Metrological maintenance of geodetic measuring apparatuses

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Abstract

Now in metrological maintenance of geodetic measuring apparatuses it is necessary to allocate a problem of working out and researches of new methods and means of checking and calibration of modern optic-electronic and digital devices. It for the reason that the methodology of checkings and calibrations of geodetic devices is regulated by a number of the standards establishing the basic metrological characteristics, thus specified documentation is calculated, basically, on optical devices. Testing schemes of optic-electronic (digital) devices are not developed enough. In the present work the description of the modernized stand and the software of the modern optic-electronic geodetic measuring apparatuses intended for checking is resulted.

Keywords: Metrology maintenance, geodetic devices, optic-electronic and digital devices, checking and calibration

1. Introduction

Now in the field of geodetic measurements transition from optical measurement methods to optic-electronic is observed. Thus development and perfection of the goniometric instruments, increasing requirements to their accuracy and reliability, and also automation of process of measurements with their help lead to necessity of creation of new methods and control devices of metrological characteristics of such instruments. All it demands rise of accuracy of their checking and calibration that is at present the actual task [1].

At many firms the considerable attention is given to lab our productivity rise at checking of measuring apparatuses. Step-by-step transition from usage of the big set of exemplary measuring apparatuses and hand-held filling of the protocol of checking, the certificate on checking to one-two exemplary measuring apparatuses, substituting by itself all big set applied at a traditional way is observed. It became possible thanks to the microprocessor engineering applied in modern measures. In these instruments there is a link with the personal computer that does possible automatic creation of the protocol of checking and архивирования results of checking. Thus, development of such methods and resources of calibration and checking of optic-electronic instruments which allow to reveal and consider operatively errors of standard measuring apparatuses is necessary, thus it is necessary to pay attention to stability of mutual position of the main knots and a carrying construction, and also simplification of a construction of all bench equipment. Therefore, tasks of creation of the universal bench equipment for metrological researches of modern goniometric instruments, time reduction, and simplification of procedure of revealing of a systematic error of system and its registration are at present actual. However checking process on the majority of instruments is not automated, or automated only partially that leads to small productivity and demands high qualification of staff working with it. The operation purpose is creation of the stand intended for checking of a goniometric part total station, and also checking and preliminary adjustments of location of a laser radiator the block electronic total station.
2. **Choice of analogue and stand modernisation**

The stand should allow to make checking of a goniometric part of the instrument, to define deviation of radiation of the laser diode from the set direction, in real-time mode and to receive a quantitative estimation (in the form of deviation of co-ordinates on two axes). Also the stand should be equipped by system of visualization of process of definition of deviation of radiation of the laser diode from the set direction, in real-time mode on the basis of the computer, controlled widespread at present time MS Windows operating system.

The analysis of clones of the considered stand has been made. The analysis was made on the basis of the patent documentation and passports collimation domestic production stands. At a stage of definition of accuracy of an intersection визирных axes collimation pipes in one point checking process on “БЮ-161” and stands similar to it is not automated and inspected operator that demands high qualification of the employee. As clone stand “ГКС-1” has been selected.

Automation and process visualization at the checking stage, provided by the developed stand, should raise accuracy of preliminary adjustment as a whole and lower possible expenses for training of staff working with the stand.

The upgraded stand represents the following construction (Fig. 1.). On a rod with a carving installed in the lower (vertical) hole of an arm the support for calibrated тахеометров is fixed. After a centering the upper plate is fixed by means of lock screws. The rod with a support can vertically move on height by means of a rod nut, over an arm. The immovability of a rod with a support after moving on height is provided with a tightening counter nut allocated in the rod bottom, under an arm. The lighting diode (1) allocated in a rubber nozzle, providing its universal mount to an eyepiece of the calibrated instrument, is connected to a power supply unit (2). On a support (3) the calibrated instrument (4) is installed. To collimation to a pipe (5) the camera (7) by means of the mount (6) is added. The received stand has an opportunity to transmit a signal from the camera to system of processing of a signal that provides the simplified preliminary adjustment the block of distance measuring. Also possibility of checking of the angular characteristics, initially present in “ГКС-1” is completely saved [1].

![Fig. 1. The upgraded stand.](image-url)
3. Working and the description of video system

Video system used for capture and processing of the map consists of a video camera and the card of a video capture installed in the PC. For video systems the camera of production of company BOSCH of series LTC 0510 has been selected. It is a compact black-and-white digital video camera with matrix CCD of a format of 1/2 inches.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage</td>
<td>~230 V, 50 Гц</td>
</tr>
<tr>
<td>Voltage range</td>
<td>~85–265 V, 45–65 Гц</td>
</tr>
<tr>
<td>Power consumption</td>
<td>4 W</td>
</tr>
<tr>
<td>Matrix</td>
<td>CCD, format of the map of 1/2 inches</td>
</tr>
<tr>
<td>Quantity active pixel</td>
<td>752 X 582</td>
</tr>
<tr>
<td>Video output</td>
<td>1,0 V, 75 Ohm</td>
</tr>
</tbody>
</table>

For a signal transmission the camera uses a standard video cable. Therefore, for reception of a signal from the camera, the PC entering into system of definition of deviation of radiation, should possess resources for reception and processing of the given signal.

