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**Mykola Bogunenکو<sup>1</sup>**  
**Luppo Oleksandr<sup>2</sup>**  
**Gennadiy Argunov<sup>3</sup>**  
**Serhii Subbotin<sup>4</sup>**  
**Alina German<sup>5</sup>**

## CONCEPT-MODEL OF SEMI-DUPLEX VHF TRAINING STATION

National Aviation University

1, Kosmonavta Komarova ave., Kyiv, 03058, Ukraine

E-mails: <sup>1</sup>L-39@ukr.net; <sup>2</sup>luppo.ae@gmail.com; <sup>3</sup>argunov\_gf@ukr.net; <sup>4</sup>sergejsub@gmail.com;

<sup>5</sup>alina3.gm@gmail.com

### Abstract

*The article is devoted to the elaboration of improvement communication systems of existing aviation simulators. Extra VHF semi-duplex communication units simulate operation like in real condition. Authors developed and produced principal layout of PTT module for improvement aviation personal skills.*

**Keywords:** simulation; communication; training; equipment

### 1. Introduction

Nowadays simulation plays huge role in the process of aviation personnel training. Simulators, in the modern sense, appeared when mass personnel studying necessity arose. They are mostly used in spheres where the real life coaching may fetch serious incidents or accidents with subsequent extra cost applied. Simulator equipment usage allows reducing expenses on tuition, remains safe and efficient due to simulation conformity with real life training. According to ICAO Doc9683 “Human Factors Training Manual” about 80% of aviation incidents accidents are caused by human factor. Flight simulators are to be used by pilots. Airspace control simulators are to be used by the air traffic controllers. Anyway, both of the training processes involve phraseology and procedural practice [1, 3].

VHF radio is commonly used in ordinary pilot – air traffic controller interaction activity. Here comes that any procedural or flight simulator should be equipped with semi-duplex VHF radio simulation module which allows precisely imitate real VHF radio usage condition. For instance beginner users don't feel themselves comfortable using PTT(Push To Talk) button which may lead to shortened or cut phrases during radio contact.

### 2. Analysis of current radio simulators market

From all above mentioned, it is understood that there is a necessity in such VHF training modules for aviation studying market. These modules are used by the universities, training centers etc. Sometimes such modules are integrated into complex or procedural simulators e.g. Full flight simulator. Otherwise these modules can be independent from simulator itself and be installed for any simulator needed e.g. maritime, subway, aeronautical, submarine simulator etc. Although they could be used as standalone radio training solution for police, fire fighters, medical brigade, search and rescue troops etc. But, such standalone or independent systems are always computer-based. It means that you can't use same machine for radio and e.g. for air traffic control simulator simultaneously [4].

Here comes true that such systems are only presented on a market as a software program to be installed on computer machine furthermore even if they are presented as standalone device-based unit, they are always appear to be a part of a complex simulator.

The highest number of solutions presented is for maritime simulation market and often goes as a part of navigation or SATCOM simulator etc. Computer based (software) and standalone device based

simulators shares market 50 by 50 with an only common disadvantage of their complexity, maritime targeting and high cost [5].

Software based simulator is a great solution in case when there is a necessity to practice only in communication, without control simulation training. Such software can be divided by professional (radio sim) and amateur (TeamSpeak, RaidCall). Unlike professional software, amateur software doesn't support semi-duplex communication. Semi-duplex radio communication means that you have to push PTT button to speak (transmit) and release to hear (receive). If both students will push the PTT button simultaneously neither of them will hear anything. In case of using duplex radio simulator as teamspeak or raidcall, both students will here each other in mentioned above situation which doesn't correspond to real radio usage. That's why radiotelephony training with PTT semi duplex radio simulator is so important.

It is obvious that necessity of a standalone semi-duplex device-based module presents on a market of simulation training.

Although, there is no doubts that a pair or more of regular small radios like "Voyager Air Soft" can compete in these segment but there are some pros and cons of their usage:

- Independence of any other device
- Comparatively low price
- Easy to purchase
- Easy to repair.
- "Perfect Simulator" – real device that works on principles used in aeronautical maritime and other spheres.

Disadvantages:

- Lack of free channels – only about 8 channels are allowed for public usage, as these devices are very popular in nowadays town, where universities are always situated it is hard to find free "clean" channel.
- Impossibility to control noise – noise is a frequent condition in radiotelephony so that it is very necessary to imitate noise for training, that is impossible using real powerful devices in a small area
- Inability to record the training process- sometimes it is very necessary to record training process because during the training it is often hard for instructor to correct mistakes, so it is very suitable for instructor to listen the recording afterword's and make a short debriefing correcting mistakes.

