# THE “SPALAKH” ASTRONOMICAL TELEVISION SYSTEM

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The description of the new astronomical television system “Spalakh” is cited. The system is intended for fast phenomena observations with exact link to time scale. The results of laboratory and actual tests of the system are given.

## INTRODUCTION

Occultations of celestial objects are the most ancient phenomena, observable from the Earth. Owing to simplicity these observations are the most popular and regular – almost 400 years these observations are being already carried out in 30 countries of the world. It is annually registered about 10 thousand of phenomena. Interest to occultations does not die away. The ranges of the problems that can solve with the help of a occultation method extend with development of new observation technologies. At the Astronomical Observatory of the Kyiv National University the observations of star occultations are being performed during 80 years. The new television complex “Spalakh” which allows obtaining the exact moments of occultation was created for such observations at the end of 2003. The television complex increases a range of registered star magnitude, and may be used both in stationary, and in expeditionary variant. Accumulation of precise observations of the television complex, deprived of own observer errors, will allow to derive more exact information about the features of the Moon and other Solar System bodies motion.

## STRUCTURE OF THE SYSTEM

The “Spalakh” television system is constructed from standard units, which are serially manufactured by the industry. The main criteria for a choice of components of the system were simplicity and an overall performance of a complex. The block diagram of the television system is shown in Fig. 1.

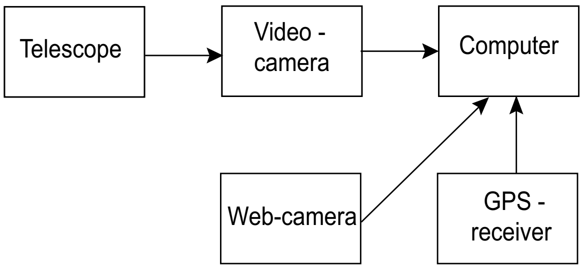


Figure 1. Structure of the “Spalakh” television system

The system is consists of optical system, a videocamera, the computer with the frame grabber and connected with the Internet (for stationary variant), the GPS-receiver. Telescope or telephoto lens may be used as optical system. It is desirable to use mirror telescopes as the videocamera has high sensitivity to red and infrared regions of a spectrum where lens optics have a significant chromatic aberration. The basic receiver in a complex is sensitive CCD TV camera SANYO VCB-3574IRP (Fig. 2).

Characteristics of the TV camera:
– spectral class IR,
– 625 television lines,
– 25 frames per second,
– effective pixels quantity is 752×582.

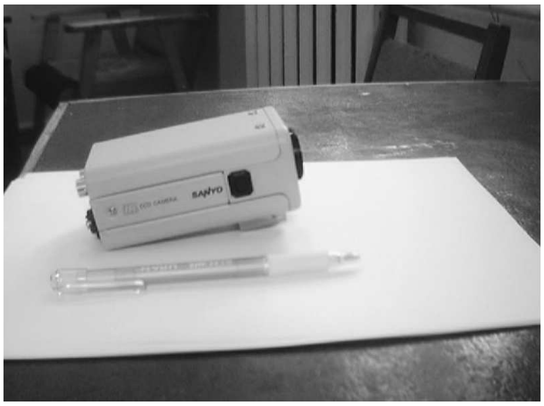


Figure 2. Main photosensitive component – CCD TV camera SANYO VCB-3574IRP

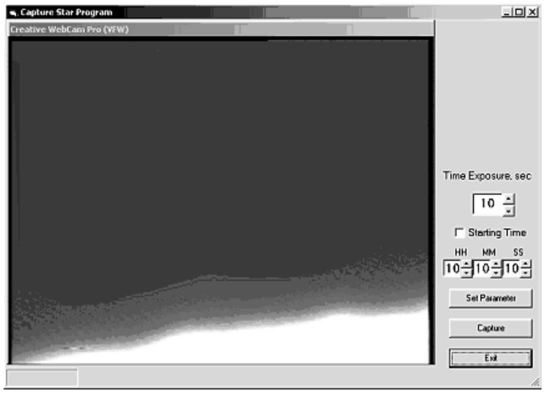


Figure 3. The screenshot of the VideoCap program with image of polar region of the Moon

Criteria of CCD camera choice were the maximal sensitivity and quality of the image. The maximum object magnitude which may be registered in a television mode equals to $12^m$ for the Repsold refractor ($D = 20$ cm) [1]. The videocamera gives out a complex signal in the television standard. The digital method of recording is used for registration. ASUS VideoSuite videocard with a videoinput is used for capture of video signal. The WebCam Pro Web-camera may be used as an additional videocamera for the technological purposes and for registration of bright objects. Web-camera is connected with the computer through USB-port. The software allows carrying out observation with any of the specified sources of the videoinformation. It is possible to choose resolution for recording frames 640×480 and 320×240 pixels. Computer Time System may link to UTC using the program AboutTime 4.8 synchronization [2] under SNTP protocol through the Internet. Such synchronization is carried out each minute. It is necessary to use the special software for maintenance of its specialized opportunities as the television system is constructed from standard components. The original software is used in the "Spalakh" system. It consists of such programs:

**1. VideoCap** is a program for observation using the television system (Fig. 3).

- It is able to work with any source of the television signal.
- It allows videosignal saving in standard AVI-format without compression that gives an opportunity to save information without distortion.
- It allows time system saving for each frame in registration protocol.
- It allows automatic start of the program carrying out for registration on the preestablished moment of time or manual by operator command.

