

AN EXAMINATION OF SELECTIVE IMAGING TECHNIQUES

By

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Except where acknowledged in the customary manner, the material presented in this thesis is, to the best of my knowledge, original and has not been submitted in whole or part for a degree in any university.

Andrew Grant Smith

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Abstract

An extensive empirical study of the frame selection method of high-resolution astronomical imaging, also known as lucky imaging, has been carried out. This method involves the capture of many hundreds or thousands of short exposure frames, the scanning and ranking of all the frames for sharpness, and the co-alignment and averaging of only the best frames into a final image. The performance of the selective imaging technique was tested by imaging several bright stars, binaries and clusters, and using the brightest pixel value in each frame as the sharpness metric. The lucky imaging parameters are the frame exposure time, telescope aperture, seeing, frame selection fraction, colour band, and distance from the co-alignment position. By using a range of aperture masks and colour filters, and a camera with adjustable exposure, we explored the widest range of parameter space of any frame selection study to date.

The results from the stellar images show that frame selection is very effective at reducing the effects of atmospheric turbulence on astronomical images. When all frames in an observation are combined, the seeing disc is diminished and a bright central core is apparent. By selecting just the best 1% of frames the core is brighter while the halo almost vanishes. In many of these cases faint spikes and dark rings appeared, indicating diffraction limited images. The results were best when small apertures were used, particularly at longer wavelengths. It was found that, for the Siding Spring site, the exposure time should be limited to 10 ms, although images were improved at all times tested. It was also found that when image frames of binaries and clusters were co-aligned on the brightest star, the improvement in sharpness was greatest at this point, and the improvement decreased with angular radius.

To prepare for future research, solar system planets and lunar features were also

imaged. These were processed with sharpness metrics suited to extended objects. It was found that frame selection was effective at improving the planetary images over traditional long exposure images. However the results were not as good as for the stellar images. Possible reasons for this are discussed.

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