
A Comparison of Performance Statistics for Manual and Automated Operations at Mt Stromlo

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Abstract

The new Mt Stromlo SLR Station was rebuilt in the 12 months following the destruction of the original station by the January 2003 bushfires, and was reopened in April 2004. It became fully operational in December 2004 and since then the station has been operated manually pending completion of the development of a more advanced infra-structure that will support automated operations.

The original station had conducted automated operations for over three years before the bushfires and the performance measures that were in place during this period have continued to be collected for recent operations. This provides a unique opportunity to compare the productivity performance between automated and manual operations undertaken at the same site and with the same management team.

Provided that periods of abnormal events are taken into account, net productivity from these two modes of operation are quite comparable with differences less than about 5% over periods of many months. The fact that automated operations persist for longer periods and in conditions that discourage manual operation appear to compensate for the efficiencies that human interaction can provide.

Introduction

The original Mount Stromlo SLR Station (7849, STRL) was commissioned in Oct 1998, and subsequently performed automated operations from late 1999 until being totally destroyed in the January 2003 Canberra bushfires. A more complete description of the operation of this station has been given by Luck, Moore and Greene (2000). During this period, operations included the automated download of predictions, tracking of satellite and calibration targets, data processing and upload of published data. Automated operations allowed the station to continue operations, collecting and publishing SLR data, while it was unmanned. In fact, such operations were effectively unmanned for 80% of the time.

Productivity metrics were captured for this whole period. As described in Luck et al, these metrics were used for establishing performance criteria required under the contract between EOS and AUSLIG (subsequently incorporated into Geoscience Australia). Processing of productivity data and generation of reports was only partially automated, with a significant component requiring routine, but brief human inspection and assessment of the system and environment.

Subsequent to the 2003 bushfires, the remains of the old station were removed and the new Mount Stromlo SLR Station (7825, STL3) was constructed on the same site. All systems were functional by the official opening in April 2004, less than 14 months later. After undergoing stringent testing of all of the new sub-systems, including a new software system and completing formal acceptance testing, the new station commenced full operations in December 2004. Given the rapid redevelopment of the station, the system (in 2005-2006) was not capable of automation hence the station has been operated manually in a more traditional manner using operators rostered to

cover day and night, seven days a week. The new station was only unmanned when lack of targets or poor weather precluded productive tracking. It should be noted however, that contractual requirements (as well as good practice) required continuing capture of productivity metrics and generation of performance reports. The definition and processing of these data had not changed between the automated and manual operations.

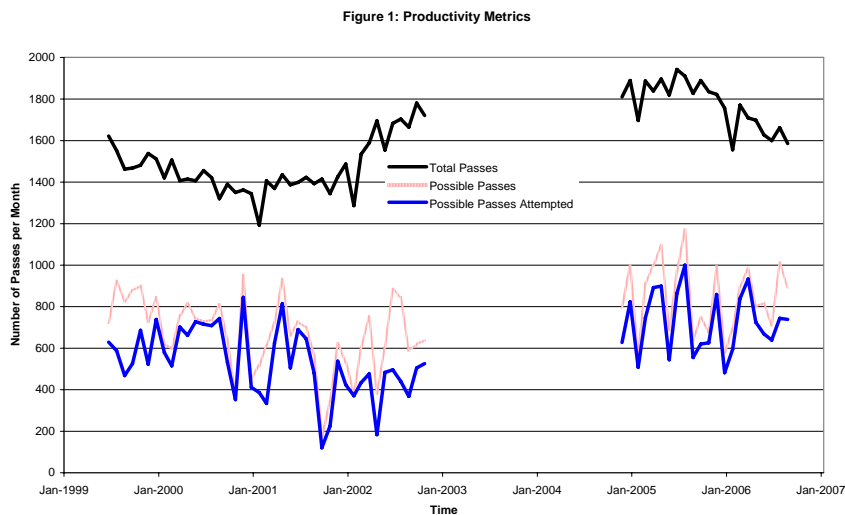
The availability of reasonable long time series in these two data sets, has therefore allowed the relative performance between automated and manual SLR operations to be assessed. It should be remembered that the two stations were both designed by EOS and operated by EOS staff and hence have much in common. It was considered that the physical and technical differences between the two stations did not influence productivity levels to such an extent as data quality and other factors.

