Concept of the Innovative System for Detecting Hidden People in Transport (ISDHPT)

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INTRODUCTION

The ISDHPT system will be used during the inspection of means of transport to detect persons trying to cross the state border illegally. The development and implementation of the system will allow us to improve the level of public safety by increasing the effectiveness of actions taken in the area of transport means control.

The ISDHPT system will consist of the following two components:

1. Mobile Operating Platform (MOP-ISDHPT)

The assumptions of the MOP-ISDHPT system:

• detection of people hidden in means of transport, in particular in trailers of trucks (tarpaulin, isothermal, container) and delivery trucks (without the need to open cargo spaces – to avoid breaking customs seals),
• mobility - the ability to transport the entire system,
• time to assemble the system: up to 60 minutes,
• time to prepare the system for operation: up to 60 minutes,
• control time: up to 20 minutes,
• reliable operation in various weather conditions - the ambient temperature in the range -20°C to + 40°C, noise, rain, wind).

2. Training Simulator (TS-ISDHPT)

The assumptions of the TS-ISDHPT system:

• operation in dedicated rooms and mobile conditions,
• possibility of mapping all MOP-ISDHPT operating modes,
• the possibility of ensuring cooperation with other, real training platforms, through web services,
• the possibility of conducting training using various simulation scenarios,
• possibility of introducing parameters imitating the presence of people by the trainer,
• the possibility of conducting pieces of training in an individual and group system and supervision for training.

THE CONCEPT OF THE MOBILE OPERATING PLATFORM (MOP-ISDHPT)

The Mobile Operating Platform (MOP-ISDHPT) will be transported in a minibus operating vehicle. The MOP-ISDHPT includes:

1. Automatic THz scanning subsystem (ASS-ISDHPT) consisting of:

• low-resolution 2D terahertz camera to terahertz range for motion detection
• high-resolution terahertz linear detector
• multi-range terahertz wave source
• X-Ray subsystem (XRS-ISDHPT) consisting of a back-scatering scanner with instrumentation.
• a controlled transport and positioning system, based on autonomous robotic platform
• equipment subrack for integration and communication with IDP-ISDHPT

2. Chemical subsystem (CHS-ISDHPT) designed to search for chemical traces of human presence, consisting of:

• a set of probes for sampling from vehicle interiors and confined spaces
• system of transport and conditioning of gas samples for detectors
• matrix of electrochemical sensors
• gas chromatograph with an ion mobility spectrometer to identify volatile organic compounds
• integration and pre-processing module based on an algorithm that analyzes input measurement data and communication with IAMDS-ISDHPT.

3. Modular subsystem for integration and analysis of measurement data for decision-making purposes (IAMDS-ISDHPT), hardware-based on CPCIS standard and a neural network accelerator, performing the following functions:

• exploratory analysis of the results of detection (sensor) measurements and image modalities used to estimate the probability of detecting people and other hazardous materials
• minimizing the probability of false-positive alarms (FP) - false object detection - with the use of learning techniques,
• a synergistic fusion of measurement data from sensors and detectors, control of scanning processes in ASS-ISDHPT, and the management and analytical process is supporting the system operator integrated with a database that provides the necessary information.

