Low-cost hexapod system for small telescopes

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Summary

We propose the concept of a new low cost unit to enable hexapod capabilities in telescopes under the 2m class. Precise compensation of tilt, pitch and centering without compromising telescope performance is presented. The approach may be extended to other active optical systems undergoing slow changes.

Introduction

Hexapod systems (mechanical platforms with a large number of degrees of freedom in displacement and tilt) are very useful in telescope systems beyond 2m, generally in the shape of the well-known Stewart platform [1], which has been extensively studied. However, the cost of such platforms make then prohibitive for telescopes below 2m.

There is a trend in astronomy towards larger and larger telescopes. Large telescopes are scarce installations, demanding large investment and maintenance expenditure, with little observation time available for the astronomy community. A lot of science, however, may be still done with small telescopes, and even amateur astronomers are participating more and more in professional surveys [2]. Such systems, however, are usually limited by the flexures of the telescope tube as the object of interest is tracked across the sky. A hexapod unit enabling compensation of focus and in-plane displacements, plus compensation of tip and tilt effects in the telescope would be extremely useful and enable true active optics capabilities in smaller-class telescopes. Furthermore, if managed at a lower cost it would be useful to the amateur astronomer community.

We propose a novel concept based in stepper motors and endless screws [3], which can compensate errors in focus, centering, tip and tilt, and even mitigate comma. The unit is based (Fig. 1) in three pairs of equally spaced scissor units consisting in a pair of endless screws, controlled by a pair of stepper motors each. In order to minimize the footprint of the system on the primary mirror, three thin lames connect each scissor with a central ring containing the secondary mirror, or, in a primary focus telescope, directly the CCD camera. Each scissor can move its annexed lame vertically in a coordinated manner with the other three, so with the proper algorithms the central ring may be moved in the plane normal to the optical axis to centre the system, along the optical axis looking for best focus, or compensating small tip and tilt movements of the image due to flexures. These are typical sources of variable defocus and comma along long telescope exposures. The calculation of such

aberrations can thus be done directly from the images acquired by the telescope, and one shot focusing made possible [4].

A further advance introduced by such an hexapod system involves relaxing the requirements on the mechanical support of the telescope, to reduce its cost without compromising performance. Such a concept is presented in Fig.2, and is currently under development.

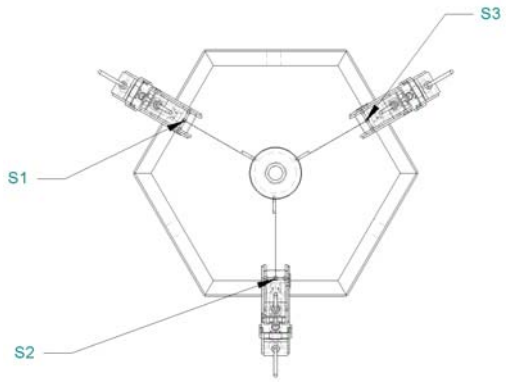

Fig.1: Concept of low-cost hexapod system for small class telescopes

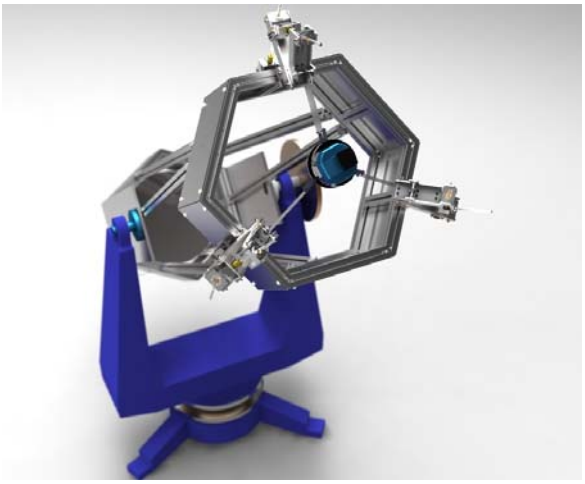

Fig.2: Concept of the complete unit

Conclusions

A novel concept of Stewart platform, of extremely low cost components, suitable for the implementation of active optics in astronomical telescopes of the smaller classes, has been proposed. The system uses the vertical displacement of a set of three angularly equispaced scissors which are built with just a pair of endless screws and stepper motors to control focus, decenter and comma in telescope images as the telescope tracks objects in the sky.

References

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