### 3. Research task

To sum up the foresaid articles it is clear that there is a necessity to create a standalone, device-based, semi-duplex VHF radio simulator with essential functions such as noise gate control, noise amplifier,

recording module, PTT button. The key tasks to this research were:

- 1) To analyze current existing training simulators for radio communication coaching.
- 2) To compose requirements to enhanced solution.
- 3) To create a device/software that meets these requirements

### 4. Development of enhanced radio simulation system

#### a) General structure

After analysis of current existing systems, the list of requirements looks like:

- 1) Standalone device without engaging computer machine due to usage of this device simultaneously with ATCO's simulator.
- 2) Low price
- 3) PTT emulation (semi-duplex mode)
- 4) Recording module
- 5) Noise emulation/noise gate
- 6) No restrictions in subscribers quantity
- 7) Sufficient channels quantity
- 8) Easy channels shifting

To meet these requirements, it was decided to create analogue device which consist of two general modules: audio module and commutation module.

Audio module itself consists of two parts: microphone part and telephone part. They both are grounded in same line and the signal passes from microphone module output to general channel line (bus) and then to telephone module and another subscribers. Principal layout of network is shown on Fig 1.

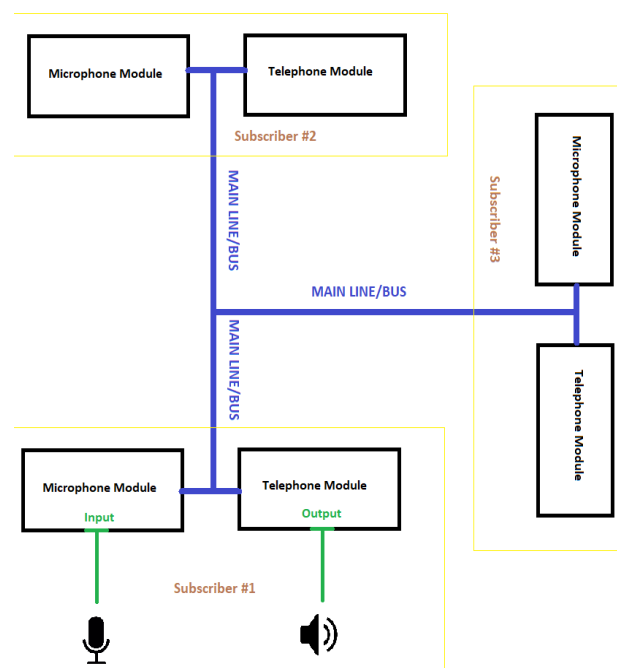


Fig. 1. Principal layout of network

The very important thing in such multi-channel device is channel shifter, other words commutator. Its main purpose is to shift (change) channels. As in aeronautical VHF radio a lot of frequency channels are used with step 8.33 kHz (earlier 25kHz) simulation device should emulate

frequency switching. In a current device 8 channels, in our Analogue case buses, are planned. In our case commutator should shift buses to emulate different frequency channels. The principal scheme with commutator looks like (Fig. 2):

