ZRÍNYI MIKLÓS National Defense
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POSSIBILITY OF THE AUTOMATIC ANALYZING AND DECODING IN LOW AND MEDIUM SPEED DIGITAL TRANSMISSION SYSTEMS

(PhD) discourse

Authorial guide and official censure

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Introduction, composition of the scientific problem

Aiming to achieve the information superiority, information operations are an up to date and most developing field of the art of war of our age. As recently the highly developed societies are also waging information war on their enemies, these operations may help modern military leadership to make effective and prompt strategic decisions influencing the outcome of combat, peacekeeping and information operations. The objective of those procedures is to secure the interested information, to process it in a very efficient and fast way for the productive utilization and also to protect the proprietary information. Information war is being kept on with the latest technology – computers, telecommunications systems – in the seat of war. In accordance with this, the knowledge of both the existing and the proposed telecommunications systems and equipment are essential for that activity.

Nowadays, in the applied communication systems, satellite telecommunications systems, radio data networks use sophisticated signal processing, modulation, frequency utilization and channel access techniques providing wide range of applications such as voice and data communication, signaling and warning for office, financial, trade, transport, industrial, agricultural, health care, security and defense purposes. These specialties can effectively use up the mentioned techniques to enhance their ability and capacity.

The common attribution of these roles and systems is the transmission of data, information and signals between or among two or more points which may have significant relevancies for national security offices. The main task is the technological and procedural examination of the attainment of the said information. The aims of this research are the study of existing telecommunications standards and solutions, and the examination of the processing (pickup) possibility with state of the art hardware elements.

The period of drastic cut of military expenditures has been followed the end of the bipolar world. The uses of human and material recourses have needed to be effective and economical. Significant growth of the information resources and the proper cover of developing telecommunication systems cannot be solved with traditional instruments. One cannot find the traditional governance of mass military in the actions of the present enemies, which characteristically operate in small terrorist groups. A deliberate and a target oriented automatic data collecting system can give solution to this challenge.

The main challenge of the automatic data collecting systems is the database. Serious challenges for the system managers are the clarification of the expectation of the database and

the corresponding set-up of the structure. In order to create an efficient equipment (system) one should have a detailed knowledge beyond engineering and database knowledge.

During the work of planning, one should examine the results of this area, and the development of these. Attaining goal is that the methods used up to present day will have been more efficient.

Hypothesizes in the beginning of my research are the following:

- a system could be created, where data come from different sources can be located in one place the set-up system can use the data automatically retrieved with analysis from the database, an equipment can be prepared, which can analyze low or medium bandwidth communicational lines in itself;
- an equipment can be prepared in a pc card form;
- the elements of the pc card can be scaled due to the optimum of the rate of costefficiency;
- the card can be extended with mezzanine modules;
- the set-up software can be build by modules by reason of the easy development and execution of test.

Aims of the research:

1. The development of receiving and decoding system capable analyze automatically and decode structure in low and medium speed digital transmission system. Analyzing the useable electronic element, with we can physically build up the automatic analyzing system, and the necessary structure of the database.

2. The observation layers of the transmission protocols, analyzing the used protocols, the content of the signaling channels and its military effect. Observe new challenges in demodulation methods, and channel access, deep knowledge in information scattering method.

3. Analyze the existing digital demodulators and its demand of hardware processing. Develop an automatic analyzer system to process these output data.

4. Elaborate new procedure, what helps to automatic analyzing technology, with a minimum resource using.

5. Compose recommendations for an integrated future singal intelligence system. Obsering the possibility for original hardware elements in a new integrated system. Study the ideal cost effectiveness of the new sysem.

