Information System for Investigation Solar Activity

Danylo Ivantyshyn, Anatoliy Katrenko

Lviv Polytechnic National University, Lviv, Ukraine

Abstract. Presented the information system for accounting and analysis of solar activity data, which provides storage, arrangement and processing of data sets manifestations of solar activity and geophysical disturbances to study helio- and geophysical phenomena relations.

Keywords: information system, solar activity, solar-terrestrial connections, database.

1 Introduction

For now, one of the important areas of solar-terrestrial physics is the study of the geoeffective manifestations of solar activity. The key issue in such studies are the connections between events occurring on the Sun, their impact on the parameters of the solar wind, magnetosphere, ionosphere and near-Earth space [1-3].

Despite the fact, in general the pattern of the solar-terrestrial connections seems quite clear, far from all the links in the chain of these connections are equally studied. To solve these problems, researchers are faced with the processing of large amounts of data on the manifestations of solar activity and geophysical disturbances.

Among systems similar to the below described information system functionally one can mention the SID-monitoring space weather instruments of the Stanford Solar Center [4]. The Center has created tools that allow us to investigate the influence of the Sun on the Earth's ionosphere, showing solar flares and ionospheric disturbances, called sudden ionospheric disturbances (SIDs). Ionosphere strongly reacts to intense X-ray and ultraviolet radiation emitted by the Sun during solar flares. Using the receiver to track the signal strength from distant VLF-transmitters and noting changes when waves are reflected from the ionosphere. Stanford Center provides centralized data repository, which allows students to use experimental data for educational purposes (fig. 1).

However, today, such systems operate with limited functionality and data to analyse that determines the topicality of this information system. Its creation, in particular, will allow to automate the process of finding information about solar activity indexes according to a given time interval and on the basis of the obtained results to form new conclusions about the possible correlation of parameters of solar activity and geophysical perturbations.
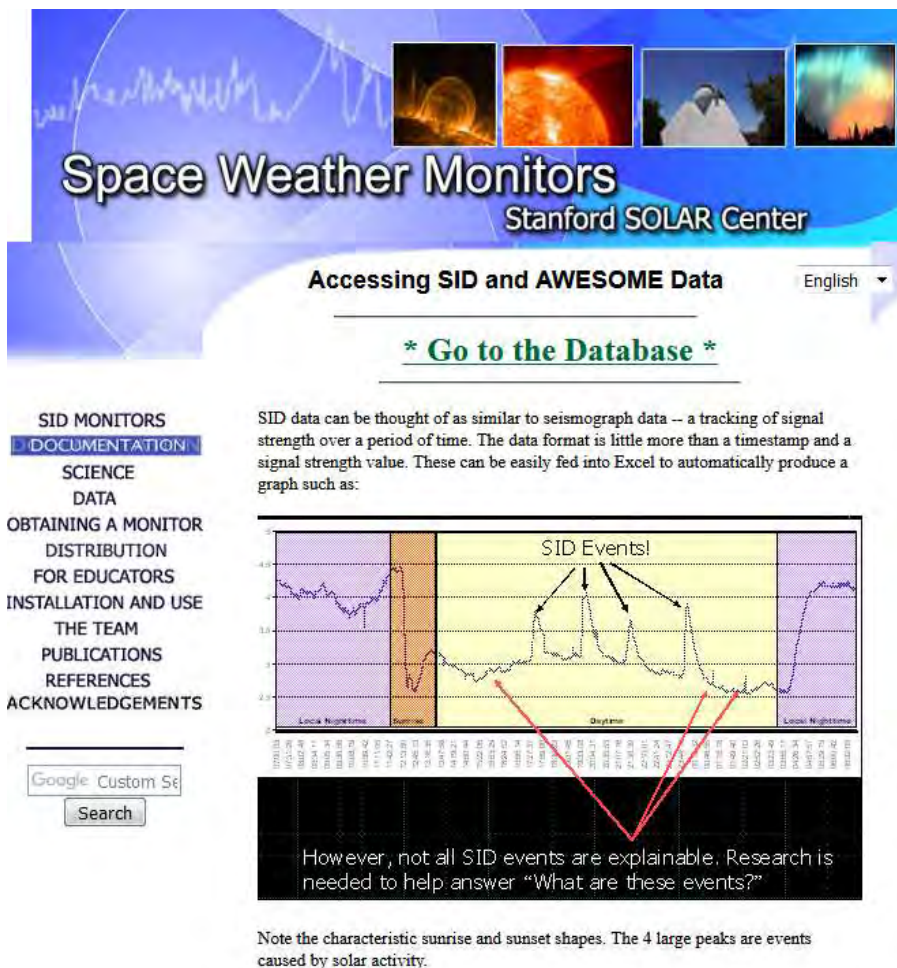
Fig. 1. Stanford Space Weather Monitors Screenshot

2   The Goal of the Work

The aim is to create an information system for accounting and analysis of indices of solar activity and geophysical disturbances to study helio- and geophysical phenomena relations.

