Monitoring the launching points of the anti-hail units

Constantin Şulea, Gheorghe Manolea, Ionel-Laurentiu Alboteanu, Alexandru Novac

Abstract— This paper presents a system for monitoring national hail system. It is proposed a specific information system for anti-hail network in Romania witch completes the known systems with information subsystems specific for both coordination missiles, release automation, and also power supply.

The computer system comprises two main components: a system for taking the decision of launch and the system for assisting the launch decision. The integrated information system for monitoring the launch anti hail rockets units enables: an increased efficiency by shortening the time for action, a good organization, a high degree of security.

Also, there are presented the monitoring and management system for the available energy in the photovoltaic supply system and one device of the system for assisting the launch decision.

Keywords— anti-hail networks, system architecture, monitoring, photovoltaic system, information theory.

I. INTRODUCTION

WE are seeing a sharp change in climatic factors often with violent manifestations. In these circumstances, it appears necessary to monitor the climate action and the creation of means of intervention to reduce economic losses caused by such events.

Achievement of an Anti-hail Systems is an important component of a comprehensive means of monitoring and intervention.

In our country it is desired the extension the National Anti-hail System, so institutions were created to conduct this program, namely "The stimulation rain and anti-hail System Administration"

To lead a well-founded and timely decision, any decision process must acquire, process and interpret a growing volume of information, in a time of increasingly shorter. For the time period of the last update of the cloud front, which can provide information about the formation of hail, and time for ordering a shooting to be as short as, it is necessary to integrate various input sizes so that the operator to have as much information to be merged into one " screen", so it is necessary to achieve an integrated information system for monitoring the launch points of combat units hail [4].

The paper proposes a specific computer system for anti-hail network in Romania that adds the known systems with specific informations subsystems for the coordination missiles, for the release automation, and also for the power supply [5].

II. INFORMATIC SYSTEM STRUCTURE

The anti-hail information system is a assembly of hardware, software components, procedures, strategies, activities and people united and organized to process data related to combating hail, to fulfill the task of reducing / eliminating the damage caused by hail and the and achievement of through measurable performance criteria established.

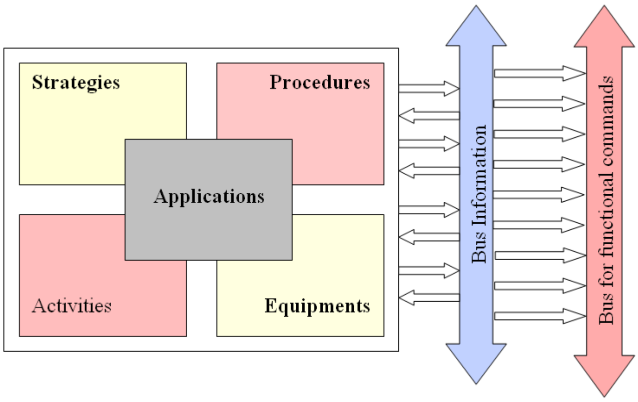

Fig.1 The information anti-hail system

In fig.1 is shown, generally, computer system architecture for monitoring anti-hail units launch points. Principal components of a launching point, necessary of the information system, as is shown in Fig. 2, are represented by a GPRS communication module, the monitoring system, the launching ramps and an optional computer running specific applications.

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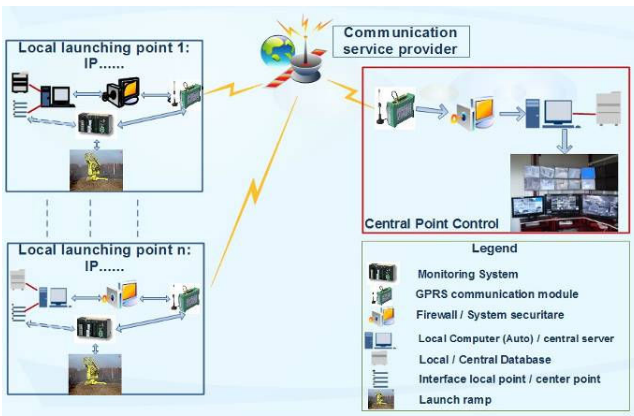

Fig.2 The information system architecture for monitoring anti-hail points

The GPRS communication module is a terminal identified by an IP address, always connected and available, the GSM network is transformed into a transmission network and packet switched technology like TCP / IP. The monitoring system for the local point will be described in the next chapters. The main components of the information system for monitoring are two subsystems (fig.3):

- the subsystem for taking the decision of launching
- the decision support launch subsystem

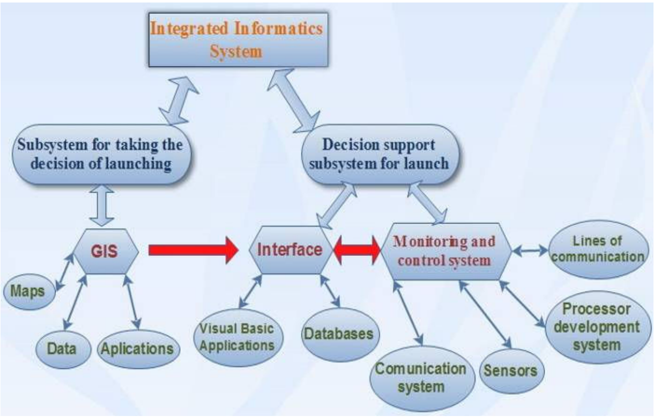

Fig.3 The main components of the system

Information systems for decision support are useful when decision criteria are numerous, conflicting data, when the search is difficult, takes time and satisfactory solution must be given rapidly, like is the case of decision to launch the rockets in the anti-hail systems.

The subsystem for taking the decision of launching addresses exclusively to the central control point. The subsystem is a multifunctional GIS which can help the staff of the center point upon the decisions which must be taken in extreme situations. The current weather system from our country allows an update to about each 7-9 minutes, the information of clouds progress come at the central point in about every 15 minutes.

As the time between when the last update of the clouds and the time for ordering a shooting to be as short as possible it is necessary to integrate various input sizes so that the operator should have as much information as pooled into a "screen".

The main layers of information - the input sizes are related to: the evolution of clouds, topography and cultivated areas, launch points and organizational elements.

The cloudy situation of the protected region is very important, intervention will take place only if the weather radar indicates the presence of hail or its risk figure 5.

