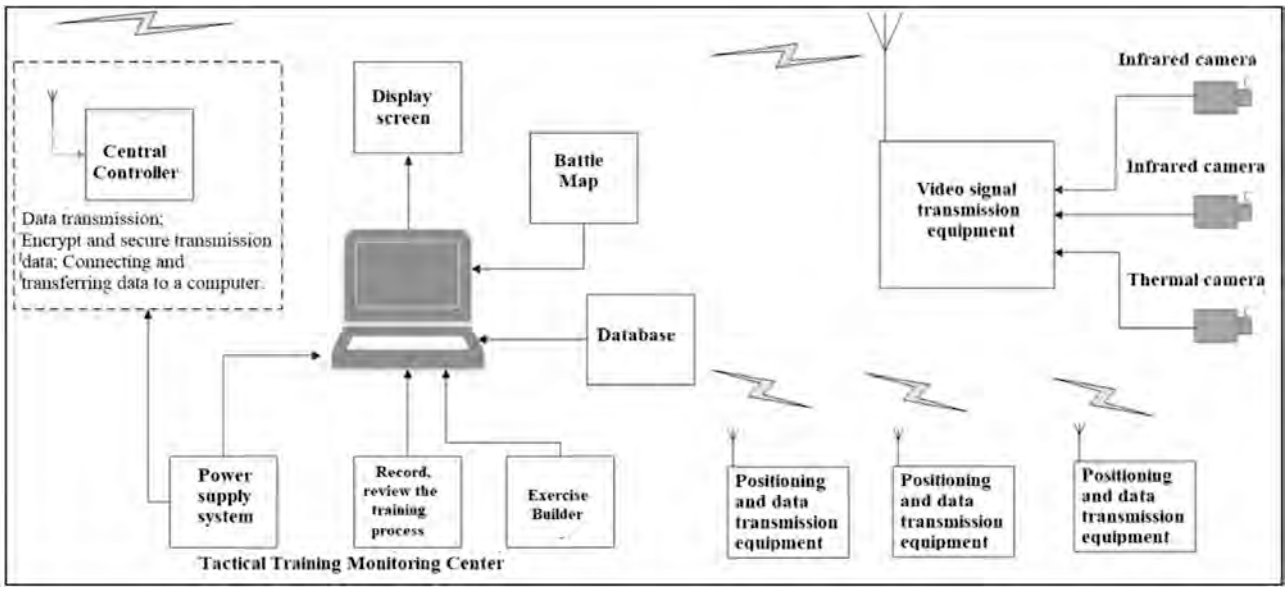

Figure 1. Function block diagram of combat training monitor system

Description of the use plan:

- When using this system to monitor training, it does not change the method, content, and training process at the unit;

- When entering the training, wireless data transmission and navigation devices are equipped for each individual, each group, or each squad (depending on the training size and the number of devices). For example, with 30 navigators, if training at the battalion level, each squad will be equipped with 1 set; if training at the company level, each team will be equipped with 1 set; If training at platoon or squad level, each individual will be equipped with a device;

- Information about the location is transmitted to the center, displayed on a digital map to compare with the battle plan prepared by the commander in advance;

- Cameras are placed in specific positions to transmit images to the center;

- The superior commander or teacher at the training monitoring center can monitor the entire training squad of the unit through the software on the computer, and at the same time can observe the soldiers' actions via the transmitted video.

System components:

- The surveillance system monitors the practitioner's actions through video obtained from active infrared cameras and thermal imaging cameras to ensure training day and night;

- The navigation system with wireless transmission locate and transmit information about the position and movement direction of the training force to the training monitoring center;

- Software system installed on the computer at the training monitoring center.

3.2. Video surveillance network design

To meet the requirements of monitoring the actions of trainees on the training ground, it is necessary to develop a plan to arrange the camera network on the field in sync with the digital map of the training area of the unit.

