APPLICATION OF CCTV IN GEODESIC MONITORING OF DISPLACEMENTS

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1. INTRODUCTION

Close-circuit television systems and equipment (CCTV) are applied in various areas of technology and industry, e.g. to observe and diagnose sewage system damages [Wojciechowski 2003], [Zwierzchowska 2004]. There are also applications in the systems of controlling boring direction of TBMs and trench less technologies. They perform there the function of displaying the control target with a laser spot, determining the direction of tunnel or boring operation. A picture from a TV camera is shown on a monitor in the operator cab.
In the presented paper, the authors describe other application of CCTV – in displacements metrological measurements of two (or more) points in any object in relation to each other.

2. DISPLACEMENT MONITORING SYSTEMS BASED ON CCTV

The basic function of a TV camera in displacement measurement systems developed by the authors is to transmit the status pictures of analogue displacement sensors of various types. One can construct various TV measurement systems whose configuration and operation depend on:

- **type, number and location of measurement sensor assembling,**
- **TV camera types (wired, wireless),**
- **method of transmitting the pictures from TV cameras to recorders or computers,**
- **methods of performing the read-out of measurement sensors (continuous recording, motion detection, recording in specific time periods).**

Photographs 1-3 show pictures from TV cameras for various sensor types used by the authors in their systems. These sensors were connected to drive elements that changed their status as result of displacements; this status was defined by readout values. Differences in values of sensor readouts in consecutive time periods reflect the displacement values in these periods.

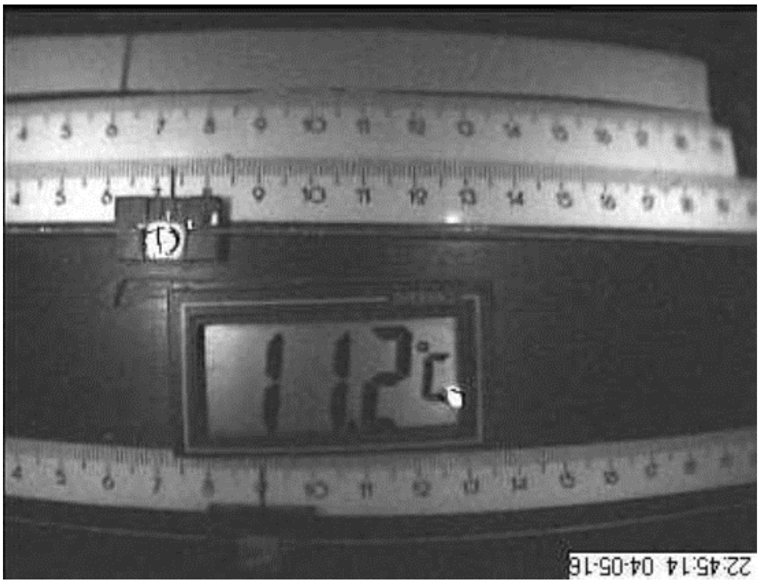

Photo 1. Recorded measurement sensors picture
(scales + indicators and a digital thermometer).

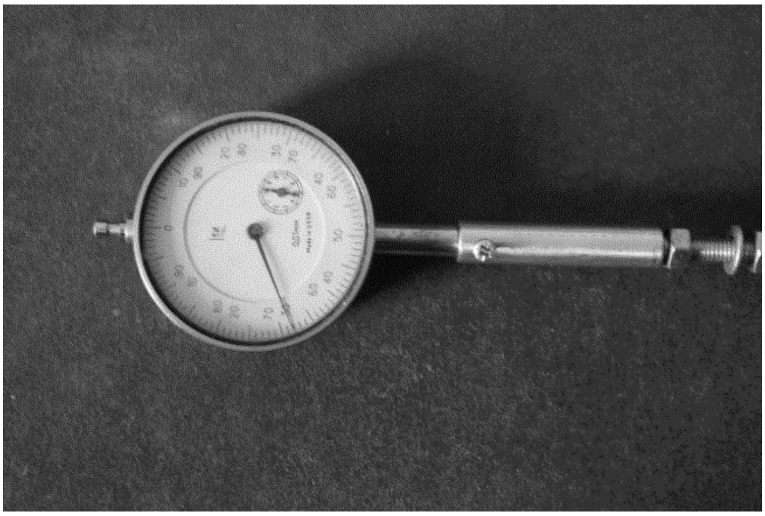

Photo 2. Recorded picture of a measurement sensor – a clock indicator.