In Figure 5 are symbolically presented planted areas to be protected, represented by rectangular polygons of different colors: green, blue, yellow, orange, red symbolizing the type of each crop (fruit trees, vines,

Fig.4 Example of evolution of clouds in Romania

wheat, maize, etc.); the coordinates of the launch point and the central point are represented by blue dots and respectively red dots. The range of launch ramps is also important, it is highlighted the area which is covered by a central point. The access roads and their types (agricultural, county, national, European) are highlighted for prompt intervention in case of failure.

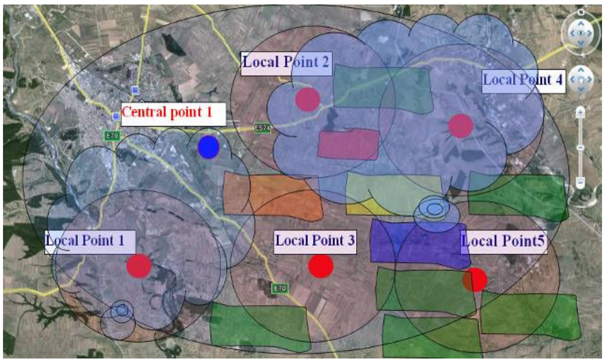

Fig.5 GIS's symbolic representation

The main output of this subsystem is the operator's decision. The local point decided is accessed through an application that connects to the decision support subsystem for launch.

III. Sources of information in a local unit launch

Based on information received from the NMA is drawn an intervention program in a combat action. Following this action will be established the launch units involved, number of rockets, azimuth and elevation angles. Follow the launch of a number of missiles in the affected areas and then look at the effect.

A local unit currently contains the following: 2 launchers, live box, rectifier load, ammunition store, two lightning, fire point, generator, ecological toilet, stand with wheels, firing shelter, various accessories.

The main information in a local unit launch is: the hail presence, the rocket presence, the air space open, the elevation, the azimuth, the voltage.

The classification of the information on the types of sources:

- discrete sources without memory: racket presence, tension, elevation, azimuth
- discrete sources with fixed constraints : free air space, hail presence

Consider "hail presence" as a source of information which has two possible realizations.
G = {g1, g2}. Each event corresponds to a probability which is equal to ½.

$$G=\{p(g_1),p(g_2)\} \text{ so that } \sum_{i=1}^{2} p(g_i)=1 \quad (1)$$

It turns out that discrete information source is defined as:

$$G=\begin{bmatrix} g_1 & g_2 \\ 1/2 & 1/2 \end{bmatrix} \quad (2)$$

Source entropy $H(G)=-\sum_{i=1}^{2} p(g_i)\log_2 p(g_i)=$ (3)

$=-\frac{1}{2}\log_2\frac{1}{2}-\frac{1}{2}\log_2\frac{1}{2}=1$ that is 1 bit/symbol

The maximum entropy of the source G:
$H_{max}(G)=\log_2 N=\log_2 2=1$
The source efficiency is:

$$\eta_s=\frac{H(G)}{H_{max}(G)}=100\,\% \quad (4)$$

The redundancy of the source G is the difference between the maximum entropy and the entropy of the sources:

$$R(G) = H_{max}(G)- H(G) = 0 \text{ bit/symbol} \quad (5)$$

Relative redundancy $\rho_G = R(G)/H_{max}(G)=0$ (6)

Considered "rocket presence" is a source of information which has 6 possible realizations.
$F=\{r_1, r_2, r_3, r_4, r_5, r_6\}$ Each event corresponds to a probability which is equal to 1/6.

$$F=\{p(r_1), p(r_2), p(r_3), p(r_4), p(r_5)\} \text{ so that } \sum_{i=1}^{6} p(r_i)=1$$

It turns out that discrete information source is defined as:

$$F=\begin{bmatrix} r_1 & r_2 & r_3 & r_4 & r_5 & r_6 \\ 1/6 & 1/6 & 1/6 & 1/6 & 1/6 & 1/6 \end{bmatrix} \quad (7)$$

Source entropy $H(F)=-\sum_{i=1}^{6} p(r_i)\log_2 p(r_i)=$

$-\frac{1}{6}\log_2\frac{1}{6}-\frac{1}{6}\log_2\frac{1}{6}-\frac{1}{6}\log_2\frac{1}{6}-\frac{1}{6}\log_2\frac{1}{6}-\frac{1}{6}\log_2\frac{1}{6}-\frac{1}{6}\log_2\frac{1}{6}$
=0,166*6*2.585=2,57466 bit/symbole
The maximum entropy of the source F:
$H_{max}=\log_2 N=\log_2 6=2{,}585$ biți/simbol
The source efficiency is:

$$\eta_s=\frac{H(F)}{H_{max}(F)}=99{,}6\,\% \quad (8)$$

The redundancy of the source F is:
$R(F) = H_{max}(F) - H(F) = 0{,}0103$ bit/symbol
Relative redundancy $\rho_F = R(F)/H_{max}(F)=0{,}0039\ \%$

Consider "free air space" as a source of information which has two possible realizations. $A=\{a_1, a_2\}$. Each event corresponds to a probability which is equal to ½.

$$A=\{p(a_1),p(a_2)\} \text{ so that } \sum_{i=1}^{2} p(a_i)=1 \quad (10)$$

It turns out that discrete information source is defined as:

$$A=\begin{bmatrix} a_1 & a_2 \\ 1/2 & 1/2 \end{bmatrix} \quad (11)$$

Calculation of entropy related to the source, the source efficiency, redundant source, relative redundancy are similar to those of "hail presence".