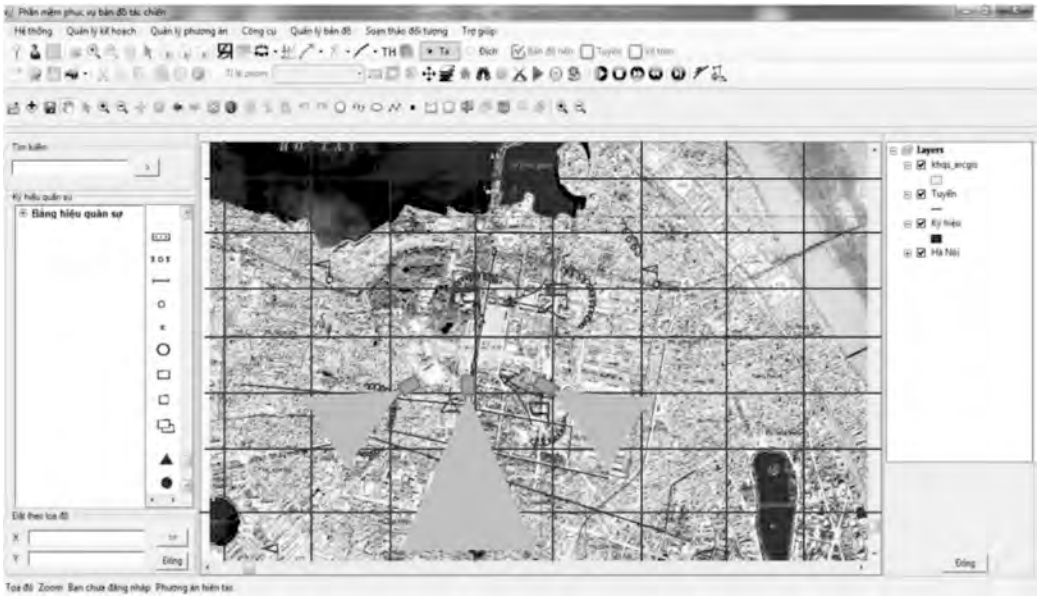

Figure 2. Camera network on 2D map

Example design with IR camera and thermal camera:

IR Camera:
- Detection distance: 80 m;
- Horizontal view: 270°;
- Vertical view: ± 30°;

Thermal Camera:
- Detection distance: 400 m;
- Horizontal view: 270°;
- Vertical view: ± 30°;

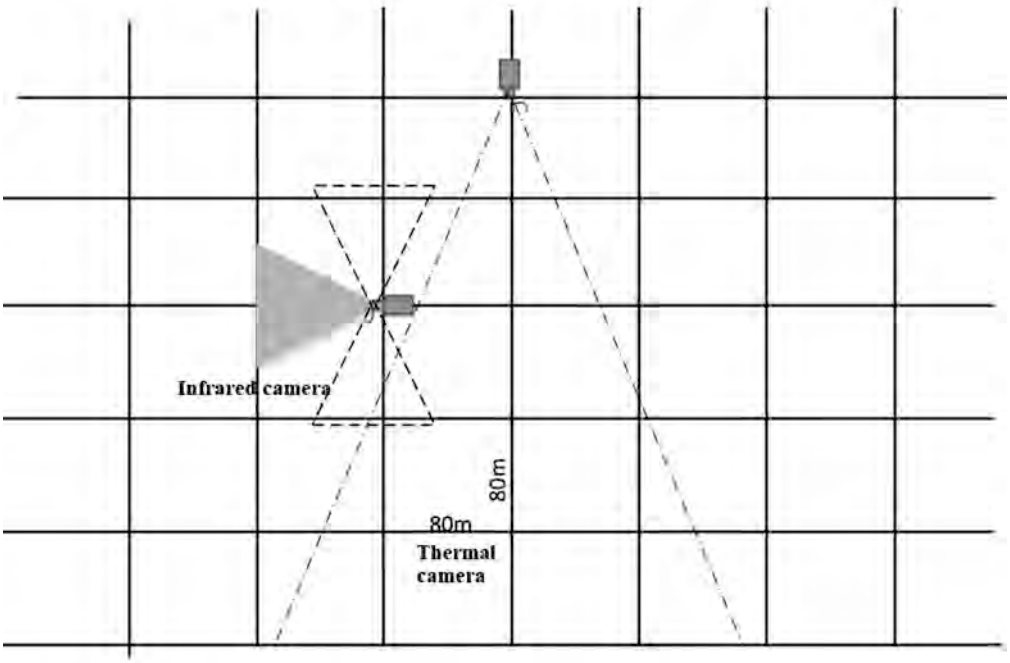

Figure 3. Estimation for spacing of camera network

Figure 3 present the estimation of the spacing for the camera network. Here, each infrared camera with a viewing distance of 80 m and control of 270° scanning will monitor an area of about 80 x 160 m in size. Similarly, each thermal imaging camera with a viewing distance of 400 m and control of 270° scanning will monitor an area about 400 x 800 m in size.

