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DETERMINATION OF ASTRONOMIC AZIMUTH USING ELECTRONIC THEODOLITE

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Abstract. The method of determination of astronomic azimuth using electronic theodolite Wild T3000, is explained in this paper. Software AZIMUTH for transfer of measurement data from instrument to computer is described. The first experimental results of proposed measurement method are presented.

1. INTRODUCTION

In practice, for some engineering purposes, it is important to provide astronomic azimuth in the field. Usually, it is necessary to provide accuracy better than $\sigma_A = 0.5''$. Also, complete measuring technology should fulfil following requirements:

- measuring procedure must be short (no more than few hours),
- measuring equipment must be portable and robust,
- measuring procedure must be as simple as it is possible,
- processing of measurement data should be on site.

Nowadays, for automatization of azimuth determination in the field, the most suitable solution are portable electronic theodolites. Those instruments have built in electronic compensators and have possibility for automatic transfer of angle readings directly to personal computers over RS232 interface.

For this instrumental solution, it was interesting to find the proper method of astronomical azimuth determination. On Institute of geodesy Civil Engineering faculty Belgrade on disposal was electronic theodolite Wild T3000.

For determination of instrumental constants, and error budget the instrument was tested in laboratory for metrology. Later, instrument was investigated on terrain by method of azimuth determination using Polaris.

For this measurement procedure, on Institute of geodesy, special software "AZIMUTH" for data collection was provided. This paper presents first experimental results.

2. METHOD OF AZIMUTH DETERMINATION

For azimuth of terrestrial direction, the indirect method by observation of Polaris in different hour angle was performed. Fig 2. presents the principle of azimuth determination using Polaris.

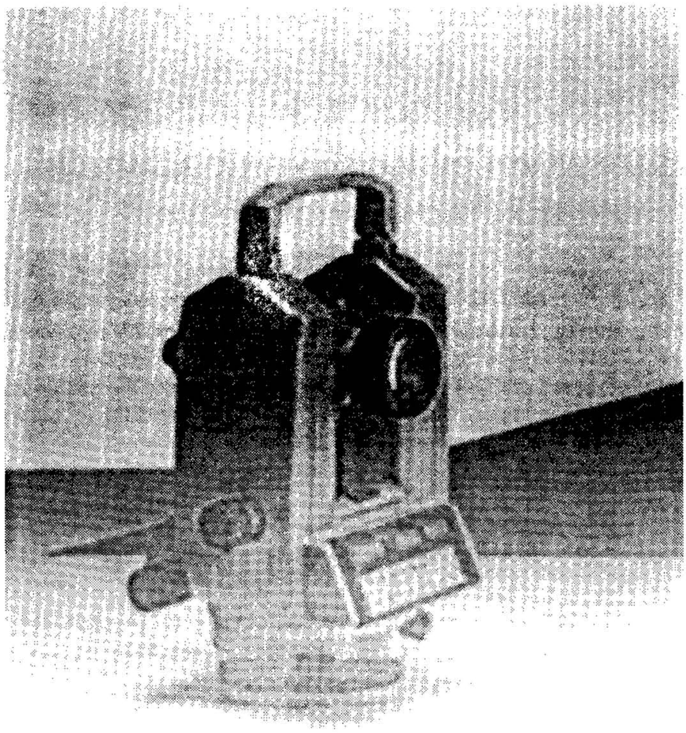

Fig. 1. Electronic Theodolite Wild T3000.

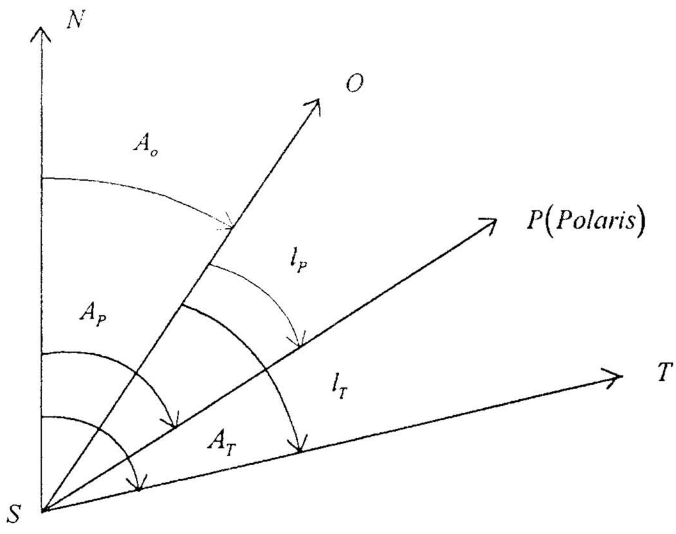

Fig. 2. Principle of azimuth determination using Polaris.

where:
A_0 – azimuth of zero of horizontal circle
A_P – azimuth of Polaris
A_T – azimuth of terrestrial point
S – observation station
l_P – reading of horizontal circle for direction to Polaris
l_T – reading of horizontal circle for direction to terrestrial point.