Possible values of "elevation" can range between 44^o and 46^o, so three possible achievements.
$T=\{t_1, t_2, t_3\}$, each event corresponds to a probability which is equal to 1/3.

$$T=\{p(t_1),p(t_2), p(t_3)\} \text{ so that } \sum_{i=1}^{3} p(t_i)=1 \quad (12)$$

It turns out that discrete information source is defined as:

$$T=\begin{bmatrix} t_1 & t_2 & t_3 \\ 1/3 & 1/3 & 1/3 \end{bmatrix} \quad (13)$$

Source entropy $H(T)=-\sum_{i=1}^{3} p(t_i)\log_2 p(t_i)=$

$-\frac{1}{3}\log_2\frac{1}{3}-\frac{1}{3}\log_2\frac{1}{3}-\frac{1}{6}\log_2\frac{1}{3}=0{,}3333*3*0{,}4249==0{,}4248$ bit/symbol e

The maximum entropy of the source T:
$H_{max}(T)=\log_2 N=\log_2 3=0{,}4249$ bit/symbol
The source efficiency is:

$$\eta_s=\frac{H(T)}{H_{max}(T)}=99{,}9\,\% \quad (14)$$

The redundancy of the source T is:
$R(T) = H_{max}(T) - H(T) = 0{,}0001$ bit/symbol

Relative redundancy $\rho_T = R(T)/H_{max}(T)=2{,}3534*10^{-4}\ \%$ (15)

Possible values of "azimuth" can range between 0° and 360° with an increment of 10°, so 36 possible achievements: $Z=\{z_1, z_2, z_3, z_4, z_5, z_6, z_7, z_8, z_9, z_{10},..., z_{35}, z_{36}\}$, each event corresponds to a probability which is equal to 1/36.

$$Z=\{p(z_1),p(z_2), p(z_3),\ldots\ldots, p(z_{36})\} \text{ so that } \sum_{i=1}^{36} p(z_i)=1$$

It turns out that discrete information source is defined as:

$$Z=\begin{bmatrix} z_1 & z_2 & z_3 & \ldots\ldots & z_{36} \\ 1/36 & 1/36 & 1/63 & \ldots\ldots & 1/36 \end{bmatrix} \quad (16)$$

Source entropy $H(Z)=-\sum_{i=1}^{36} p(z_i)\log_2 p(z_i)=$

$-\frac{1}{36}\log_2\frac{1}{36}-\frac{1}{36}\log_2\frac{1}{36}-\frac{1}{36}\log_2\frac{1}{36}-\ldots\ldots\frac{1}{36}\log_2\frac{1}{36}=$
= 0,0277*36*5,1702=5,1558 bit/symbol
The maximum entropy of the source Z:
$H_{max}(Z)=\log_2 N=\log_2 36=5{,}1702$ bit/symbol
The source efficiency is:

$$\eta_s=\frac{H(Z)}{H_{max}(Z)}=99{,}72\% \quad (17)$$

The redundancy of the source Z is:
$R(Z) = H_{max}(Z) - H(Z) = 0{,}0144$ bit/symbol
Relative redundancy $\rho_Z = R(Z)/H_{max}(Z)=0{,}0027\ \%$

Possible values of "Power" can be between 23V and 25V, so 3 achievements possible. $U=\{u_1, u_2, u_3\}$, each event corresponds to a probability matrix as below.

$$U=\{p(u_1),p(u_2), p(u_3)\} \text{ so} \sum_{i=1}^{3} p(u_i)=1$$

It turns out that discrete information source is defined as:

$$U = \begin{bmatrix} u_1 & u_2 & u_3 \\ 1/4 & 1/2 & 1/4 \end{bmatrix} \quad (18)$$

Source entropy H(U)= $-\sum_{i=1}^{3} p(u_i)\log_2 p(u_i)=$

$$=-\frac{1}{4}\log_2\frac{1}{4}-\frac{1}{2}\log_2\frac{1}{2}-\frac{1}{4}\log_2\frac{1}{4}=2*0{,}5*2{,}0001==2{,}0001 \text{ bit/symbol}$$

The maximum entropy of the source U:
$H_{max}(U)=\log_2 N=\log_2 3=0{,}4249$ bit/symbol
The source efficiency is:

$$\eta_U=\frac{H(U)}{H_{max}(U)}=470{,}7\% \quad (19)$$

The redundancy of the source U is:
$R(U) = H_{max}(U)- H(U) = 2{,}3533$ bit/symbol
Relative redundancy $\rho_U = R(U)/H_{max}(U)$=553,86 %

IV. Decision Support Subsystem Architecture

A. Hardware architecture for decision launch support subsystem

The local point decided is accessed through an application that connects to the decision support system for launch. Once taken the decision to launch, it must be implemented in shortest time possible by using interfaces, communications system, monitoring and control subsystem for assisting the decision. If it is necessary to make a diagram of the decision process, the decision is the central element. To make the right decision we need a system to help us make a decision and another system to help us (assist) to implement decisions in conditions of maximum efficiency.

The decision support subsystem for launch aims: reducing intervention time, better organization, a high degree of security, greater efficiency, reduced operating and maintenance costs, improve performance.

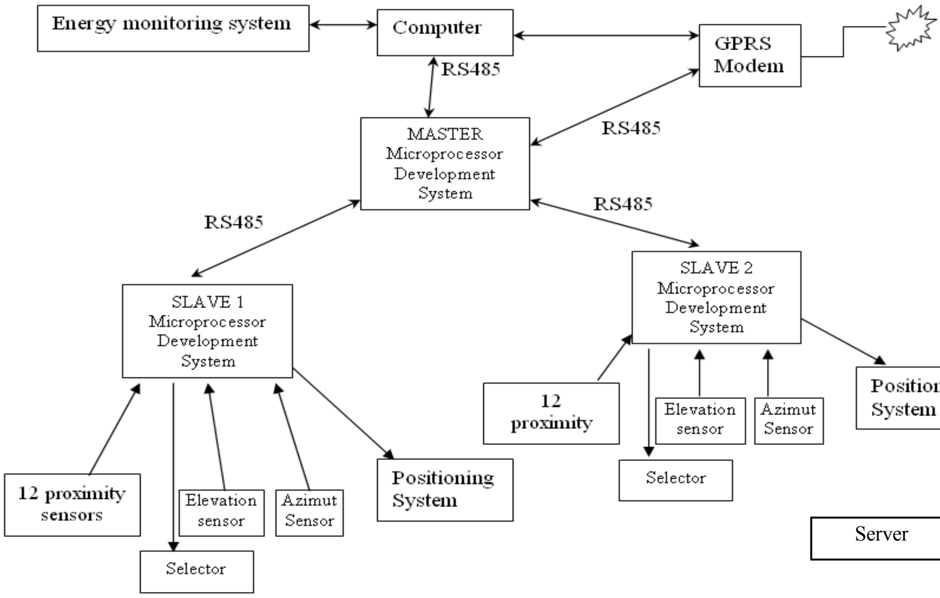

Fig.6 Hardware architecture of the system of monitoring local point

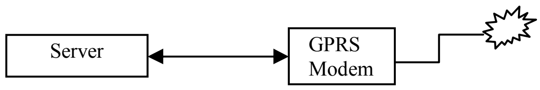

Fig.7 Hardware architecture of the central monitoring system

B. Modeling of the monitoring system for the movement of energy for ranked priorities consumers [3]

Use Monitoring and control algorithm was developed taking into account the principle electrical diagram shown in Figure 8. Notations from the figure bellow have the following meanings: TC3 TC1 - Current transducers; TU1 ... TU2 - pressure transducers; L1 ... L7 - static contactors; K1 ... K3 – contact.