For solution it is tasks the card of video capture EZCapture V1A3, company AVerMedia productions, possessing all necessary characteristics has been selected [2].

For monitoring system creation behind a ray direction possibilities of modern computer systems of processing of video signal have been studied. Having taken for a basis a video camera with the permission sufficient to provide accuracy of measurements and having included it in the optical circuit probably to obtain the data about a direction of radiation of the diode.

The map received by the camera, allows to receive the information on ray deviation, and represents in the conditions of the stand a plane with a strongly pronounced stain in a ray entry point. In the conditions of the stand, having set a local frame of reference and having calculated co-ordinates of centre of this stain, probably to define and relative deviation of a power axis. In this case the extremum of intensity of radiation, i.e. the brightest point of the map.

One received by the camera of the main characteristics of the map becomes a required point, allowing to state its statistical estimation, the histogram of brightness representing graphics mapping of function, where – number of pixels of brightness is. The form of the histogram and its range often allow to give quality standard of the map and possibility to carry it to one of known classes [2]:
- the bimodal histogram is characteristic for maps with well distinguishable fragments, for example, block letters on page of the text or contrast objects on a homogeneous background;
- the unimodular histogram often corresponds to maps with fuzzy fragments, for example, large расфокусированные objects against with fine details of various brightness;
- the uniform histogram can be observed for maps with a considerable quantity of small fragments of various brightness. Having considered features of a construction and the underlying hardware characteristic it is clear that the map received by the program from a card of a video capture, has a strongly pronounced extremum of brightness – centre of a stain of the laser diode. Also owing to working conditions of a construction the search task is not complicated by presence of strong interferences or distortions on the map that does not
superimpose are additional requirements on map filtering. Thus, the task of definition of centre of a stain is reduced to two stages:

1. differentiation:

\[ B(i) = B(i) - B(i-1), \]  

where \( B(i) \) – brightness of a point;

2. search of local extremum

In an application window in appropriate fields the found co-ordinates of a point are displayed and there is a record of co-ordinates to instructions of time of measurement in a broad gull-file in a program directory.

In a parallel way with point search in real-time mode there is an output of the video map to plotting on it of a grid chart of a local co-ordinate system in appropriate pane of the program. At detection of co-ordinates of a required point the square of the grid chart containing it, changes the color (Fig. 2).

![Fig. 2. Appearance of a working window of the program.](image)

For definition of co-ordinates of a point with the greatest brightness the special program written in language C # by means of resources of an application creation of a package of Microsoft Visual Studio 2008 has been created. The End result is the program with a graphic interface of the user (GUI), containing in one or several files. Process of operation of the program is reduced to search of co-ordinates of a point, their output to the screen, result record in a text broad gull-file, with instructions of time for each measurement, and output to the screen of the map received from the camera. On the map, for simplification of processing of results the grid chart is superimposed. The square, in which the required point is allocated, is selected with color.

Table 2. Objects of an application window.

<table>
<thead>
<tr>
<th>Type of the object</th>
<th>The object name</th>
<th>The remark</th>
</tr>
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</table>
| Start button       | btnGo           | By button pressing there is a start of following processes: 
|                    |                 | - capture of the map from the camera 
|                    |                 | - map translation in a data array 
|                    |                 | - is set a local co-ordinate system 
|                    |                 | - there is a search of co-ordinates of a point 
|                    |                 | - the map is displayed with the grid chart put on it 
|                    |                 | - there is a record of co-ordinates in a broad gull-file |
| The stop button    | btnStop         | By pressing stops the processes started by pressing btnGO |
The main knots of a construction are interchangeable that is one of stand pluses. The knots which are responsible for transmission of the video map and its processing, can be substituted on any similar under characteristics as the standardized interfaces of connection of instruments are used. The stand construction is technological enough productions on the serial instrument-making equipment as inherits many parts from “ГКС-1”. The received stand works in the complex with a processing system on the basis of the computer, under control of operating systems of a class of Windows NT. The Software used by system, has functions necessary for given system, namely:

• fast both convenient output and the information control;
• the Simple and evident interface;
• low system requirements.

Also the software is characterized by high portability within the limits of OS of Windows and usage of standard functions of capture and map processing that does not create obstacles for replacement of components of the stand.

4. Conclusion

Thus, the construction of the stand presented in given operation, allows to automate checking procedure дальномерной parts тахеометра. It is necessary to mark that the given stand from video – system, is universal how at addition with the specialized software for various types of measuring apparatuses, can be used for checking of optical and digital levels, optical and electronic theodolites. The software on processing of results of measurements will allow to reduce essentially time of data processing of measurements and creation of the protocol of checking.

References