3   Functional Model System

The functional information system model was designed using the methodology of DFD (data flow diagrams) [5, 6], including model of context (fig. 2) and decomposi-

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tion diagrams. External entities of the system are "Solar- and geophysical data" and the "User". Input data of the system are indices of solar activity and geophysical disturbances obtained from resources such as NOAA, SOHO, Solar Dynamics Observatory, WDC for Geomagnetism, and others and stored in a database, including:

- time dependence of solar wind density and velocity;
- angular width and velocity of coronal mass emissions (CME);
- time dependence of solar sporadic radio emission in decameter range;
- time dependence of magnitude of the interplanetary magnetic field;
- time dependence of proton flux;
- Dst and AE indexes of geomagnetic activity;
- time dependence of magnitude of the atmospheric infrasound;
- time dependence of magnitude of the atmospheric electric field.

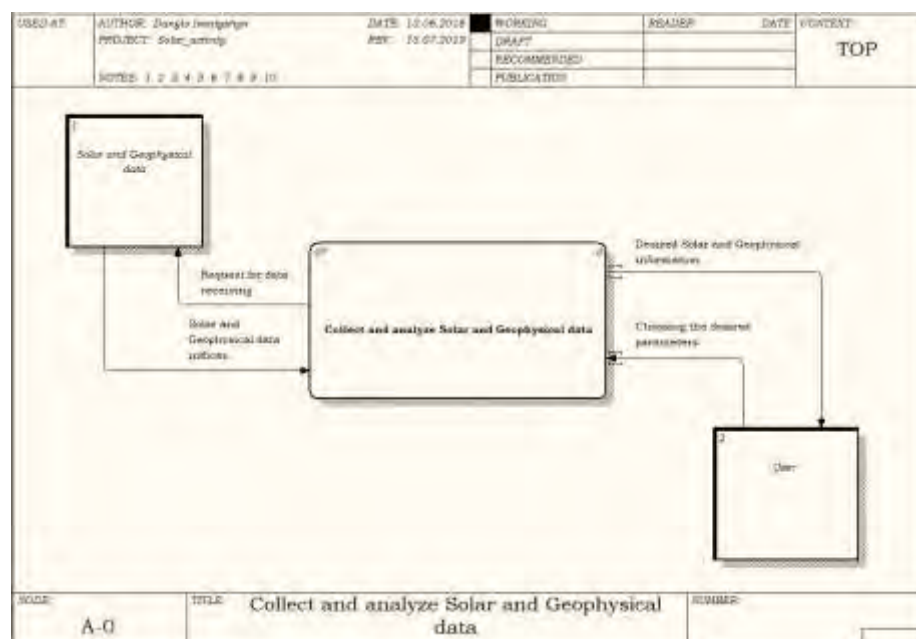The output data is the resulting data generated using queries.

Fig. 2. Context diagram of the information system for accounting and analysis of solar activity data

On the first level DFD showed the functions entrusted to the information system and data repository (Fig. 3).

The information system provides listed functionality:
- send request and receive data from a server;
- formatting and data analysis;
- database management;

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- obtaining information on the indices of solar activity and geophysical disturbances.
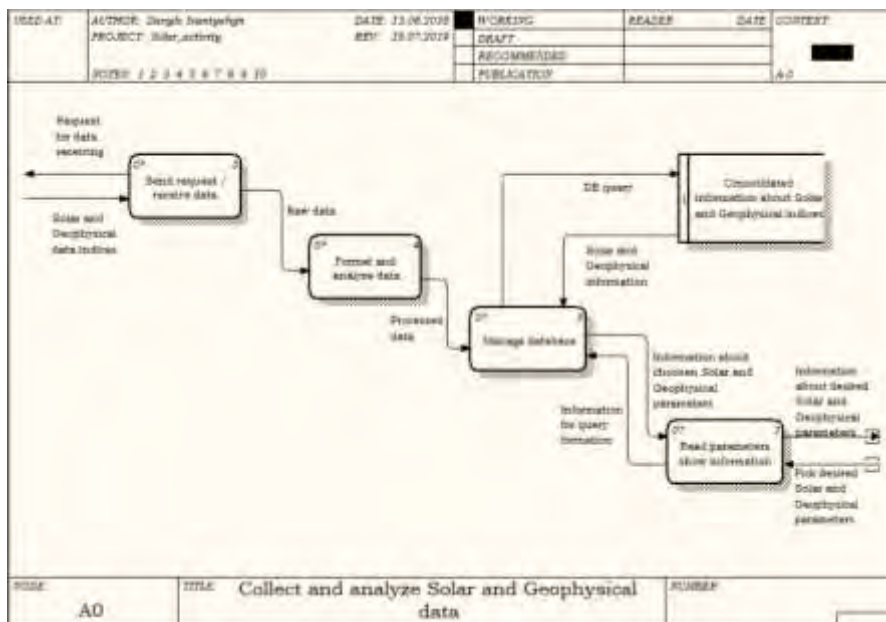