In order to develop the consumer monitoring system model and to implement the algorithm according to priorities set by consumers are established the following categories:
-Class "0" radiotelephone RT1, rocket;
-Class "a" stand lighting;
-Category 2 'lighting, radio and television;

The principle of charging batteries

The batteries B1 and B2 are connected to solar panels: in the same time, if the charging current is greater than the WP1, TC1> TC2 WP1 and> WP2; successive if the charging of one battery is between thresholds WP1 and WP2, i.e. WP2<TC1 <WP1andWP2<TC2<WP1 (Fig.9).

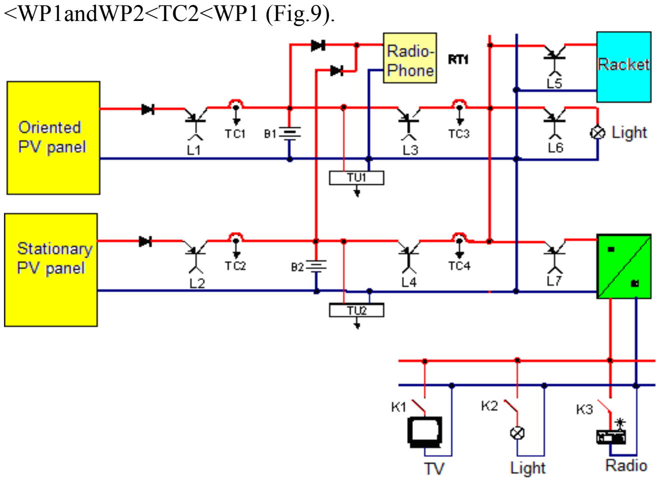

Fig.8 The electrical diagram of principle of the energy movement monitoring system

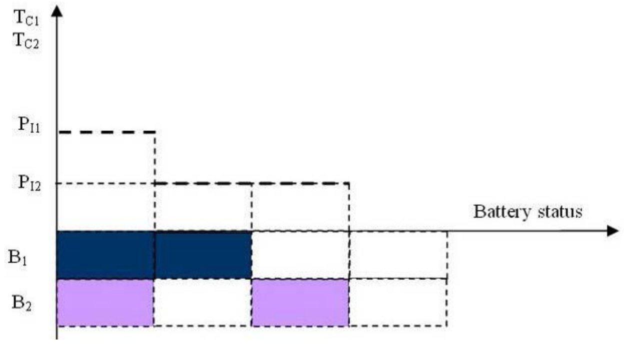

Fig.9 Current levels depending on the decision taken by coupling / decoupling panels

It is chosen which battery charging current is greater B1 if TC1> TC2, B2 if TC2> TC1. This represents a measure of the unloading degree.

The principle of connecting consumers

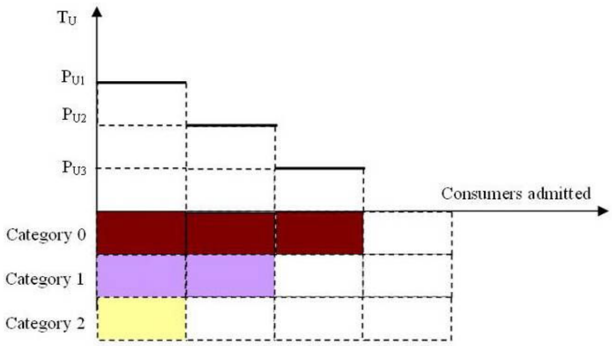

Fig.10 The voltage levels according to there are taken decisions of consumers connection

As shown in Figure 10 it is allowed to connect all the consumers if the battery terminals reaches the threshold voltage PU1, consumers of the category zero and one are allowed if it is reached PU2, and is allowed only the connection of consumers to the category zero if the terminal voltage decreases to the threshold PU3.

C. Simulation of the monitoring system for the movement of energy for consumers with ranked priorities [3]

Based on the monitoring algorithm already presented Simulink model was developed for the monitoring of the movement of energy circulating in the autonomous photovoltaic system.

The simulation results reveal the state of the photovoltaic panels respectively the categories of consumers according to the energy available in battery terminals, thus in figure 12 is presented the evolution of battery terminal voltage and in figure 13 are shown the states of the PV panels respectively the state for each category of consumer.

Analyzing the simulation results, results that consumers are connected to the system according to a threshold required for the remaining battery power. Thus the 0 class consumers are connected to a terminal threshold voltage of 11V, 1st class consumers are connected to the minimum of 12V, while those of category 3 to 13V, PV panels are disconnected from a maximum of 14V.