Metrics

The metrics used in this assessment include the following:

1. The number of all ILRS satellite passes with a maximum elevation above the 20 degree site horizon.
2. The number of all possible passes – i.e. the number of passes that are trackable, accounting for poor weather, low elevation passes and pass overlaps or priority.
3. The number of attempted passes – i.e. the number of possible passes for which the SLR station fired the laser in an attempt to track the satellite.
4. The number of passes that were successfully tracked – i.e. at least one normal point was generated.

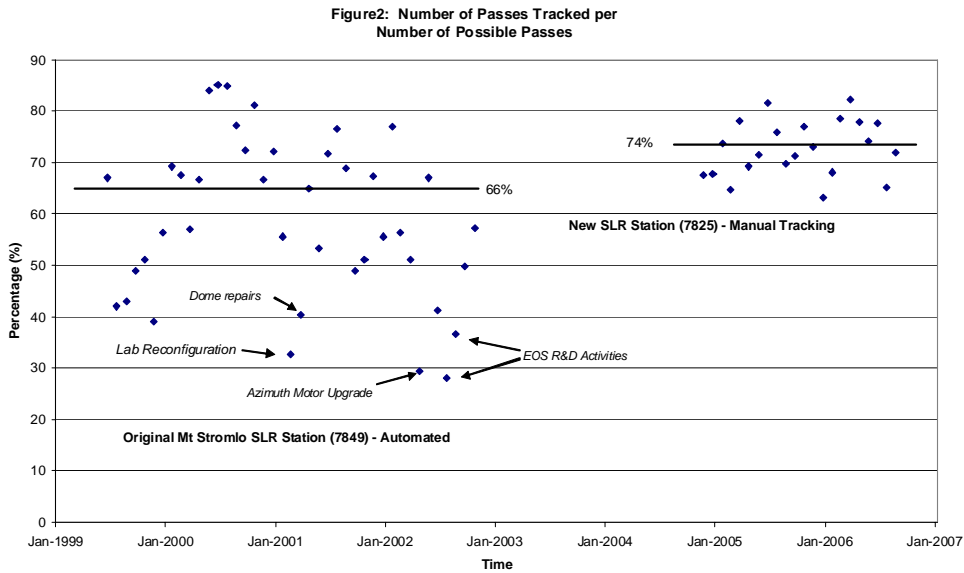
The following figure shows the time series of these metrics for the two periods.



Results

Potential Productivity

Figure 2 provides the number of passes successfully tracked normalized by the number of possible passes. This ratio provides a measure of the system's potential productivity. If the ratio reached 100% then every pass that could realistically be tracked would be tracked. This figure shows that on average the potential productivity of the automated system reached 66% while the manned system was significantly more successful with an average potential productivity of 74%. Note that some exceptional points were excluded from the calculation. The points were associated

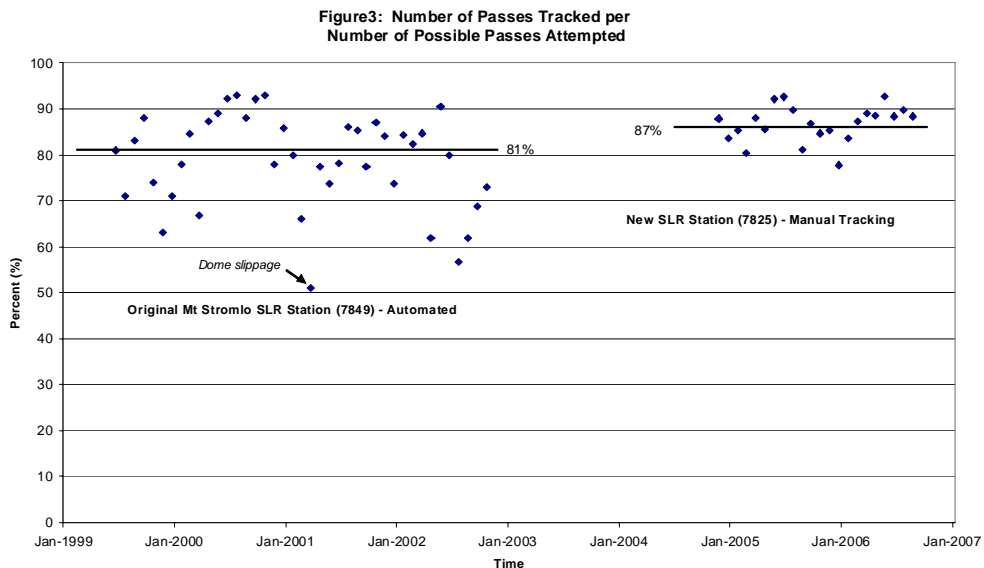


with station activities that significantly affected the ability of the station to perform normal operations. This result suggests that everything else being equal, a human operator should outperform a mechanical system, where for example a human can respond to unusual events such as system failures more quickly.