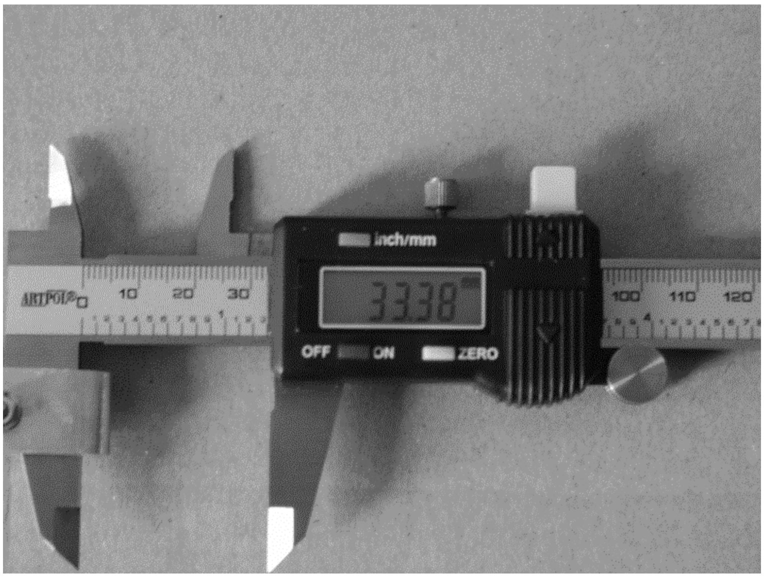

Photo 3. Recorded picture of a measurement sensor – an electronic scale caliper.

An example diagram of a constructed measurement system was presented in Fig. 1.

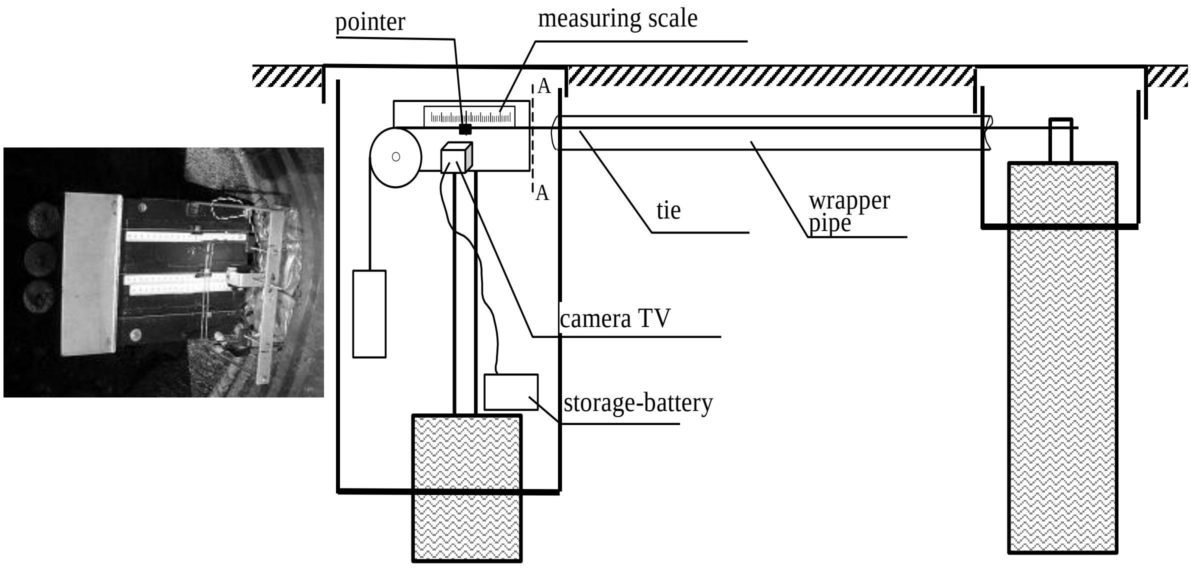

Fig. 1. A diagram of a telemetric measurement system with a TV camera and a computer.

In the system presented in Fig. 1, the status pictures of 3 measurement sensors were sent to the computer through a cable and recorded on its disk each 0.5 hour. In monthly periods, the measurement results were copied to a portable disk and converted further into displacement values and their diagrams. They have been presented in section 3.
In Fig. 2 we have presented various configurations of displacement measurement systems that are defined by methods of transmitting and recording pictures of sensors from TV cameras.