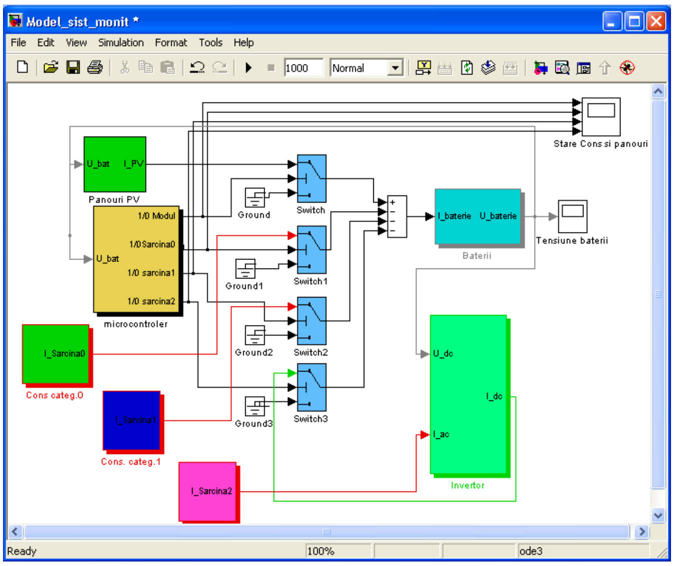

Fig. 11 Simulink model of the monitoring system for the movement of energy

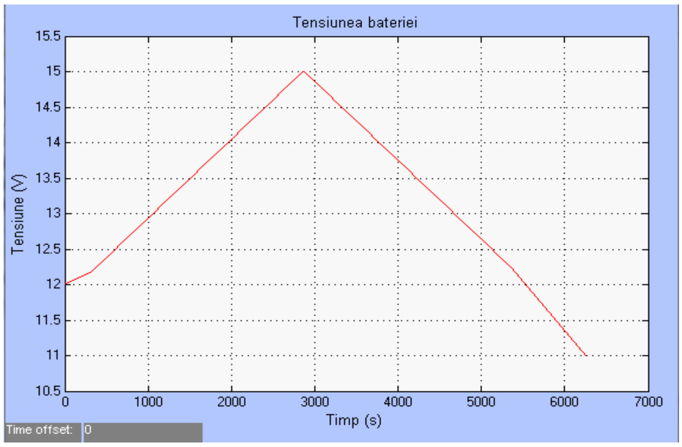

Fig.12 The voltage evolution on battery terminals

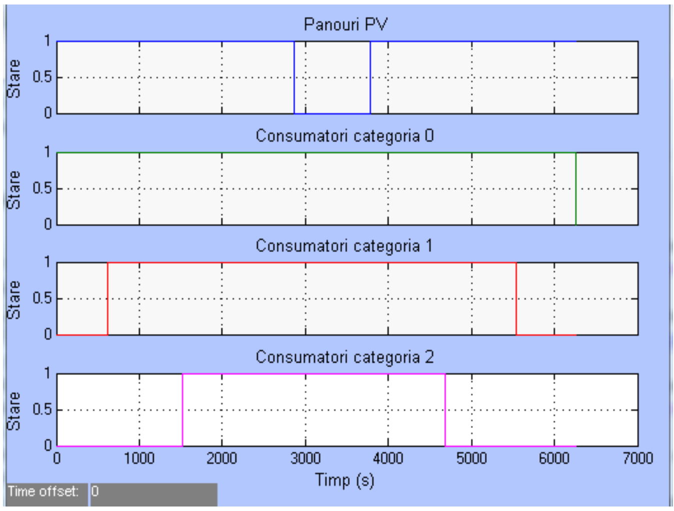

Fig.13 The categories consumers state and the PV panels state

D. The development of software for the orientation panel system and monitoring energy circulation system [3]

The microcontroller primarily program is designed in high-level language Visual C + + [107] and requires working with functions and procedures which use variables of different types, which requires both an internal definition and external definition.

For a greater flexibility in tests achievement it was chosen the solution of storage data acquisitioned on the PC. Also, the switching commands are summarized at the PC level.

For ATMEGA128 microcontroller programming was used the software AVR3 Studio. The program was designed in "C", knowing that the ATMEGA family has been optimized for the use of high level languages.

The language chosen for the development of PC's software is Visual Basic. The main window of the program indicates the name of equipment, three buttons for controlling data transfer ("Start transfer date", "Stop transfer date" şi "Cerere date"), a button for the fast lock of panel drive motor ("Blocare c-dă panou") and a button to initialize the panel ("Iniţializare panou"). Also, current values are available from the two photovoltaic panels, the value of current absorbed from the battery pack, the battery voltage, the solar radiation, ambient temperature and the photovoltaic panel temperature, date, time and current status of the targeted photovoltaic panel (position).

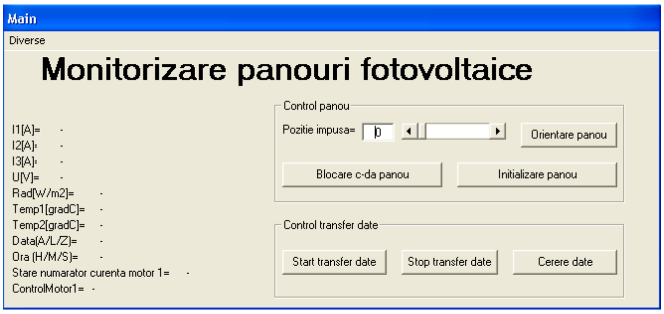

Fig.14 The main window of the monitoring program

There are available four channels which can present the currents through panels, the current absorbed from the battery, the voltage at the battery terminals, the solar radiation, the ambient temperature, the temperature of a photovoltaic panel, the panel's current position (in number of parties to the origin), the consumers state of AC and DC current (Fig. 16).

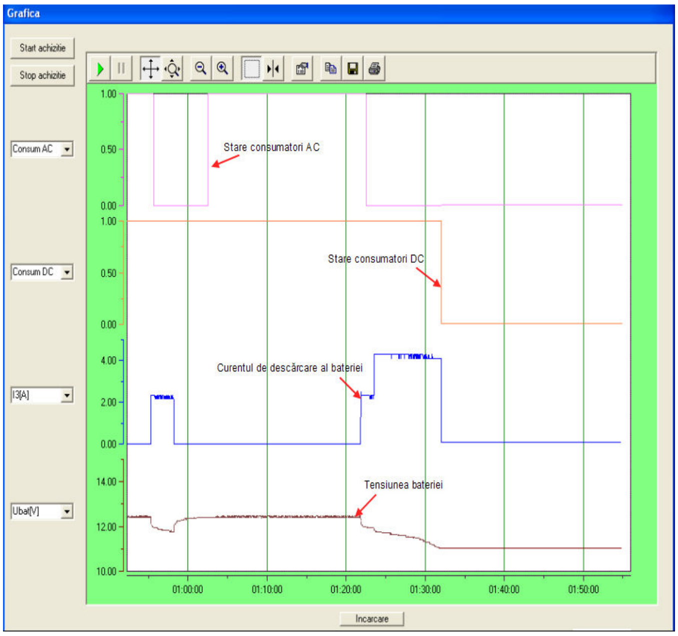

Fig.15 Graphic records of the program window

E. Slave device of the decision support subsystem for launch

In the next figures are presented the main component of the Slave device. This device is located on the launching ramp and monitors: the rockets on the ramp, both the elevation and the azimuth of the ramp.

