MACQUARIE University
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STEERING STARBUGS:
Routing Fibre Positioners for TAIPAN

Starbugs in TAIPAN

The Australian Astronomical Observatory's TAIPAN instrument deploys 159 Starbug robots to position optical fibres to accuracies of 0.5 arcsec, on a 32 cm glass field plate on the focal plane of the 1.2 m UK-Schmidt telescope. Made of two concentric piezo-ceramic tubes, a Starbug vibrates as electric pulses are sent through the tubes, allowing movement in X and Y axes and rotation about *theta*. The Starbugs will allow TAIPAN to configure fields faster than conventional methods used in multi-fibre instrument, allowing the instrument to complete the TAIPAN and FunnelWeb Surveys.

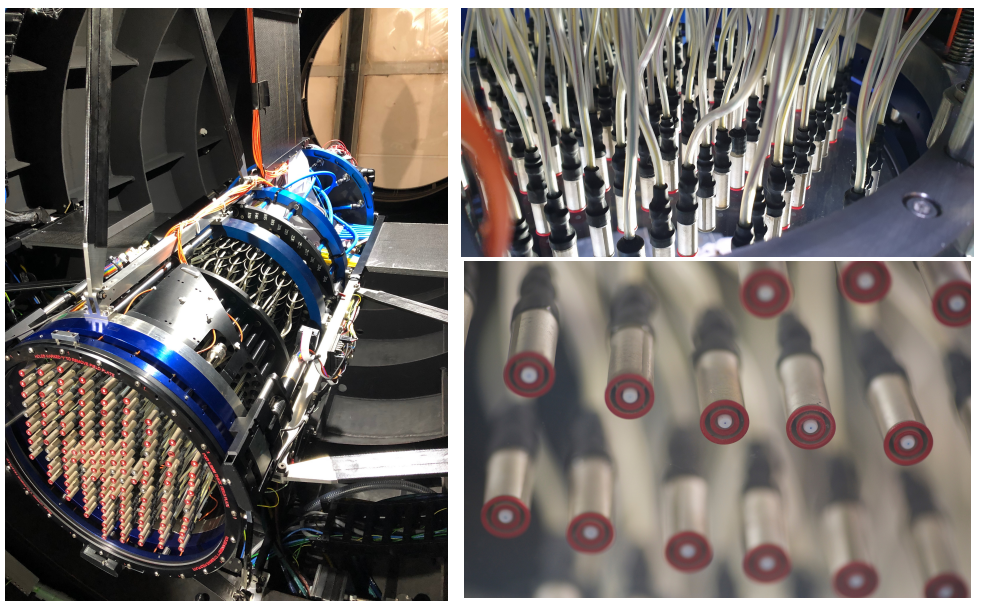

Fig.1. TAIPAN fibre positioner in the UKST, and its fibre-carrying Starbugs

An automated path-finding algorithm is used by 'The Router' to route individual Starbugs to independently move in a crowded field.

Constraints and Limitations

A configuration needs to fit several requirements and constraints:

- Avoid crashing into other Starbugs
- Stay within the Glass Field Plate
- Remain within the maximum travel distance ('patrol radius') of Starbugs

The instrument operations also requires fields to be routed in advance and 'in-situ'. The TAIPAN Metrology and Positioner tasks uses a MongoDB database to update the latest locations of each Starbug and their 'state' (on-target, active, faulty, etc), which the Router is able to access if re-routing a configuration is required.

Routing an Observation Field

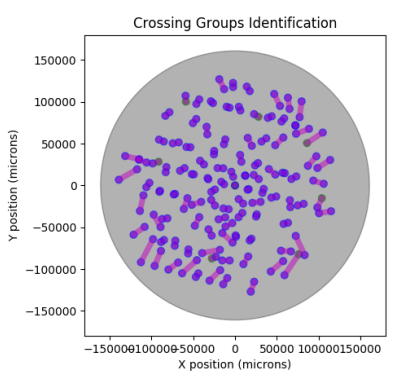

Fig.2. Initial target allocations for a field (NGC 2547)

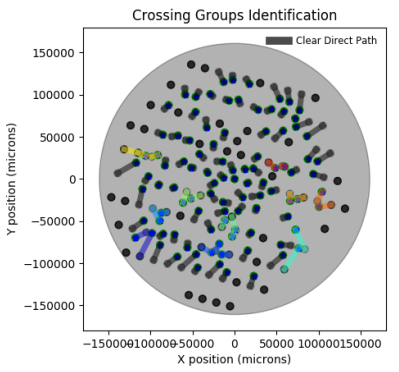

Fig.3. Direct paths to targets marked in grey and crossing groups in colour

The software employs a tiered approach to find a collision-free path for every Starbug, from its current position to its target location. This consists of path-finding stages of increasing complexity and computational cost. For each Starbug a direct path to the initially allocated target is attempted. Then we break these paths into crossing groups and try to move individual bugs in each crossing group. If more collisions exist, then it moves colliding bugs without targets out of the way. If bugs are unable to move out of the way due to more collisions, the process if repeated until as many targets are routed as possible or till designated number of loops are run. If unsuccessful, the target is tagged as un-routable. The TAIPAN router typically configures a field of 159 star bugs in less than 20s.

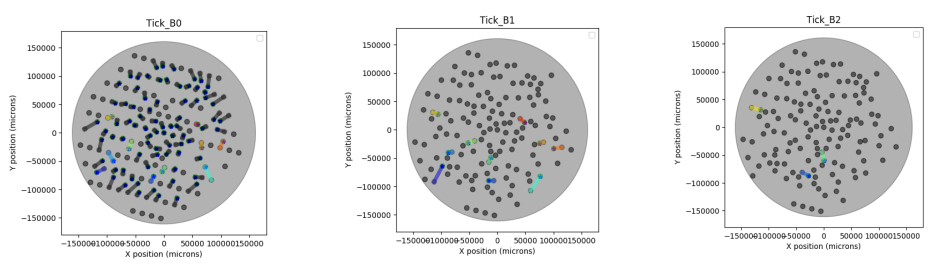

Fig.4. Member of a crossing group moves in a sequence which allows crash-less movement. The movement sequence for designated targets contains 3 'ticks' for NGC 2547 test field above.

Future work

The next stage of TAIPAN will see the number of Starbugs increased to 309. We plan to test an A* algorithm-based router to handle the increased complexity of the routes of the Starbugs, and time taken to create a configuration.

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