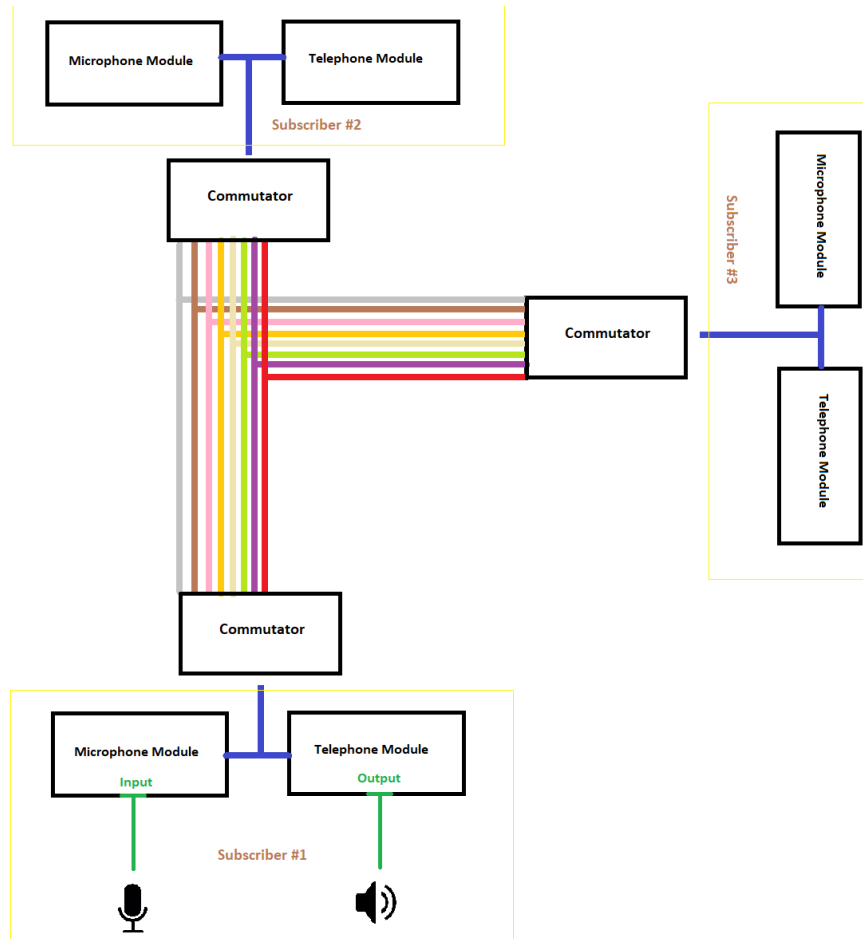


Fig. 2. Principal layout of network with commutator and buses.

Each bus on a figure is marked with different color (tone). A subscriber device is connected with commutator which is connected to all 8 buses. It shifts main bus from subscriber to one of eight network buses. Each bus emulates frequency channel.

### b) Structure of subscriber

As mentioned above, subscriber consists of 4 main parts and 4 axillary parts. Main parts are: Microphone module (Fig. 3), Telephone module (Fig. 4), PTT module (Fig. 5), and commutator (Fig. 6). Axillary parts are: PTT switch, headphones, mike and commutator control panel. Microphone Module has 2 amplifiers which amplifies signal from microphone and send it to main bus. Telephone module receives the signal from main bus then amplifies it with two amplifiers

and sends it to the headphones. PTT button stands between Telephone Module, Microphone module and headphones, microphone. Its relay has two contact groups which are activated by pushing PTT button. On stage 1 (button released/listen mode) Microphone is disconnected from microphone module while headphones are connected to telephone module. On stage 2 (button pressed/transmission mode) microphone is connected to microphone module while headphones are disconnected from telephone module. Commutator uses 8 relay controlled by Microcontroller to connect main bus of subscriber to one of 8 network buses. Microcontroller uses data from commutator panel to enable the relay which corresponds to frequency selected on panel. Otherwise classic commutator switch can be used, in this case the total device cost 1.5 times less.