Applied research methods

I have practiced an extended research in the collection and systemizing information concerning wireless digital data transport system. In order to extend my knowledge I have scrutinized the scientific literature and the publications on the internet. I have felt very important to analyze my thesis in practice, so I have materialized several examined system and I have supported my hypothesis by examining and analyzing the results. I have got aquatinted with research activity on digital satellite communicational system both in Hungary and in foreign countries. I have worked with development and planning exploratory system from 1997, so thus I built my dissertation on my personal experiences. In my research I have utilized knowledge from data collection systems used by foreign offices. Parallel with dissertation I have developed an automatic, real time data process system based on discovered problems, which increase the effectively the Hungarian Military Intelligence Office with less human resources. I have issued regularly the results of my research in professional publications, and I have given presentations. After having explored problems, having collected scientific literature, I have synthesized new solution and I have answered the emerged questions with the method of deduction. I have developed a mathematical model in order to answer and solve technical and technological questions and problems, and I have certified it with computerized simulations, tests and measurements. I have compared experiences with the results of elaborated experiments, I have drawn conclusion and I have advised solutions to the emerging problems.

The dissertation does not concern the following:
- examination of military spy satellite, a meteorological satellite systems, satellite with special function;
- a terrestrial microwave relay network. The continuous reception experiments shows, that the microwave rely connections are decreasing. The reason of this tendency is that the optical network has a drastic cost cut, and these systems are encumbered step by step on wire, mostly on optical network.

For the achievement of the set aim, the thesis is built up with the following chapters:

Chapter 1

I review the challenge of modern radio exploratory in the information operation. I present the challenges arisen during operations, the possible solutions in the view of technical challenges. I propose a modern data collect and data process system, and a uniform database structure with the view of explored challenges.

Chapter 2

In this chapter I present the technology of software radio, its main types with the analysis and exploration of the optimal structures. I examined the elements applied with the draft technical instruction. I analyzed the operational demand of algorithms applied for the achievement of the aims. I give a suggestion for the development of an appropriate structure taking into account the technical needs.

Chapter 3

I analyze the future task in the communicational devices, its harmony in the suggested architecture. I suggest the appropriate division of task into modules, and the implementation of the modules on the most optimal elements of hardware.

Chapter 4

After analyzing the tasks, I develop a modern, half-automatic data collecting system. During the plan I use the most modern sign processor devices, and I demonstrate the tasks materialize with it. Beyond the applied elements, I scrutinize the devices purchasable in the market, and I develop the most efficient algorithm with the analysis of the operation of the devices. At the end of the thesis I summarize the subject, I drew conclusions, I make suggestions and highlight the scientific results.

Summarized suggestions

In my thesis I have given a summarized analysis of the possibilities of automatic executed electronic support and signal intelligence. I analyzed the capacity of systems used by foreign offices, and I adapted them into the Hungarian conditions. With the image of problems and

challenges, in this stage of development I suggested a creation of a common signal intelligence database, which can be applied both in strategic and tactical tasks. I have taken into account the national specifications and the differences derive from different task system. The resources of the input data are the automatic devices. The construction of database supports the immediate feedback of information formed during the data process into the data collect system thus ensuring swift ability of maneuvering. I have aimed detailed and correct documentation of formation of recorded broadcast by the system.

Elaborating of the subject:

- I have worked up the scientific literature (books, scientific periodicals, doctorial thesis, electronic materials);
- I have used my own international experiences common receiving practice;
- I have examined other NATO member state's satellite data collect systems;
- I have compared the possibilities of the service of devices which use different technology;
- I have had consultations with experts, who teach BMGE wireless telecommunication system in theory, and who perform R&D activity;
- I have had consultations experts, who work in the defense sector and develop the satellite communications sector;
- I have systematized the accumulated knowledge, and based on it, I have made out an up-to-date satellite monitoring system;
- I have driven a part conclusion of the systematized knowledge according to themes, and based on this I have driven up a final conclusions, which establish scientific results;
- I have made known the gathered information in course for warrant officers.