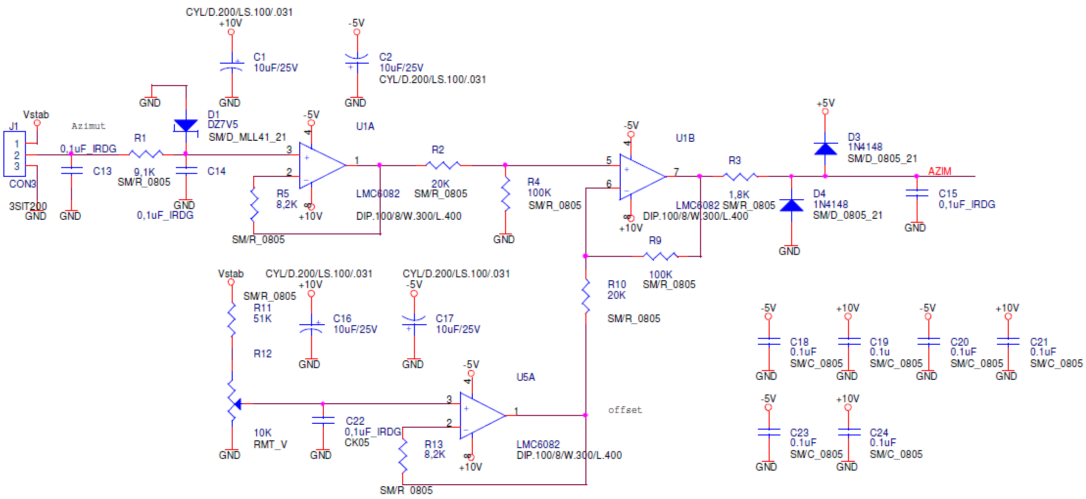

Fig.16 Differential amplifier stage for azimuth

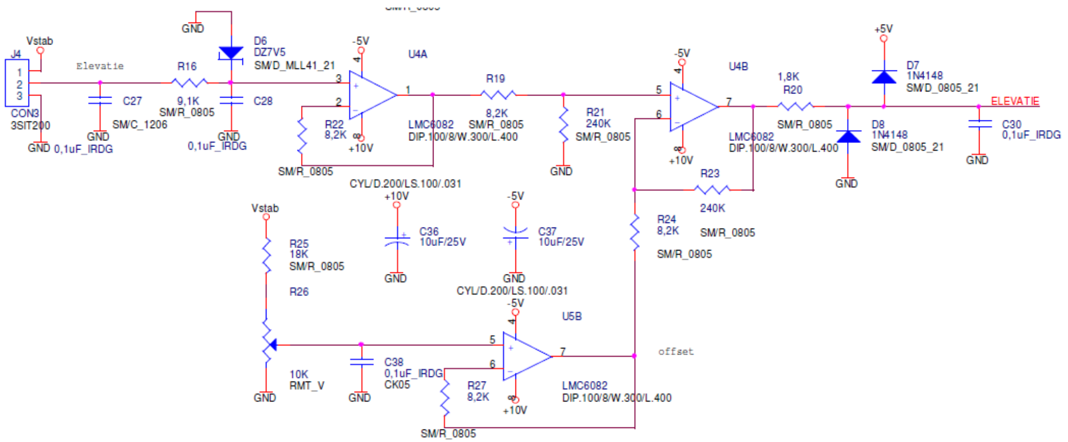

Fig.17 Differential amplifier stage for elevation

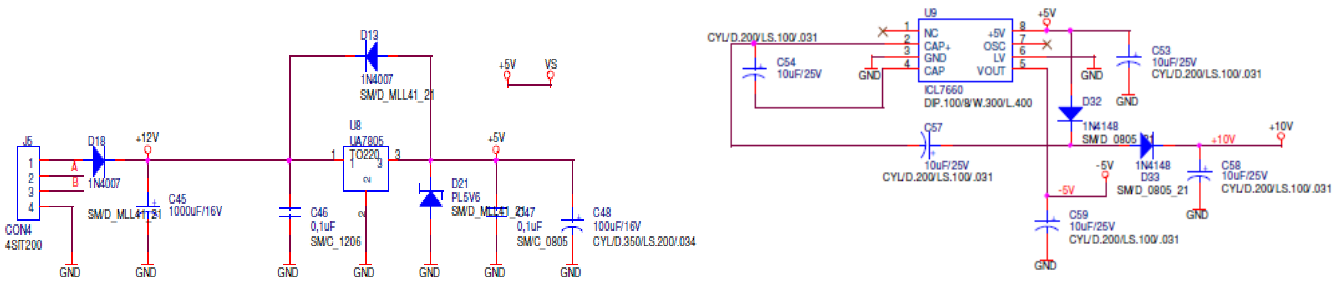

Fig.18 Power Block 12/5V and voltage generator -5,+9V

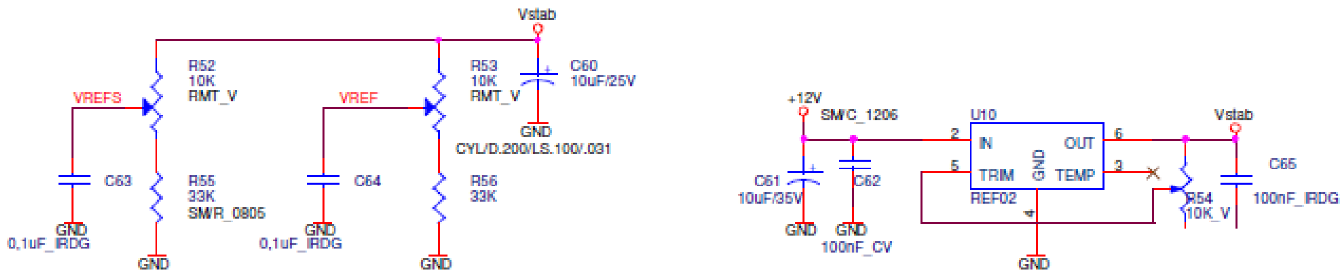

Fig.19 Block reference voltage adjustment and reference voltage for CAN

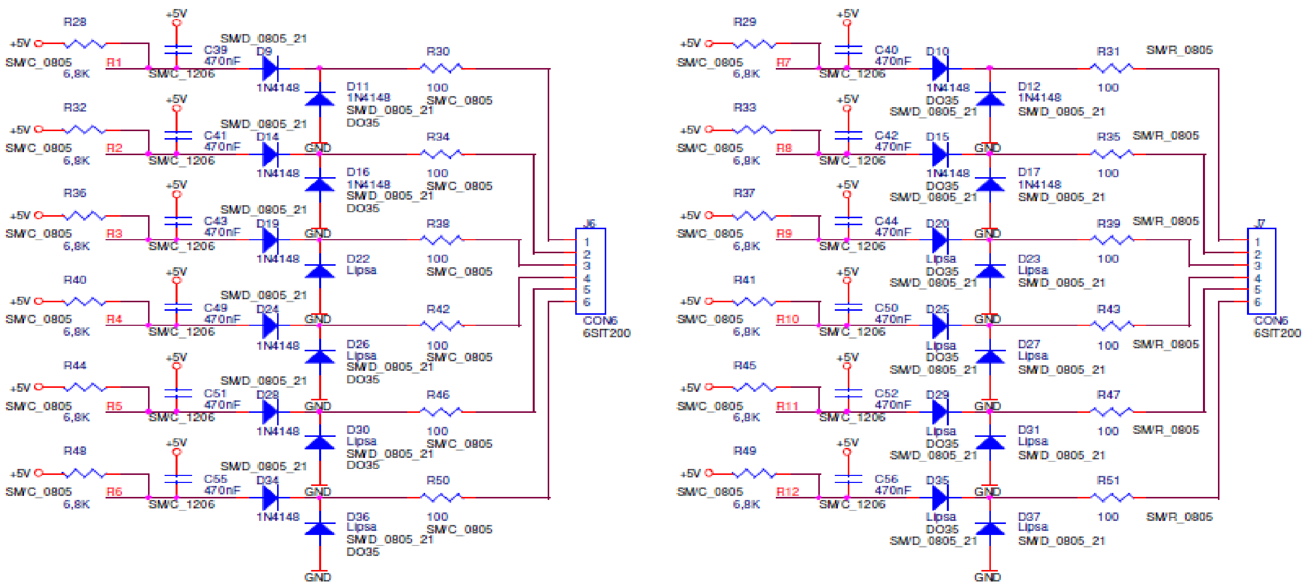

Fig.19 Rocket block

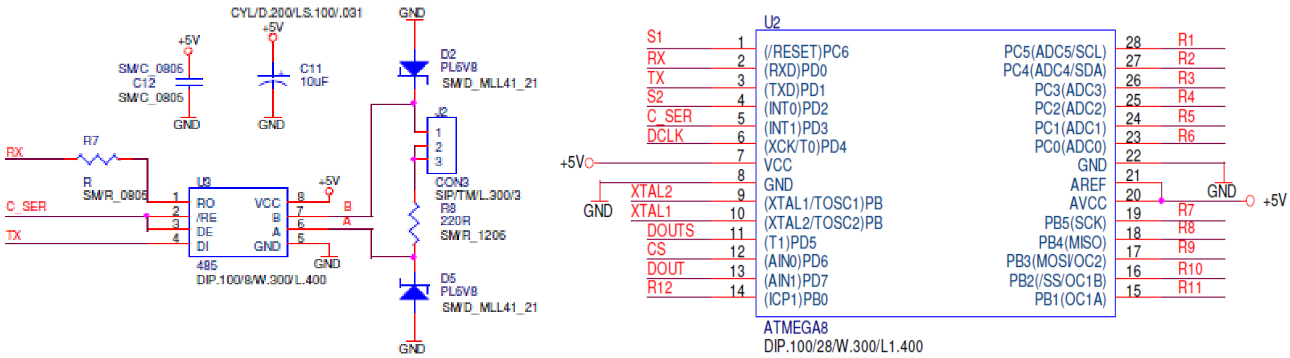

Fig.19 slave address selector and Atmega8 microcontroller

F. Software architecture of the decision support subsystem for launch

The main input sizes for this system are:

- the ramp launch number - for a secure identification by the operator
- the battery voltage – the checking the available of the energy supply system; due to prioritization system of the consumers it will always be ensured the minimum energy for positioning ramp and release heat [1].
- Confirmation of the presence hail clouds - an element of safety before launch
- Confirmation of the free air space - a safety element before launching
- Opening / Closing inside ramp - an element of security and protection of the launch ramp
- Positioning elements: azimuth and the elevation
- Number and position of presence the rocket on the ramp - thus ensuring control over the activity of launching and loading ramp