Video data requires high bandwidth around 2 Mbps. Additionally, the battlefield normally does not allow to set up of wired transmission lines due to the combat process and vast mountainous terrain. Wireless broadcast with an Omni-directional antenna is also not suitable because of the limitation of the coverage range. The proposed solution is using a wireless bridge with a directional antenna. A pair antenna can transfer data with a bandwidth up to 120 Mbps around a 1 km distance. To reduce the number of wireless bridges, a cluster of cameras can connect wired to an antenna as in Figure 4.

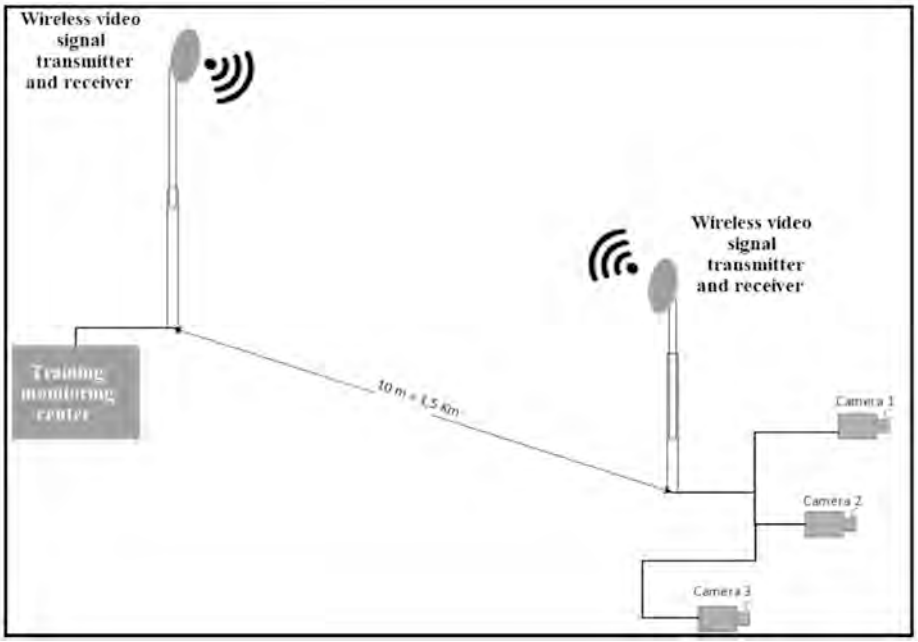

Figure 4. Video data transfer model

3.3. Navigation vest

This wearable device that is worn by soldiers during the training, is named Navigation vest. The report information from the vest consists location of the soldier or his unit. The device also contains a display for represent the state of a lesson or some simple command from the control center. Two main parts make up the device, are navigator module and the LoRa module. Figure 5 sketches a block diagram of the navigation vest. The navigation module support up to versatile Global navigation satellite system (GNSS), including GPS, Galileo, GLONASS, and BeiDou, with horizontal position accuracy up to 2 m. The precision is enough for the combat training program. The information transfer between the vests and control center is encrypted by an RSA 128-bit cryptosystem.