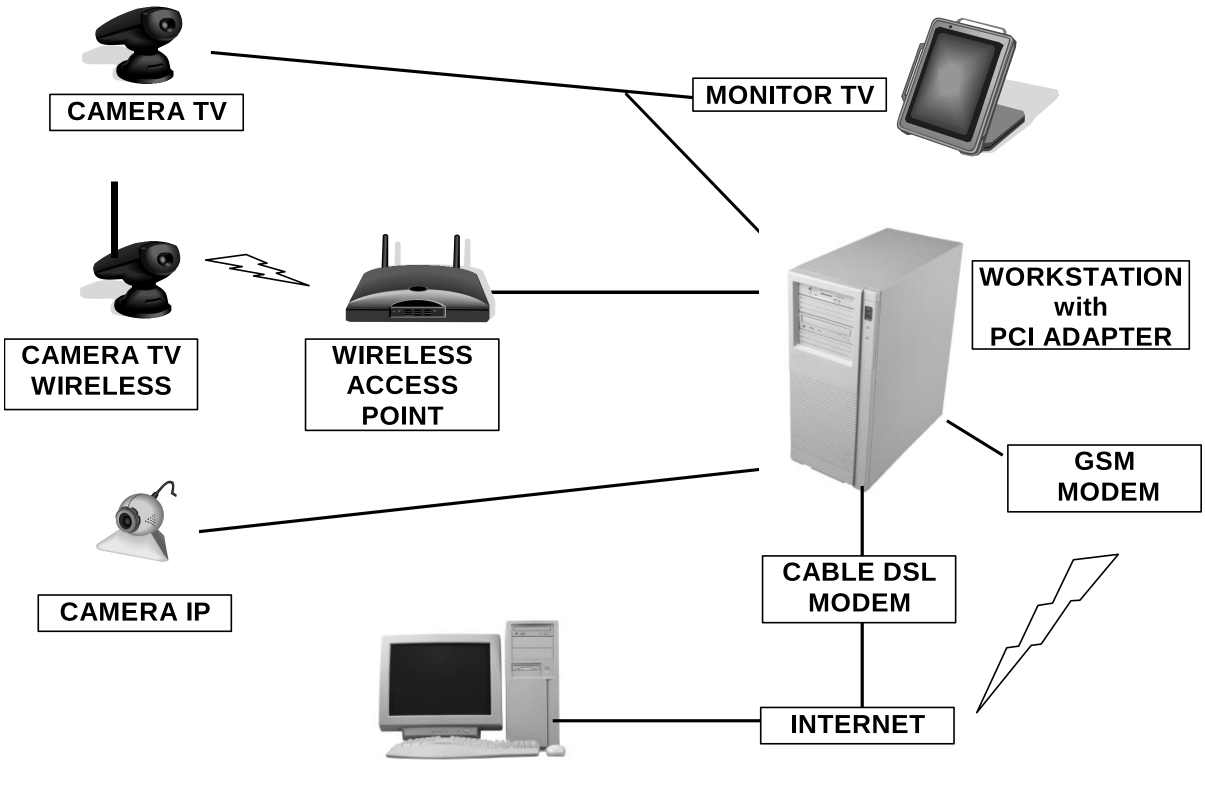

Fig. 2. Methods of transmitting and recording sensor pictures from TV cameras.

3. LINE DISPLACEMENT MEASUREMENT RESULTS OBTAINED FROM A CCTV MONITORING SYSTEMS

In Fig. 3 and 4 we have presented the results of length changes of three straight line sections determined by four signs stabilized in the ground. Measurement sensors in the system were 3 line scales assembled on a sign common to all sections. Readout indicators were, on the other hand, assembled on steel legs, assembled on the signs from one side. From the other side, the legs were drawn through the disks assembled on a common sign and loaded up. Readouts from sensors were made from the PC monitor, with precision ±0.2 mm. Changes presented in diagram 3 are corrected by thermal correction values that were determined from the changes in legs temperature, recorded in measurement sensors pictures (photo 1).