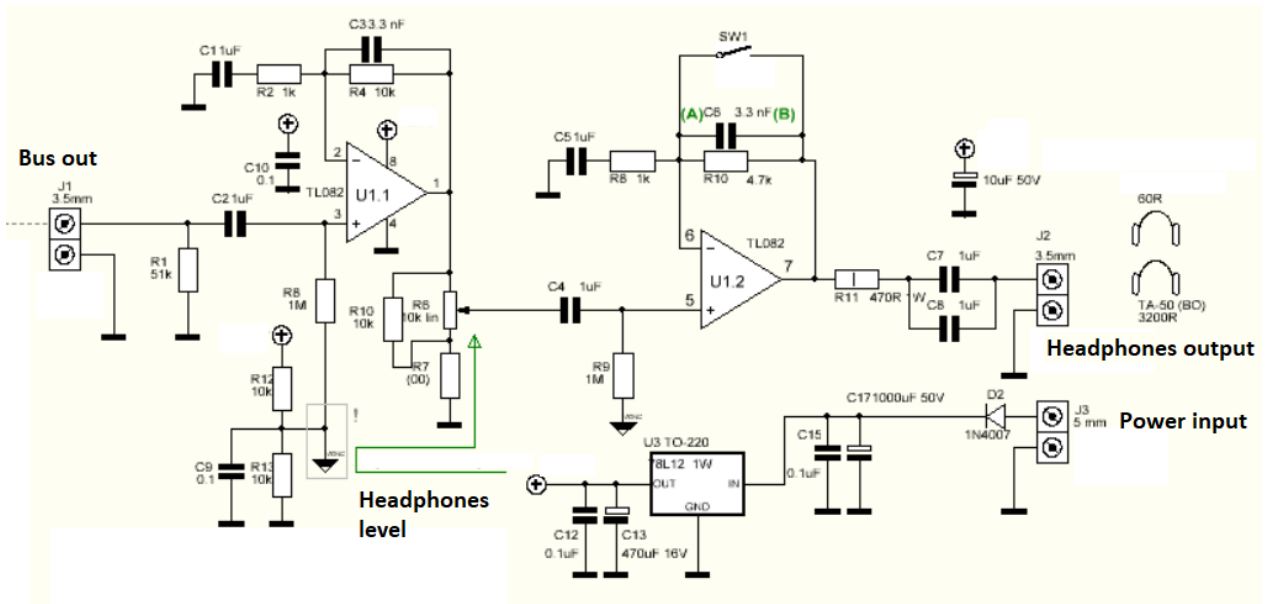


Fig. 3. Principal layout of Telephone module.

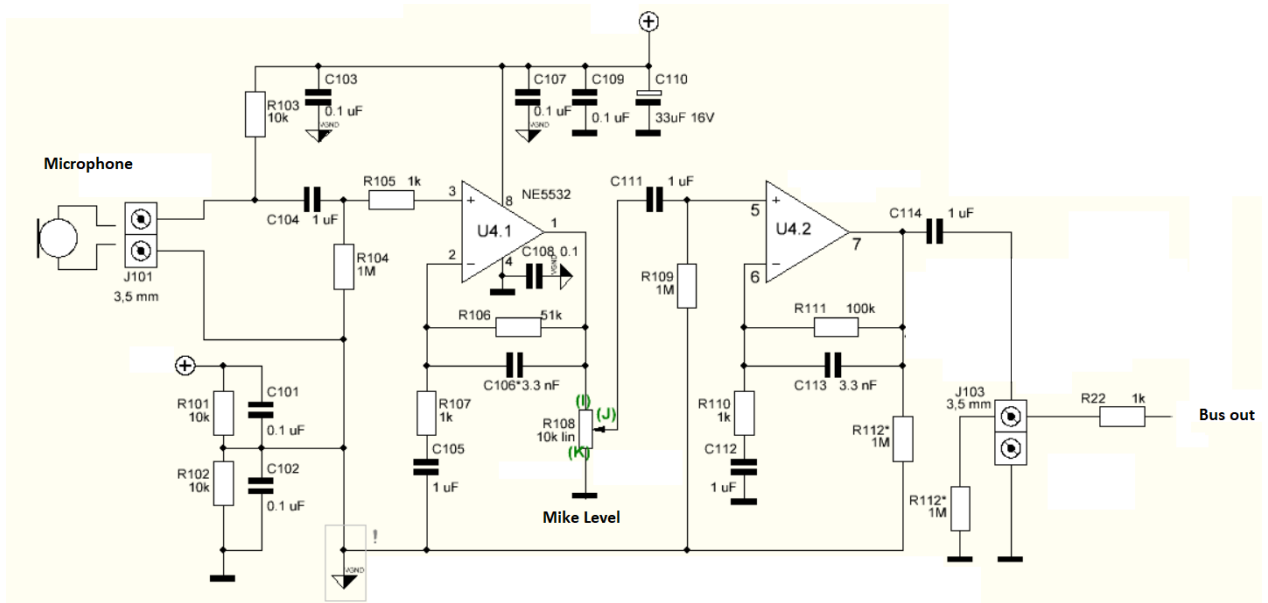


Fig. 4. Principal layout of Microphone module.

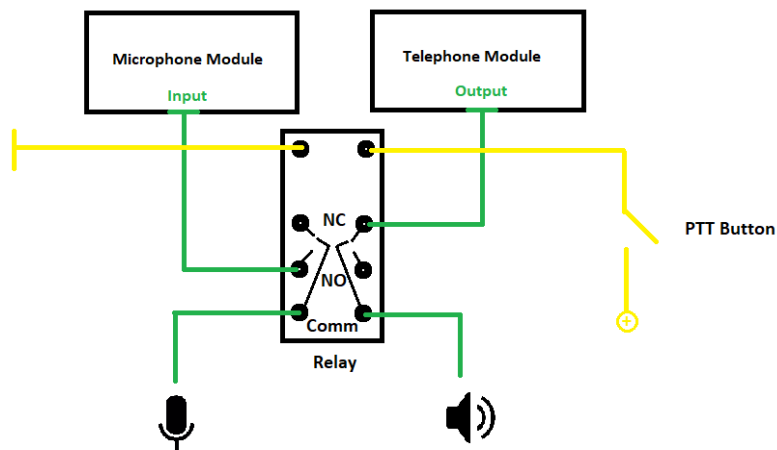


Fig. 5. Principal layout of PTT module.