Fig. 3. The first level data flow diagram of the "accounting and analysis of solar activity" information system

4 Conceptual Model Database

A system analysis of the subject area allowed us to build a conceptual model of an information system database using ER-modeling [7]. The first stage of construction of ER diagrams is selection of the entities. ER diagram of subject area represent plurality of entities, attributes and relationships. ER diagram of the described information system shown in Fig. 4.

In this diagram separately outlined (red) three tables - they characterize indicators of near-Earth space:

- Earth's magnetic field - depends on interplanetary magnetic field and solar wind parameters;
- atmospheric electric field (AE) - depends on interplanetary magnetic field, coronal mass ejection and parameters of the solar wind;
- atmospheric infrasound (AI) - depends on interplanetary magnetic field, coronal mass ejection and parameters of the solar wind.

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As shown on the scheme – all entities have a common dependence on the table Date by which you can query data by date&time. Also easily to notice that all entities of nature are not characterize the state of near-Earth space contain a common dependence on the entity of Radio emission. Since all these parameters are indicators of solar emission, though in our system, we consider them as separate parameters influence the Earth's atmosphere.
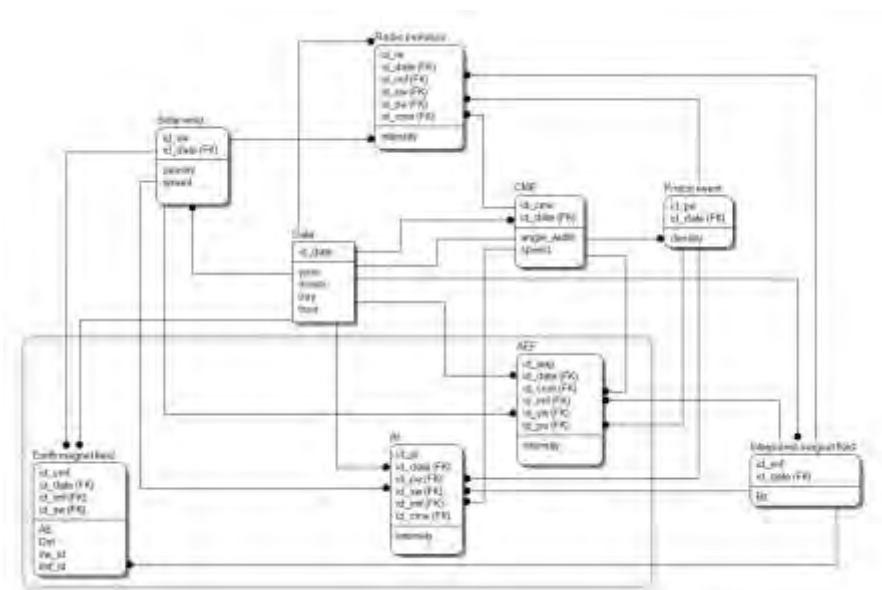

Fig. 4. ERD data model information system

Described information system automates the process of finding information on solar activity according to specific date&time and based on the results form new conclusions about the possible correlation parameters of solar activity and geophysical disturbances.

5   Conclusions

1. By analysis of the subject area of investigation solar-terrestrial relations, the main indices of solar activity and geophysical disturbances were choosen. Overview of similar systems that operate nowadays showed that such systems operate with limited functionality and data to analyse that determines the topicality of this information system

2. A functional model of the information system with the use of DFD methodology has been developed, which made it possible to determine its main functions.

3. Designed conceptual model of the database of the information system, reflecting the main entities and the relationship between them.

4. The developed information system allows to carry out research on helio- and geophysical phenomena relations.

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