

## STATIC MONITORING PERFORMANCE

### Introduction

Monitoring of structure movements and vibrations (bridges, buildings, monuments, towers etc.) is an increasingly important task for today's construction engineers. **IBIS-S** introduces a totally new solution in this field of application, with many advantages over traditional instruments for both static and dynamic monitoring:

- remote sensing at a distance of up to 1 km
- displacement accuracy up to 1/100 mm
- real-time one-dimensional simultaneous mapping of all displacement detected on the structure
- fast installation and operation
- the same instrument can be used for static and dynamic monitoring
- structure vibration sampling up to 100 Hz
- operates day-night, in all weather conditions



Fig. 1: IBIS-S

Hereinafter the results of a demonstration of IBIS-S performance are given as an example of static monitoring results: the demonstration consisted of the comparison of IBIS-S results with an up-to-date Total Station results in measuring a target displacement equipped with a micrometer system used to force known displacement to the target.

The results consist of the visualisation of IBIS-S measured displacement compared with the forced displacement and Total Station results.

### Measure description

The test has been carried out at University of Rome "La Sapienza" in an internal cloister of the Engineering Faculty: IBIS-S and the Total Station have been installed on one side of a cloister aisle about 33m distant from the target equipped with the micrometer system as shown in the following figure.

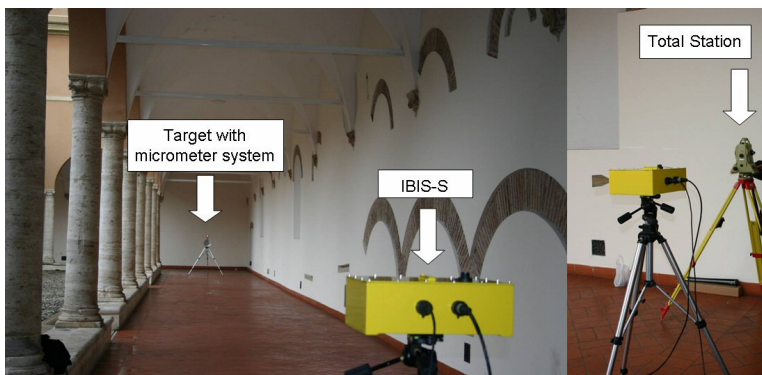


Fig. 2: test site

The following displacements have been forced to the target:

- session 1: 3 steps of 1mm towards the devices and 1 step of 3mm forwards;
- session 2: 2 steps of 0.5mm towards the devices and 1 step of 1mm back;
- session 3: 5 steps of 0.1mm towards the devices and 1 step of 0.5mm back.

IBIS-S was configured with the following operational parameters:

- maximum range: 200m
- distance resolution: 50cm
- sampling frequency: 10Hz

Fig. 3 shows the image of scenario acquired by IBIS-S: the figure shows several peaks corresponding to the columns of the cloister and a peak, highlighted with a red circle, corresponding to the target.

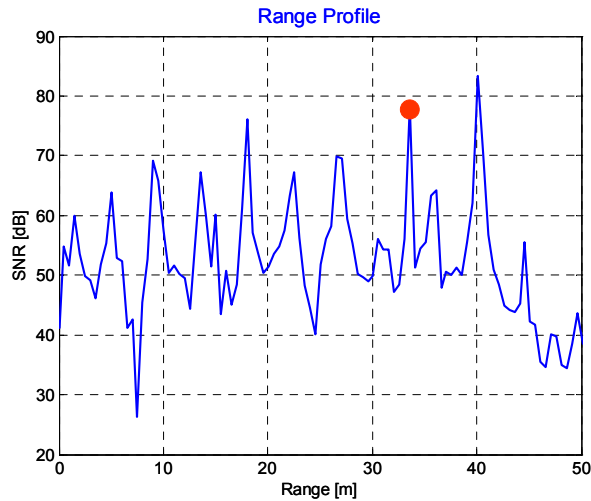


Fig. 3: Distance profile (radar image)

In the following the results of the measure of the target displacement are reported. It is worth noting that IBIS-S was also able to measure at the same time even the displacement of the several columns belonging to the scenario.

**Results - Displacement data**

The following figures show the graphs of the target measured displacement obtained by IBIS-S raw data and Total Station raw data: the left column contains IBIS-S results while the right column contains Total Station results for the three measurement sessions with 1, 0.5 and 0.1 mm increment step.