- The choice to missile for launching
- The altitude of explosion – for a higher efficiency of fighting against hail fall it is important the place of seeding in the cloud and this is achieved by positioning a ramp and by programming rocket altimeter.

The main output data will be represented by positioning the ramp, by firing order and by the daily-monthly shooting report. Interface shown in Figure 9 was made with the help of Visual Basic 6.

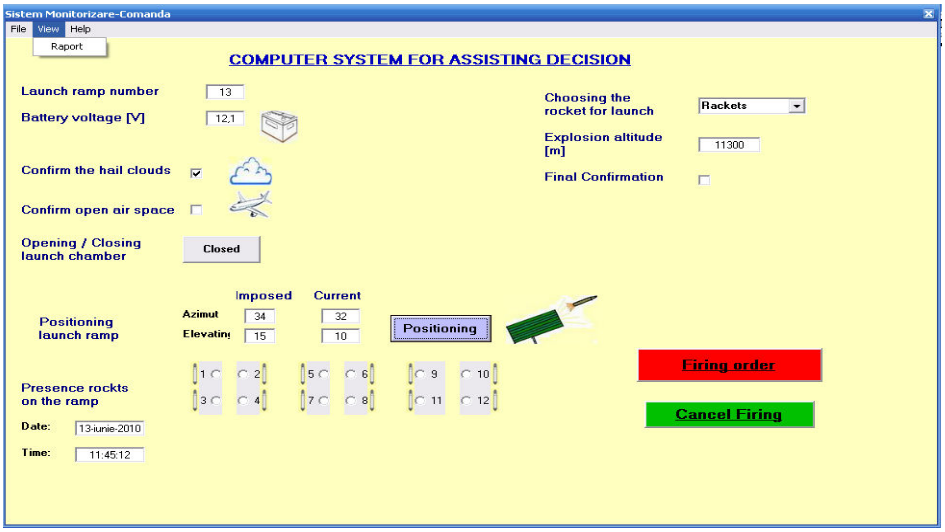

Fig.8 Computerized decision support system interface

At the central point are ensured:

- Centralization of data, storing them in databases or journals of values;
- friendly graphical interface that allows quick viewing of the status of items represented by standard symbols or suggestive drawn so that it can be easily identified by any operator and colored according to the state (normal or alarm);
- determining the state of alarm and reporting their location (symbols, colours, flashing), the bubble element associated text, sound alarms and table and display instructions for remedying the situation, if the problem solving requires the participation of the operator or of the intervention team and can't be solved the with control loops;
- reconfiguration by the operator or administrator of the control loop parameters, alarm thresholds, etc.