For each observation to Polaris the azimuth of zero of horizontal circle can be derived as:

$$A_{0_i} = A_{p_i} - \overline{l_{p_i}}$$

Reading of horizontal circle for direction towards Polaris should be reduced for influence of slope of telescope rotation axes

$$\overline{l_{p_i}} + i\,\mathrm{ctg}\,z$$

where:
i – slope of telescope rotation axes
z – zenith distance of Polaris.

reading of horizontal circle	telescope position		
l_T	I	first girus	double girus
l_P	I		
l_P	II		
l_T	II		
l_T	II	second girus	
l_P	II		
l_P	I		
l_T	I		

Fig. 3. Double girus scheme.

For elimination of systematic errors, the double girus procedure is used (Fig. 3). For each position of telescope, the average value of azimuth of zero of horizontal circle can be derived as:

$$(A_0)_I = \frac{\sum(A_{0_i})_I}{n_I} \quad ; \quad (A_0)_{II} = \frac{\sum(A_{0_i})_{II}}{n_{II}}$$

where n_I, n_{II} – number of observations to Polaris in first and second position. Then:

$$\overline{A_0} = \frac{(A_0)_I + (A_0)_{II}}{2}$$

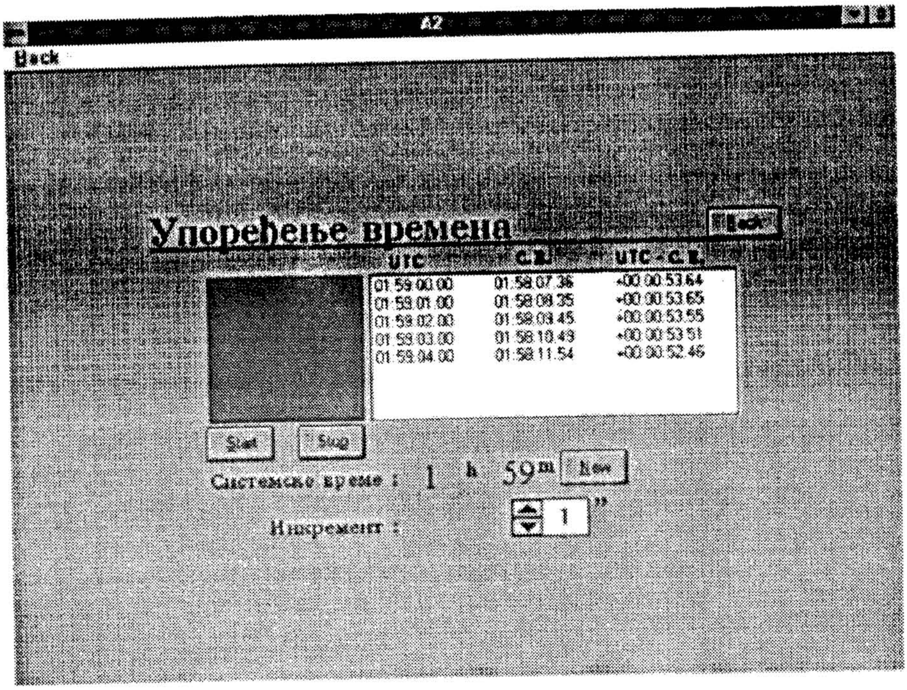

Fig. 4. Time registration mask.

Azimuth of terrestrial point can be derived for each observation to terrestrial point.

$$A_{T_i} = \overline{A_0} + l_{T_i}$$

For each telescope position, the average value can be derived as:

$$(A_T)_I = \frac{(\sum A_{T_i})_I}{n_I} \quad ; \quad (A_T)_{II} = \frac{(\sum A_{T_i})_{II}}{n_{II}}$$

where: n_I, n_{II} – number of observations to terrestrial point in first and second telescope position average value of terrestrial azimuth is:

3. AZIMUTH – SOFTWARE FOR DATA ACQUISITION

For automatization of above explained procedure, the software "AZIMUTH" was provided. This software was evaluated under the Windows operating system using the Visual Basic compiler.

Software supports all measurement phases:

- storing of descriptive and information data (name of stations, observer, instrument type, etc.)
- time registration (Fig 4.)
- telescope direction collection using electronic circle readings (Fig 5.)
- control of measurement data during the observation.