4. Operator station (OS-ISDHPT) containing the operator's server with the visualization system (two monitors for displaying images and results), adapted to the ergonomics of the vehicle
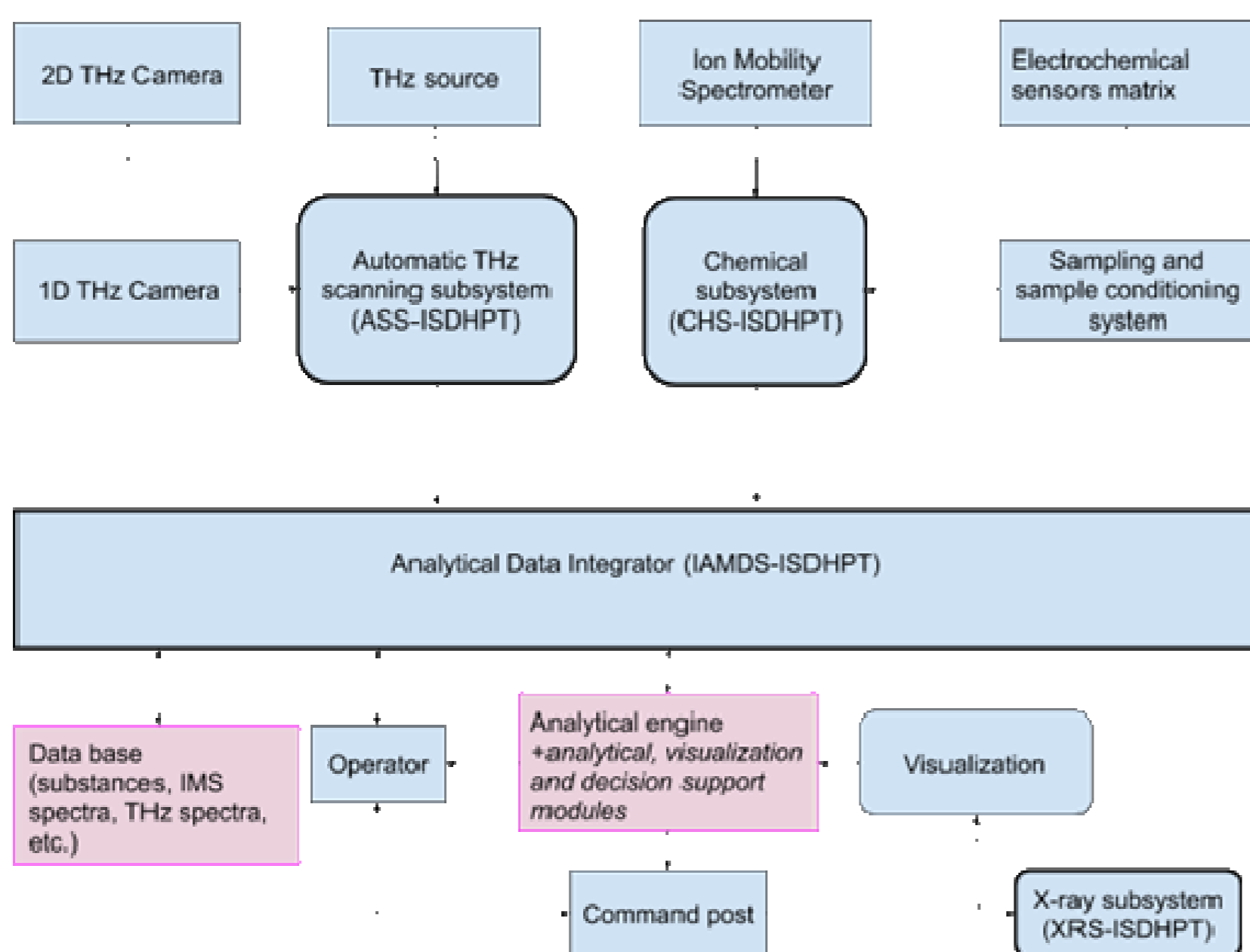

Fig.1. The functional diagram of MOP-ISDHPT.

THE TRAINING SIMULATOR – CONCEPT (TS-ISDHPT)

The training simulator (TS-ISDHPT) will include the following functionalities:

• Operation both in dedicated rooms and in mobile conditions
• Possibility of mapping all MOP-ISDHPT operating modes
• Possibility to ensure cooperation with other, real training platforms through Webservice
• Possibility to conduct training using various simulation scenarios
• Possibility for the trainer to introduce parameters characterizing the presence of people
• Possibility to conduct training in an individual and group system and to supervise the course of the training.
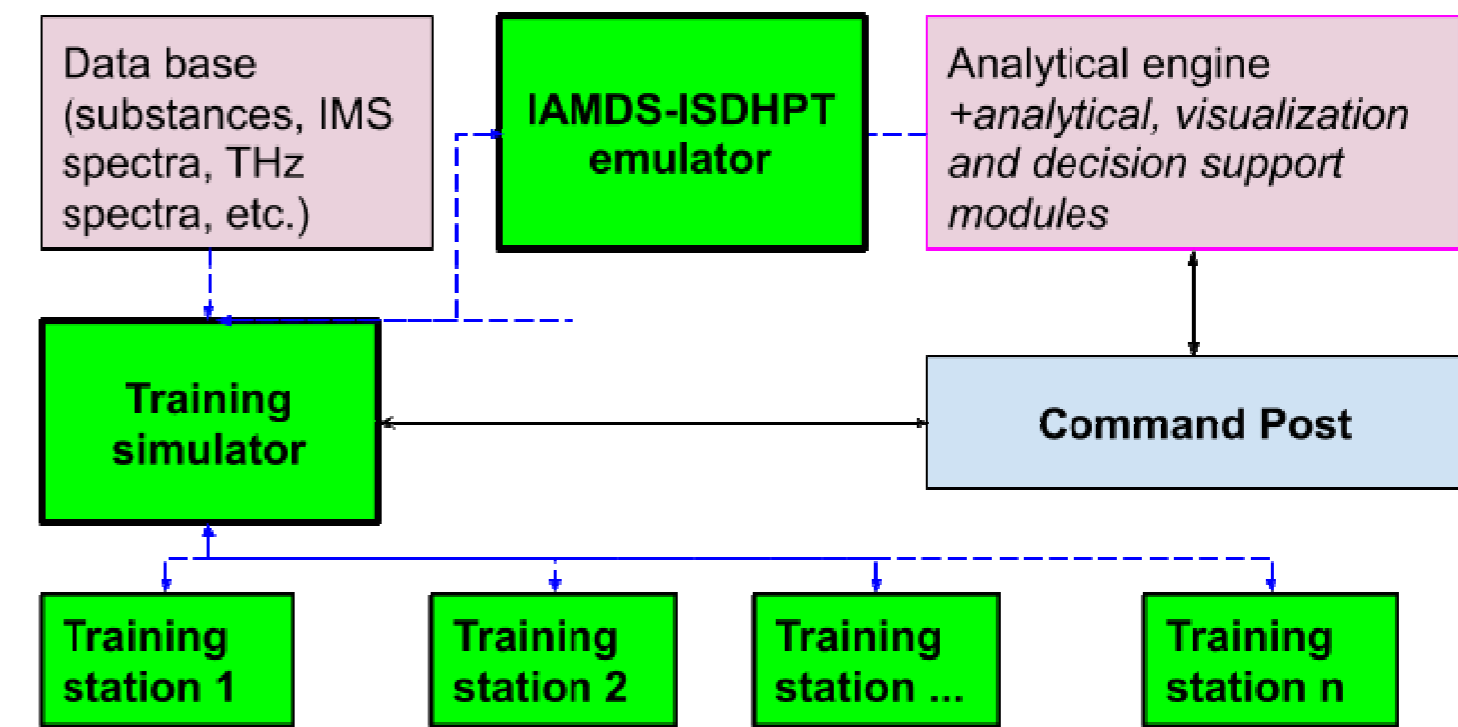

Fig.2. The functional diagram of TS-ISDHPT.

CONCLUSIONS

The main innovative features of the proposed solution are:

1. The use of multi-parameter air composition assessment has been based on the detection of CO_2, i.e., gas, which is present in the exhaled air, but also present, for example, in exhaust gases, in clean atmospheric air. In the proposed solution, not one, but many compounds present in the exhaled air are searched for; moreover, substances produced by the entire human body will also be monitored. The detection of human presence will be based not on the observation of changes in one parameter, but on the observation of the parameter(s) matrix. Also, the use of highly sensitive techniques with high identification potential (gas chromatography coupled with ion mobility spectrometry) will allow the detection of substances specific to the human body at low concentration levels.

2. Possibility of detecting other substances of criminal importance - the proposed detection technique (GC-IMS) can detect explosives, chemical weapons, drugs, and their precursors and other dangerous chemical compounds - which allows the implementation of the optional project objective.

3. Synergic use of detectors working in different ranges of electromagnetic waves (terahertz band, x-ray band) allows scanning of various types of objects, from vehicles with a semi-trailer secured by a tarpaulin to steel containers, while maintaining a radiation dose that is safe for people.

4. The sensor matrix allows us to obtain many signals, and thus a kind of "fingerprint" means that with the increasing number of specific properties (supplementary data) from positive detections of people, it will be possible to improve the detection algorithm.

5. Functional modularity of detection subsystems, which is not found in the existing solutions of systems for detecting people, increasing the probability of detecting or excluding unauthorized persons.

6. The possibility of recording indications from all ISDHPT subsystems and their use in the training process means increasing the training's realism. It means training a very effective and attractive case analysis method for students.

7. Use of CPCIS (Compact PCI Serial) standards - a modular open standard for the construction of small-sized industrial computer systems, compliant with the specifications of the PCI Industrial Computers Manufacturers Group - PICMG, which enables the system to be expanded with additional detectors and imaging systems.

8. Application of hardware neural network accelerator to support decisions.

9. The use of artificial intelligence algorithms, including machine learning based on neural networks, which will be trained (trained) to assist the operator in quickly detecting people. A dedicated hardware accelerator to speed up the detection process will be used to accelerate the detection process so that it takes place in quasi-real-time.

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