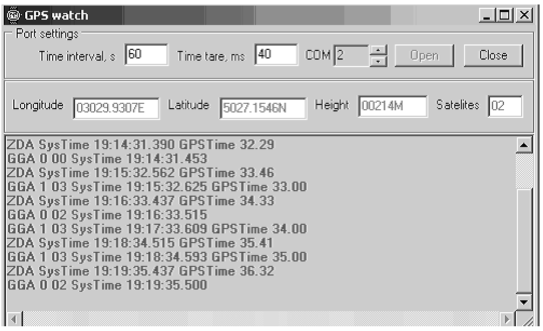


Figure 4. The screenshot of the GPSwatch program with a real time protocol

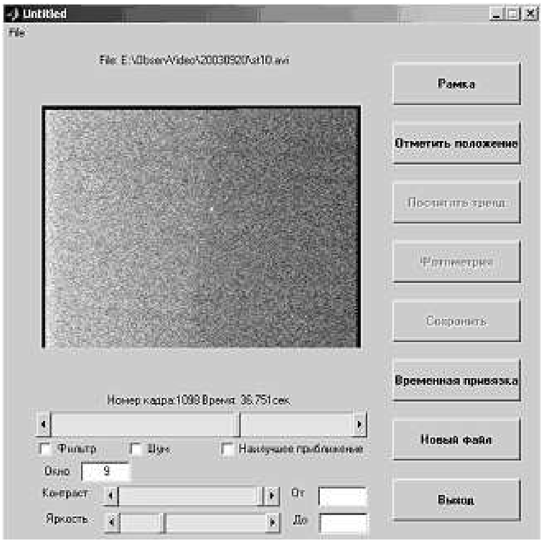


Figure 5. The screenshot of the OccultDark program for TV observations with the "Spalakh" system of processing

**2. GPSwatch** is a program for determination of time system using GPS-receiver (Fig. 4).

- It makes correction of computer time system at the beginning of observation set.
- It writes computer time system tares to the protocol using the GPS-receiver signals.
- It allows obtaining the observation place coordinates using the signals of GPS-receiver. This opportunity is used for observations in expedition.

**3. OccultDark** is a program for observation processing (Fig. 5).

- It allows each frame of videorecord examining.
- It allows taking into account a possible motion of star, which is the consequence of the clockwork errors.
- It allows obtaining the photometric curve of occultation.
- It allows determining the time of spasmodic changing of object brightness depending on strong fluctuations using the photometric curve by three methods: median filtration, noise level and best approximation.

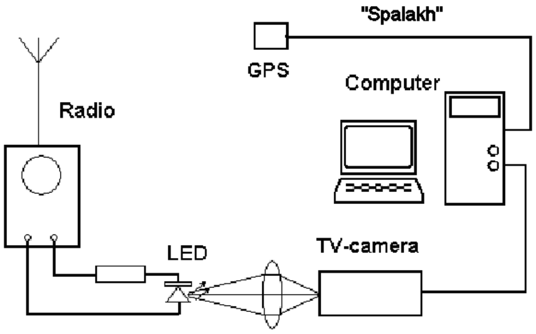


Figure 6. Laboratory scheme of the system time accuracy test

## LABORATORY INVESTIGATIONS OF THE TIME REGISTRATION ACCURACY

Laboratory investigations of a television system were carried out for testing of reception accuracy of the time link. Videoimage of the light-emitting diode was recorded for this purpose using the television camera and standard way time fixing. Exact times signals of radio station RVM was feed on the light-emitting diode from a radio receiver (Fig. 6).

The moments of light-emitting diode flashes according to the television system $t_k$ were compared with a known time of arrival of exact times radio signals $t_r$ [3]. In result we have received values of the time difference $\Delta t = t_k - t_r = 7 \pm 10$ ms. The systematic part of this difference is caused by displacement in time of two independent sequences – frames in video signal and exact time signals. This part should not exceed 40 ms duration of one frame in case of stable work of system. The results of laboratory measurements have been shown this. The given $\pm 10$ ms error for the time amendment shows the maximal deviation from average value for one frame. It characterizes instability of time link, which is connected with work features of hardware and program components of the television system. During real observations this error will be less due to the instability of a method of time link system and instability of passage of exact time signals, fluctuations of radio signals amplitude, atmospherics, *etc.*, which take place for laboratory researches, will be added.

Thus, researches have shown that the random error of link of the frame end to UTC equals to 10 ms. General accuracy of time system of the "Spalakh" television system which includes 40 ms transfer duration of one frame equals to 50 ms.

## CONCLUSIONS

The simple and effective television system for occultations observations with an accurate time scale, which may be used in stationary conditions and on expeditions, was created.

Sensitivity of television system allows working with objects up to $12^m$. The time registration accuracy of the phenomena with television system is equal to 50 ms.


[1] *Kleshchonok V. V., Buromsky M. I.* First results of observations with astronomical television complex "Spalakh" for fast processes registrations // Visnyk of Kyiv Univ.–2004.–**42**.

[2] [`http://www.arachnoid.com/abouttime/index.html`].

[3] Universal Time and Polar Coordinates.–Moscow: Time Service Commission, 2002.–Bull. E.–**109**.–20 p. (in Russian).