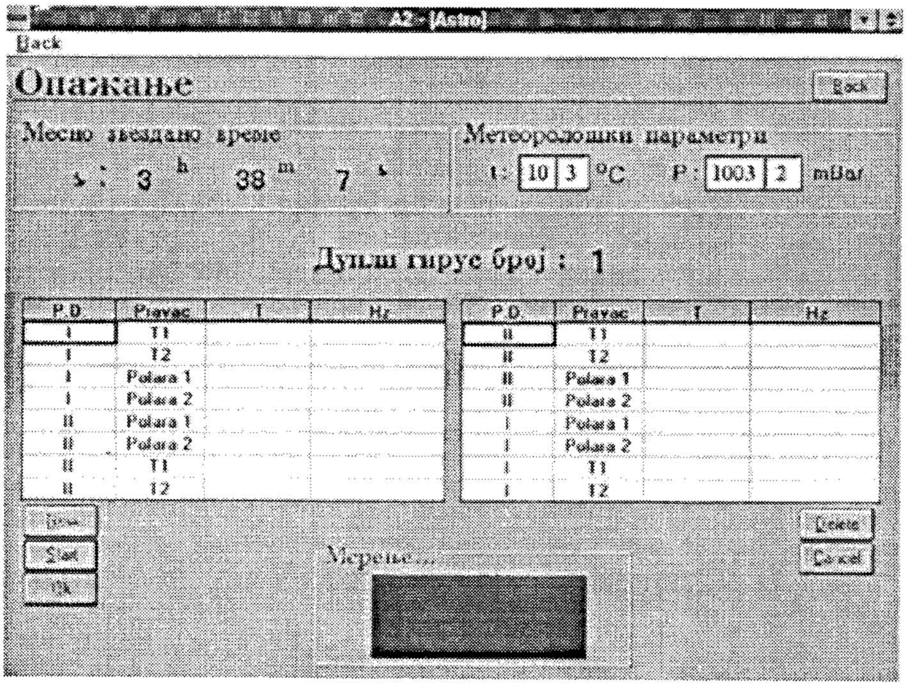

Fig. 5. Electronic circle readings collection.

4. FIRST EXPERIMENTAL RESULTS

The first experiment was made in summer of 1996. on test polygon "ZLATIBOR".

Instrumentarium consists of :

- electronic theodolite wild T3000
- PC computer Notebook TOSHIBA
- PHILIPS radio
- Wild reflector for night observation.

The azimuth of five terrestrial directions in test net "ZLATIBOR" were determined Fig 6. Distance between the points are from 1km to 3km.

Azimuths were determined using the double girus procedure. For each azimuth four double giruses were performed in two separate nights. The standards of azimuths which were derived from dispersion from average values are at the level of 0.5" and night errors have not been detected.

5. CONCLUSIONS

From first experimental results we can definitely say that this instrumental solution can achieve acquired accuracy for all necessary technical and scientific purpose. The time for field work and computation was mush reduced (two hours one enough for one azimuth determination). Operator can be concentrated to observation, data acquisition is automated and there is no errors in circle readings.

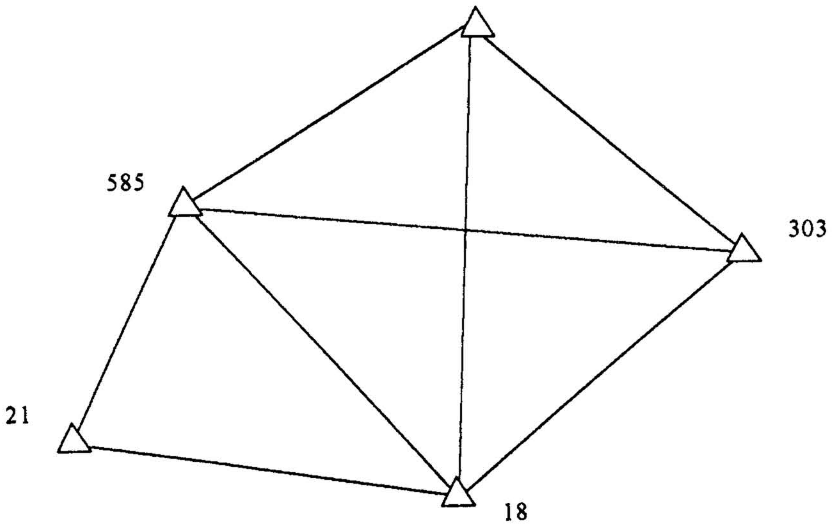

Fig. 6. Test net "ZLATIBOR".

In future, for field work, the biggest problem will be anomalies in refraction. In order to prevent this error source the investigation has to be performed in order to provide solution for fast refraction anomalies detection. Also it is necessary to take this fact in consideration during the project design process.

References

Milovanović, V.: 1988, Odredjivanje astronomskog azimuta, Skripta GF Beograd.
Wild 3000 User Manual (1990), Wild Heerbrug.