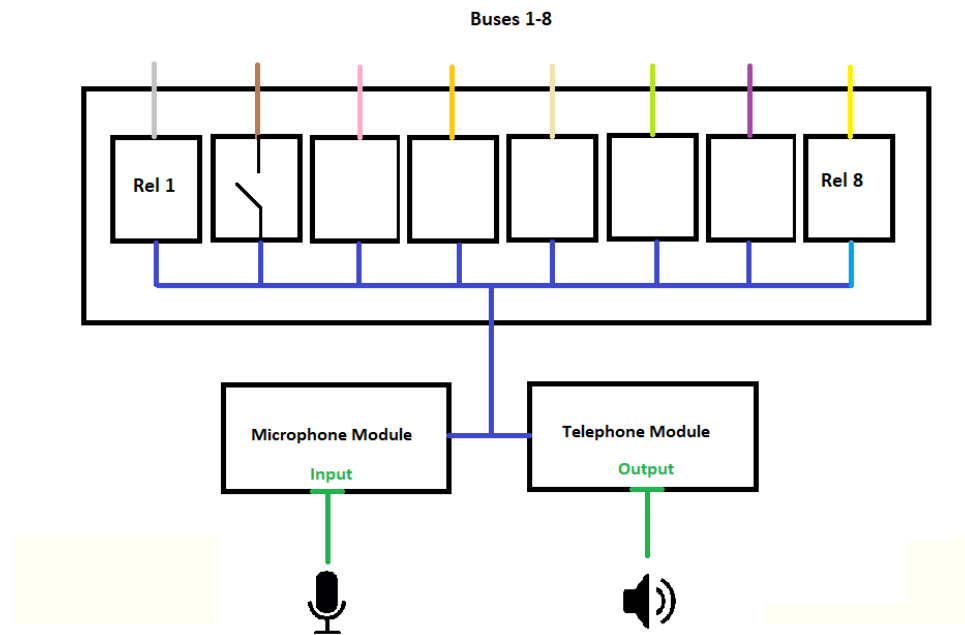


Fig. 6. Principal layout of Commutator.

### c) Performances

Power supply: 12 volt direct current  
 Microphone resistance: 1.5-2.5 kOhm  
 Headphones resistance: 30-60 Ohm  
 Channels: 8 (depends on commutator capability)  
 Subscribers on a channel: unlimited  
 Max bus length: up to 50 meters (depending on conductor)

### d) Auxiliary devices

1) Commutator control panel might be presented as Relay-Microcontroller module or as a classical commutation switch. Relay-microcontroller module is developed on a basis of Arduino Pro micro with own IDE. It was chosen for its reliability and ease of programming due to own IDE. It consists of microcontroller, relay module, 8-segment indicator and n-coder.

First of all, a frequency and corresponding relay are programmed into Arduino microcontroller. The current frequency (channel) is indicated on 8 segment indicator. User can change standby frequency with n-coder and shift active and standby frequency with n-coder button. When the certain active frequency selected, microcontroller switches the relay which connects main bus of subscriber to corresponded to this frequency network bus.

2) PTT button is an outsource button on a wire, which stand for switching PTT listen/transmit modes. Can be equipped with extra microphone and speaker.

3) Recording device. As already mentioned above, record ability is a vital thing for simulator. It is presented as an 8 channel soundcard with appropriate software such as Cubase. The soundcard is connected to all 8 network buses and is not a standalone device and controlled from computer.

4) Network bus. It was chosen to use shielded twisted pair due to its perfect transmission ability.

### 4. Conclusions

After performing a research process it came obvious that a new type of training device is needed on market of aviation or transportation knowledge. It should be a standalone device-based unit with PTT button, semi-duplex communication, channel setting and recording. Analogue type of device was chosen due to its similarity to real VHF radio. The device was invented and developed. Principal schemes and layouts were drawn. Then, a concept model was assembled and tested. The developed device fully meets all requirements inclusively low cost and ease repair.