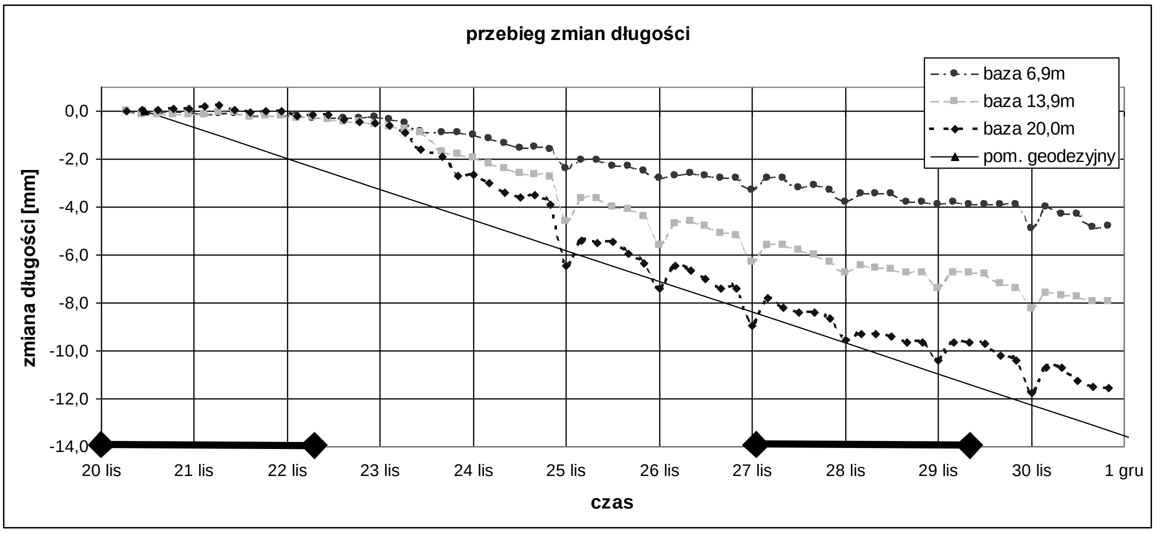

Fig. 3. Diagrams of length changes from November 20 – December 1, 2003 (◆—◆ breaks in wall operation).

Fig. 4 presents diagrams of horizontal displacements, determined from the changes to the length of individual sections. Values of determined displacements in the presented period of time are almost the same and their values do not exceed the uncertainty range for determining them .

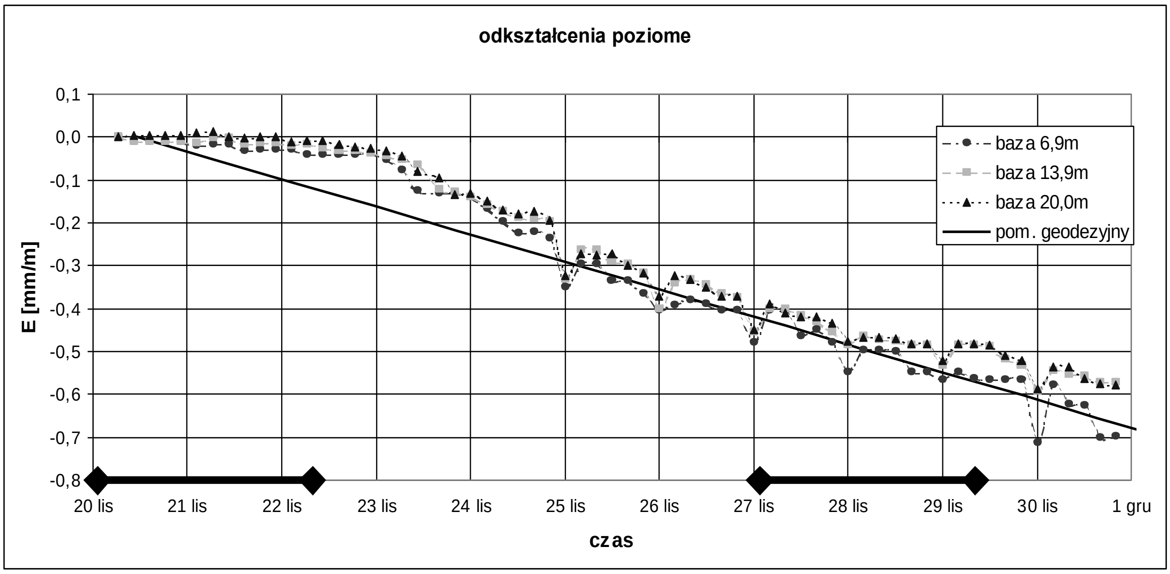

Fig. 4. Diagrams of horizontal displacement changes from November 20 – December 1, 2003

(◆—◆ b reaks in wall operation)

4. CONCLUSIONS

The possibilities of applying CCTV systems in geodesic (metrological) monitoring of displacements are a realistic concept of such measurements automation that can be implemented. The described example (section 2 and 3) of one such system's implementation proved that their construction is simple and results obtained from them – precise. CCTV systems, due to using mechanical analogue sensors can provide displacement measurement precision of c.a. ±0.001 mm. At the same time they are not as sensitive to external environment as electronic sensors.

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