I have made my research firstly in the basis of Hungarian Military Intelligence Office as a scientific workplace. My work has been helped with the fact that after gathering information I have had the opportunity to use it in practice. According to my suggestion the gathered information, the information prepared by processors and personal information should be store in different tables. Thus with the use of appropriate filtering and references there should be form automatically a whole connecting network. According to my suggestion the whole source material is available for the processors. During the development of database, I have taken into account the database set-up (which is available) used by allied for the sake of ease

of partner service information stream. With the use of exploring data arose on the upshot of database (with the feedback into the data collector) the aimed signal intelligence has become realizable. Thus the activity of data collection and data procession much more effective, with optimal utilization of resources. With the use of these principles the fundamental need for intelligence has become available: the actuality, availability and the period of intelligence may close.

I have examined the technical challenges nascent during the reception in the light of theoretical challenges of intelligence. I have suggested forming a system, in which there are the following elements:

- PC DSP card;
- analog front-end card;
- DDS based tuner unit.

With this composition there can be form a reception system, which is applicable in a flexible way, and which has a little power dissipation and which is cost effective. The improvement and expansion can be solved. The common hardware platform allows that the cost of operation and reservation remain on lower rate. With the examination of adaptations worked out by producers, and check out the limitations in the demodulation bandwidth in the different modulation modes. I certified with measurements that in the shortwave applications the input band filters necessity, because of the dynamic environment in these frequency band.

I analyze the behavior of the synthesizers, and certified the fast hopping tuners work only with DDS-based local oscillators, instead of phase looked loops. The supposed phase noise and settling time can work only this case of structure.

I have analyzed real antenna signals and I certified the necessity of the preselector stages. These elements are the base of the dynamic-improving possibility, and the reduction non-linear behavior of the amplifiers. Establishing the bands in the preselectors costumised by the local antenna signals and the international radio recommendations.

I have developed an automatic FAX analyzing and recording system for the SIGINT department in the MIO.

New scientific results

1. As I overviewed the challenges of the electronic warfare I recognized that a deliberately well set up standardized database makes a scouting system really efficient. I mage suggestion for the structure of data saving of radio reconnaissance

system to avoiding the theoretically examined- and the functional problems previously. Beyond data collecting the developed data base supports automatic data processing activity as well.

2. As I analysed the structure of communication systems based on modern radio-software technology and the functions of its each modules I defined the basic functions and the needs of operations for the implementation. Having known this items I make a proposal for the structure of a data processing integrated circuit/chip which is indispensable to build up a modern reconnaissance system.

3. By helps of baseband signals processor circuits and an integrated sign processor circuit/chip I produced a low consumption automatic data saving system that proved the correctness of the assumption I have taken not only in fixed but as well as in mobile utilization.

4. Through speculative calculations and functional tests I demonstrated that the ordinary video cards – can be purchased in the retail market – able to support radio reconnaissance tasks or execute some functions completely.

Publications:

Proofread articles::

1. **Digitális jelfeldolgozás alkalmazása I**,

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2. **Digitális jelfeldolgozás alkalmazása II**,

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3. **Nagy sávszélességű jelfeldolgozás kihívásai**,

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4. **Korszerű rádiófelderítés kihívásai az információs műveletekben**,

 Hadmérnök III. Évfolyam 2. szám - 2008. június ISSN 1788-1919

5. **Új generációs jelfeldolgozó kártya tervezésének kihívásai I**.,

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7. **Szoftverrádiókban alkalmazott digitális szűrők**,

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9. **Graphics cards in radio surveillance**,

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Felderítő Szemle IX. évfolyam 2. szám, 2010. június, ISSN 1588-242X

Professional CV

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Educations:

2006-2010:   Zrínyi Miklós National Defense University, correspondent Phd. student

1998-2001:   Budapesti University of Technology and Economics, engineer

1993-1997:   Bolyai János Military and Technology College, engineer

1988-1992:   Egressy Gábor Technical School, mechanican

Appointments:

2006-   MIO head of subdivision

2002-2006:   MIO subordinate officer

1997-1998:   MIO subordinate officer

1992-1993:   Tertainstall LTD., technician

Language skills:

1996:   English intermediate „C"

2010:   German first grade „C"

Rank advance:

2004:   Major

1998:   Captain

1997:   First lieutenant

Budapest, 6.07.2010.

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János Fürjes

major

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