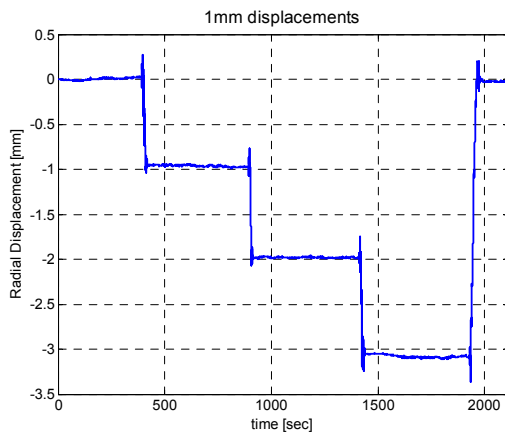


Fig. 4: IBIS-S 1 mm displacements results

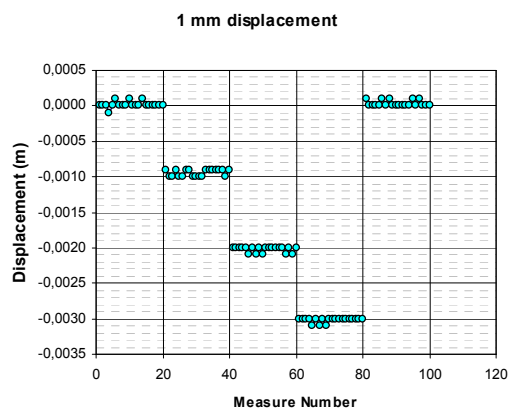


Fig. 5: Total Station 1 mm displacements results

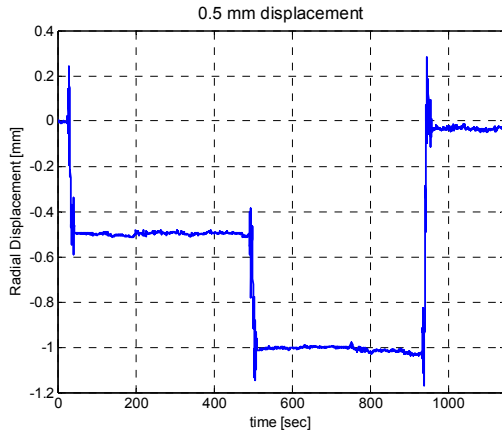


Fig. 6: IBIS-S 0.5 mm displacements results

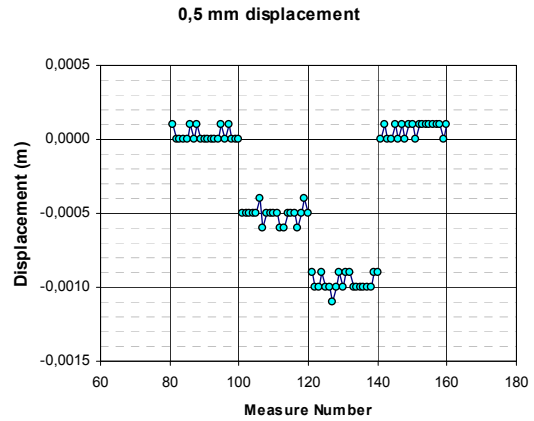


Fig. 7: Total Station 0.5 mm displacements results

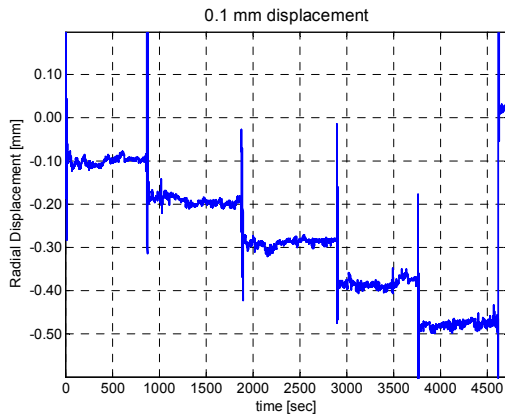


Fig. 8: IBIS-S 0.1 mm displacements results

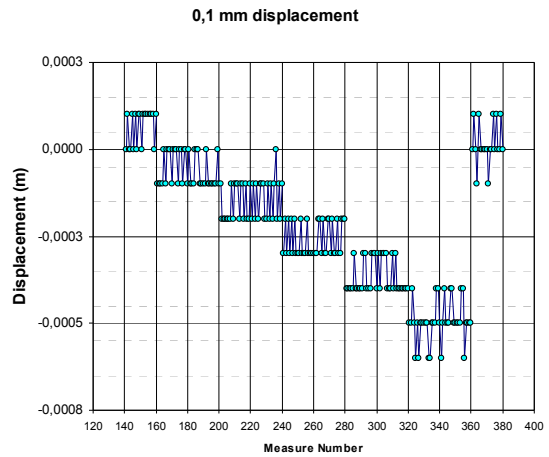


Fig. 9: Total Station 0.1 mm displacements results

Looking at the previous images it can be seen that IBIS-S results are analogous to total Station results for all the three measurement sessions. By a direct comparison of Fig. 8 and Fig. 9 it can be seen that Total Station displacement resolution is limited to 0.1mm while IBIS-S displacement resolution is up to hundreds of millimetres as illustrated in the following figure that shows a zoom in the temporal range [4000-4100] seconds of session 3 measure.

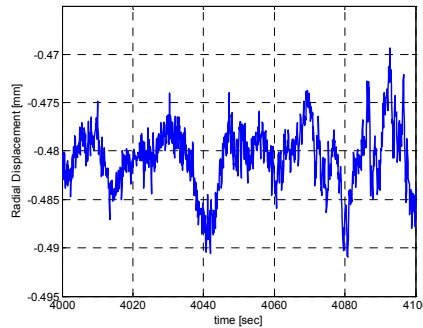


Fig. 10: zoom on session 3 measured displacement

IBIS-S measured target displacement shows a fluctuation of the order of hundredth of millimetre due to the internal noise on the instrument but even to the variable environmental conditions of the measure.

Because IBIS-S was sampling the scenario even when the operator approached the target and forced its movement, in the previous figures regarding IBIS-S results there are some peaks and some noise first and after the target movement corresponding to the few seconds during which the displacement was forced. The operator noise could also be seen during the data acquisition as illustrated in the next figure that shows IBIS-S management SW Panel with the real-time results of a part of session 1 measure.



**Fig. 11: IBIS-S real time results**

### Conclusions

The comparison of IBIS-S results with an up-to-date Total Station results in measuring an object displacement highlights at least three of the advantages to use IBIS-S:

- high accuracy and precision in displacement monitoring;
- real time result rendering;
- IBIS-S capability to measure at the same time the movements of all the targets belonging to the scenario.

In order to solve complex monitoring scenario IBIS-S can be integrated in Total Station monitoring networks: real time result rendering and IBIS-S capability to measure at the same time the movements of all the targets belonging to the scenario could help address specific requirements of the monitoring activity.

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