Tracking Capability

The next figure provides the number of passes successfully tracked normalized by the number of attempted passes. This ratio provides a measure of the system's capability for successfully tracking a target. If the ratio reached 100% then every pass tracked would result in generation of normal points. Figure 3 shows that on average the potential productivity of the automated system was 81% while the manned system was marginally more successful with an average of 87%. Note that a few exceptional points were again excluded from the calculation. For example, at one point the telescope enclosure was slipping due to a mechanical fault such that the system continued to attempt passes, but a misalignment of the telescope and dome meant that no returns were possible.

These results suggest that as long as a pass is attempted, the automated system has on average as nearly as good a chance in successfully acquiring the target as a human operator. Perhaps any skills that an operator may have in acquiring a target is balanced by the persistence of an automated system



Actual productivity

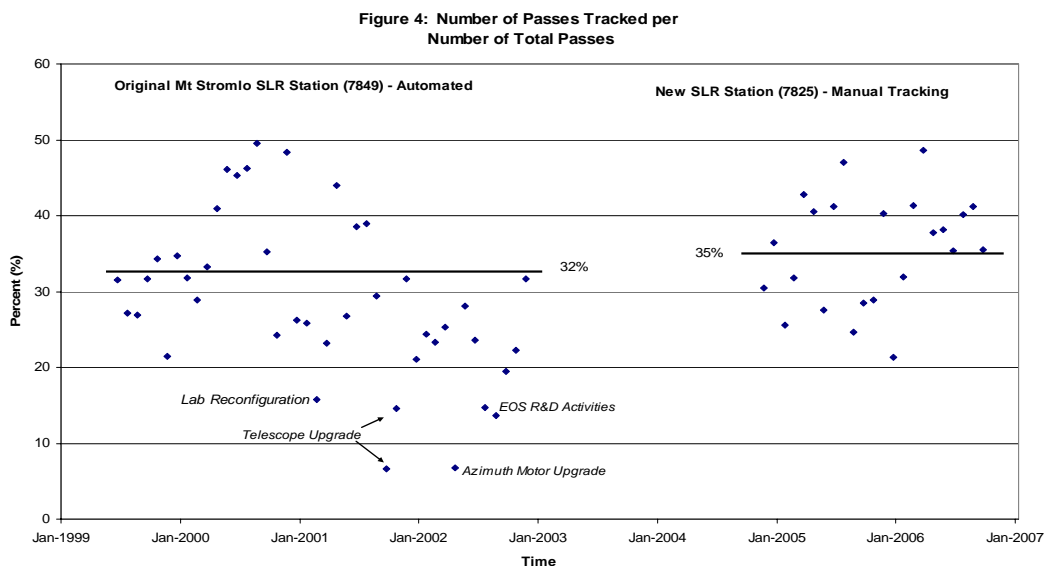
The final figure provides the number of passes successfully tracked normalized by the total number of passes. This ratio provides a measure of the system's net or actual productivity, or passes tracked irrespective of conditions. In this case if the ratio reached 100% then every pass would have been tracked successfully. Figure 4 shows that on average the actual productivity of the automated system was 32% while that for the manned system was 35%, not a statistically significant difference. Note that some exceptional points were also excluded from the calculation as discussed earlier.

The major contributor to the absolute value of this ratio is of course the weather. It should be noted that during manual operations, the station was often unattended during overcast periods. In contrast, the automated system generally continued operations regardless of weather conditions. It is believed that this difference favoured the automated system, since there would have been opportunities to successfully track during breaks in the sky cover or respond quickly to clearing conditions.

Conclusions

Availability of two years or more of productivity data from SLR tracking at one location, using similar techniques and equipment, and the same staff, has allowed an objective assessment of the performance from automation and manual operations.

The results indicate that there was overall very little difference in net productivity between the automated and manual operations. While human operators appear to have an advantage when on-site and undertaking tracking in clement weather, the automated system had an advantage in less ideal condition and could take opportunities that were lost to operators.



It is therefore clear that sophisticated automation systems can equal, if not better, manual operations. As far as the system at Mount Stromlo is concerned, it is felt that continuing improvements in the software and hardware systems will result in automated operations exceeding manual productivity figures.

References:

- [1] Luck, J., C.J. Moore and B. Greene. Autonomous Laser Ranging Results from Mount Stromlo. Twelfth International Workshop in Laser Ranging, 2000, Matera.