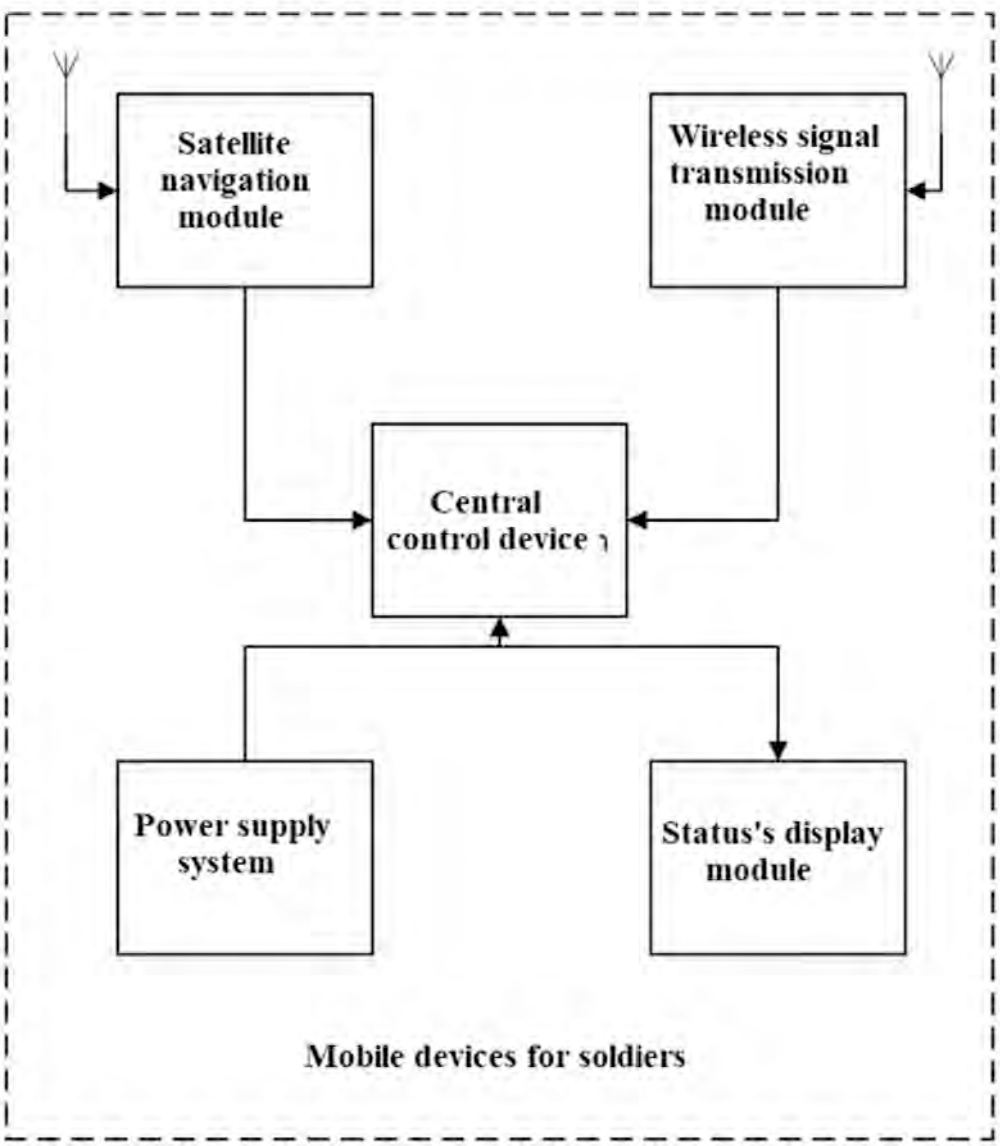

Figure 5. Navigation vest block diagram

3.4. Control center

The Control center can be deployed in two configurations depending on the condition of the battlefield. In the portable configuration, an integrated military-grade computer that contains display, communication modules, is used by the commander for monitoring. This configuration is recommended for small-scale battle or on-side practice at platoon level. The second configuration is deployed at the training center, usually in a fixed arena. The control center room can have a large video wall display.

A large number of devices can be connected to our center through multiple communication modules. This system support battles up to regiment level training.

- Devices:

Figure 6. IR camera

Figure 7. Navigation vest

Figure 8. Portable control center

- Combat training planer on digital map: force arrangement; draw expected maneuvering routes