-management control system: activation / deactivation of the sensor or execution elements, archiving logs and reports, creating / deleting accounts operators, etc.

In the fig. 9 is presented the algorithm of the interface for the decision support subsystem for launch

The connection is initiated from the point of order and the transmission is automatic at the rate determined or when one of the parameters change, as follows: the number of the launch installation, the type of the launch installation, the azimuth, the elevation of the two groups, the presence of the rockets on the installation, the time of purchase data for each part of the launch installations.

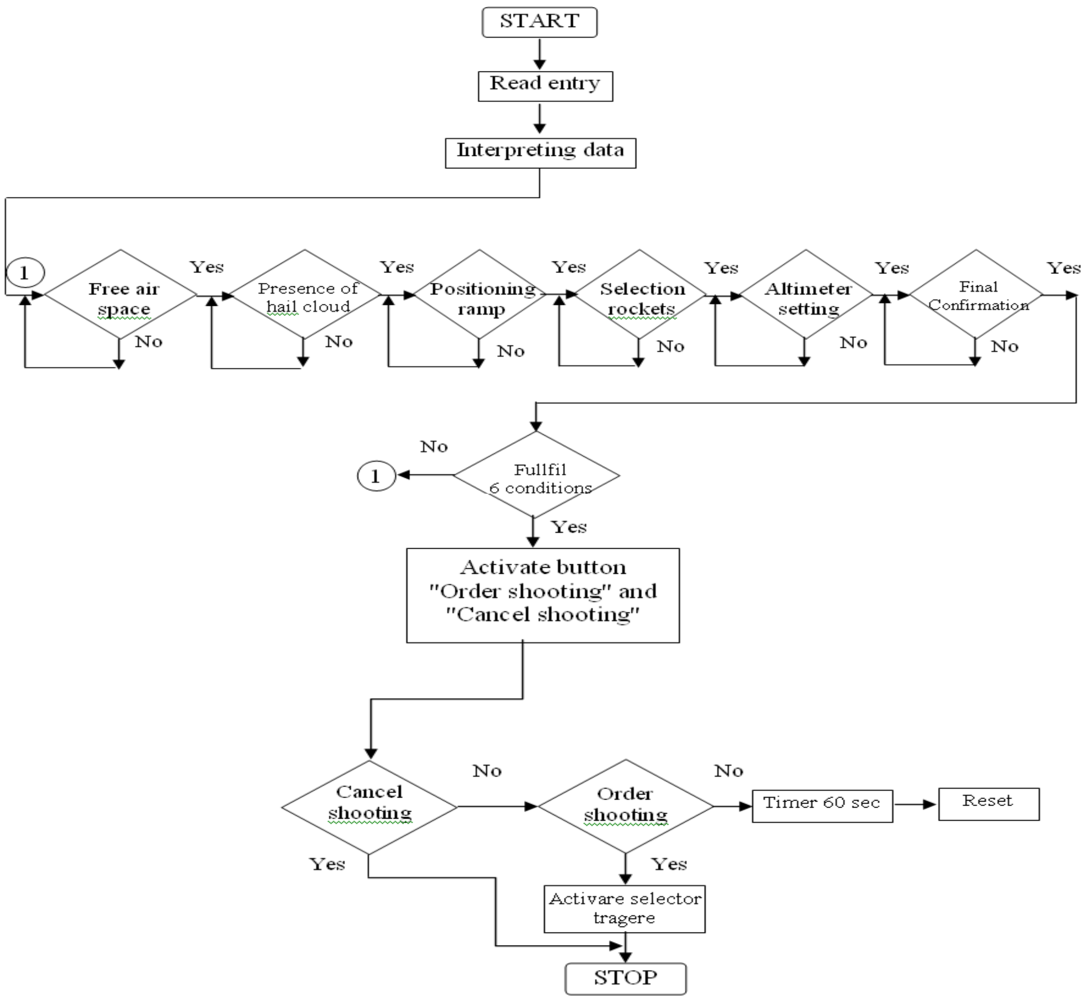

Fig.9 The main algorithm of the interface for the decision launch support subsystem

The equipment located at the point of order provides the following facilities:

- the possibility of selection the launch points for establishing the connection;
- ability to enable / closing the communication channel;
- console for sending specific commands;
- the possibility of automatic transmission of the launch coordinates with the help of an adjacent application;
- console for displaying the monitored data;
- console for voice communications;
- the possibility of recording data.

Equipment located at the point of launch provide the following facilities:

- Voice communications interface;
- Audible and visual signalling prealarma signal;
- Audible and visual signal alarm signal;
- Release data display, automatic transmission of monitored data.

V. Conclusion

The systems of risk management have begun to have an increasingly higher importance, mainly due to the devastation caused by climate change. Thus, the anti-hail systems have seen a great evolution in the late twentieth century.

The anti-hail systems with increased efficiency are based on the principle of seeding clouds both in the air and land. Due to the evolution of the radar systems and of the dedicated software, the cloud is no longer perceived as an object but as a physical-chemical process in which are important the exact areas of intervention in order to produce favourable changes.

The informatic system for the Romania anti-hail network comprises two main components: the subsystem for taking the decision of launch and decision support subsystem for launch.

In the realization of the system will be consider the use of communication via GPRS, is a cheap communication, monitoring the parameters throughout the all period of operating, log-values, status and alarms, operator actions journals, friendly graphical interface and the generation of tabular and graphical reports for any period.

Using a microcontroller system to monitor and manage the movement of energy from the photovoltaic system would increase the operating performance of the system, would provide more comfort for the staff and lead to the principal objective: energy for consumers in the zero category.

The information system for monitoring the units launch of anti-hail rockets will increased the network performance and efficiency by estimating both the entropy and the efficiency of information sources. The application of information system leads to an increasing efficiency by reducing the intervention time, a better organization, reducing operating and maintenance costs, degree of security.

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