The result of testing on a practical lesson resulted in such conclusions:

- The accuracy of PTT button usage arose.
- Due to record ability, debriefing came more accurate and productive.
- Students became more convenient with frequency setting

- Total performance of Master simulator arose due to usage of standalone device instead of additional software.

- Simulator training became more interesting and thus, productive.

To sum up the device was developed accordingly to the requirements of aviation studying market. The student testing results showed that simulator training became more interesting, practical and productive due to brand-new features of device.

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**М. М. Богуненко<sup>1</sup>, О. Є. Луппо<sup>2</sup>, Г. Ф. Аргунов<sup>3</sup>, С. В. Суботін<sup>4</sup>, А. Р. Герман<sup>5</sup>**

### Концептуальна модель напівдуплексної учбової станції

Національний авіаційний університет, просп. Космонавта Комарова 1, Київ, Україна, 03058

E-mails: <sup>1</sup>L-39@ukr.net; <sup>2</sup>luppo.ae@gmail.com; <sup>3</sup>argunov\_gf@ukr.net; <sup>4</sup>sergejsub@gmail.com;

<sup>5</sup>alina3.gm@gmail.com

У статті розглянута концепція покращення системи зв'язку для існуючих авіаційних тренажерів при установці додаткових блоків напів-дуплексного ДВЧ зв'язку, які імітують роботу наближену до реальних умов. Наведені схеми, які розробили автори, дозволяють покращити навичка авіаційних спеціалістів.

**Ключові слова:** тренажер; зв'язок; напів-дуплексний зв'язок; ДВЧ станція; підготовка; обладнання радіо - телефонного зв'язку

**Н. Н. Богуненко<sup>1</sup>, О. Е. Луппо<sup>2</sup>, Г. Ф. Аргунов<sup>3</sup>, С. В. Суботин<sup>4</sup>, А. Р. Герман<sup>5</sup>**

### Концептуальная модель полудуплексной ОВЧ учебной станции

Национальный авиационный университет, просп. Космонавта Комарова 1, Киев, Украина, 03058

E-mails: <sup>1</sup>L-39@ukr.net; <sup>2</sup>luppo.ae@gmail.com; <sup>3</sup>argunov\_gf@ukr.net; <sup>4</sup>sergejsub@gmail.com;

<sup>5</sup>alina3.gm@gmail.com

В статье рассматривается концепция улучшения системы связи существующих авиационных тренажеров установкой дополнительных блоков полудуплексной ОВЧ связи, имитирующих работу приближенную к реальным условиям. Приведенная разработанная авторами схема позволит улучшить навыки авиационных специалистов.

**Ключевые слова:** тренажер; связь; полудуплексная связь; ОВЧ станция; подготовка; оборудование радио- телефонной связи

**Mykola Bogunenko.** Associate professor.

Education: High Military flight school (Kharkov), 1978, Air Force Academy, 1988

Research interests: navigation and management; problems develop of air navigation systems; aviation safety provision; develop of air traffic control intelligence systems; flight safe services; vortex wake detection systems; application of geoinformation systems for aviation.

Publications: 61

E-mail: l-39@ukr.net

**Oleksandr Lupp**. Candidate of Pedagogic Sciences. Associate professor.

Education: Academy of Civil Aviation, Leningrad, USSR (1982).

Research area: air traffic management enhancement, human factor investigation, methods for ATCOs' professional skills improvement.

Publications: 68.

E-mail: lupp.o.ae@gmail.com

**Gennadiy Argunov**. Associate professor.

Education: State Flight Academy of Ukraine, Kirovograd, Ukraine (1994).

Research interests: prediction and elimination of potential conflict situations in the process of air traffic control.

Publications: 21.

E-mail: argunov\_gf@ukr.net

**Serhii Subbotin**. Bachelor.

Education: National Aviation University, 2018

Research interests: navigation and development of air navigation systems; simulation training and development of simulation training devices for aeronautical personnel.

Publications: 7

E-mail: sergejsub@gmail.com

**Alina Herman**. Bachelor.

Education: National Aviation University, 2018

Research interests: research of brand-new scientific solutions and creation of their implementation concept in aviation market. Simulation training as a solution decrease the influence of human factor on aviation safety.

Publications: 7

E-mail: alina3.gm@gmail.com