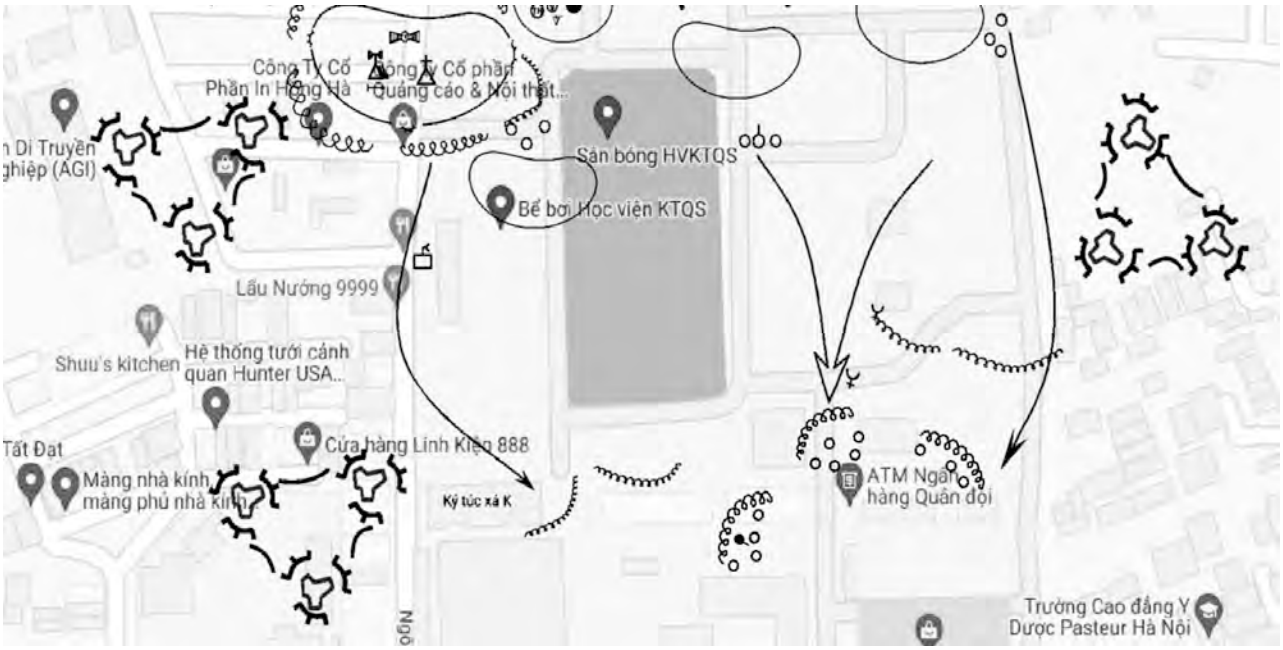

Figure 9. Combat training planer

5. CONCLUSION

With high applicability, closely following the practical needs of infantry units, the Infantry division combat training monitor system can be applied to units to improve efficiency and quality training, which contributes to the modernization of the Vietnamese Army.

With limitations in infrastructure and high requirements for security due to its specificity in the Army, the product still has many problems that need to be further improved, such as optimization algorithms, information security, building equipment that integrates new functions on shirts and hats to expand the application domain, serving more closely the training and rehearsal plans for officers and soldiers.

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Hệ thống giám sát quá trình huấn luyện tác chiến bộ binh cấp phân đội sử dụng công nghệ ICT

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TÓM TẮT

Theo truyền thống, việc theo dõi, điều chỉnh và đánh giá quá trình huấn luyện chiến đấu trong quân đội Việt Nam được thực hiện mà không có bất kỳ thiết bị hỗ trợ nào. Người chỉ huy chỉ được quan sát trực tiếp, ghi nhớ, tốc ký để đánh giá quá trình huấn luyện nên việc rút kinh nghiệm gặp một số khó khăn nhất định. Xuất phát từ nhu cầu thực tế đó, chúng tôi phát triển hệ thống giám sát diễn tập chiến đấu của sư đoàn bộ binh dựa trên công nghệ thông tin và truyền thông (ICT). Trong hệ thống được đề xuất, nhiều loại cảm biến khác nhau đã được kết nối để thu thập một số thông tin từ chiến trường. Dữ liệu được phân tích để cung cấp nhiều quan điểm về huấn luyện chiến đấu trong thời gian thực cũng như sau khi thực hành. Qua đó, hệ thống không chỉ giúp chỉ huy xây dựng kế hoạch huấn luyện trên nền bản đồ số 2D, theo dõi tiến độ huấn luyện của các phân đội bộ binh thông qua cảm biến, mà còn xem xét, đánh giá, tổng kết, rút kinh nghiệm sau mỗi lần diễn tập, giúp cán bộ, chiến sĩ nhận biết ưu điểm và những nhược điểm, khắc phục dễ dàng, nâng cao chất lượng đào tạo và học tập.

Từ khóa: *ICT, theo dõi qua video, huấn luyện chiến đấu*

Received: 07/08/2021
Revised: 14/09/2021
Accepted for publication: 20/10/2021