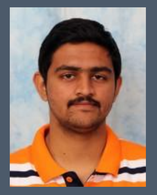
ADD_IN

MRSD Project 2015-2016 : Team F
Mentor and Sponsor: **David Bourne**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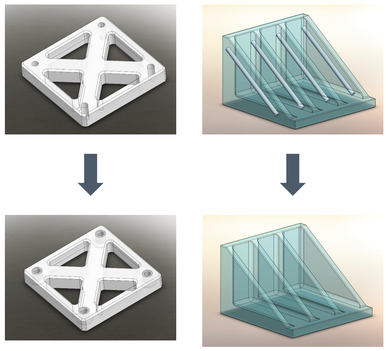
PROJECT DESCRIPTION

ADD_IN is a Human-Robot Additive 3D printing System that can encase Commercial Off-The-Shelf (COTS) components seamlessly within its printed structure. By adding an additional degree of freedom to an existing FDM 3D printer and allowing a user to insert COTS components onto a partially printed surface, we propose to develop a system that can rapidly produce **strong**, **useful** and **low cost** parts.



USE CASE

Motivation: 3D Printed parts are often sufficiently strong, but fail at the interface with other components

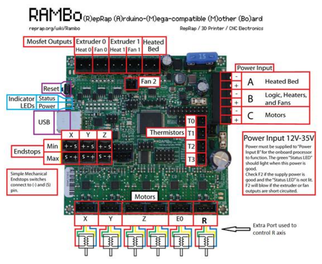
Solution: Enclose threaded inserts to distribute force over larger area and reduce material stress

"One thing we did was use 3D printing to create the legs, so the actuators and hydraulic lines are embedded in the structure, rather than made out of separate components."

- Marc Raibert

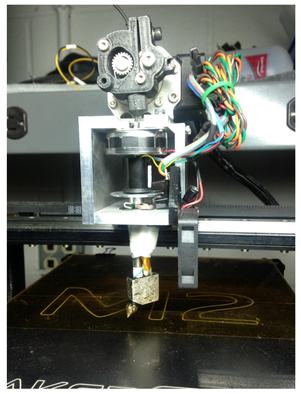
ELECTROMECHANICAL & FIRMWARE

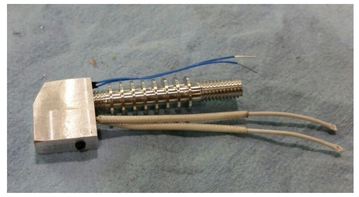
- Existing RAMBO board was used to drive all the motors
- Firmware was modified to parse the extra axis commands
- Inverse Kinematics solution was implemented in firmware



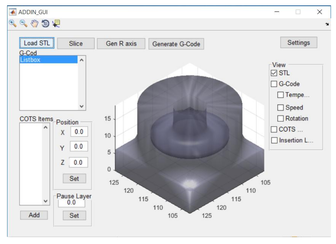
NOZZLE DESIGN

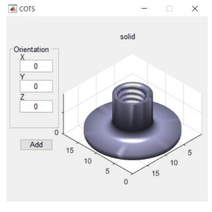
- Hollow stepper motor was installed to enable rotation
- Heat block was re machined to a slimmer design to avoid hitting the COTS part
- Nozzle was screwed into the heat block at a 45° angle to achieve clearance
- Slip ring installed to maintain the thermistor and heater connections during rotation
- Sturdy mount constructed to encase the new parts and avoid jitter

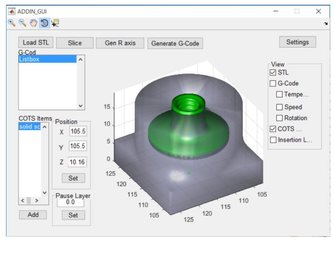




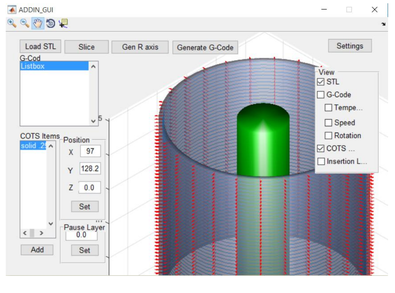
SOFTWARE







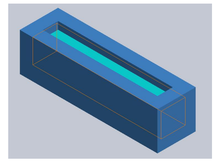
- Rotation commands for the additional axis are generated in post processing
- Easy to use MATLAB based GUI was developed
- User can select the STL files of the part and the COTS item to be inserted
- Invokes a slicing function called Skeinforge that generates G-Code for the XYZ axes
- Positioning the COTS item for accurate R-Axis G-code generation is made easy by visualization
- Orientation of the R-Axis can be visualized

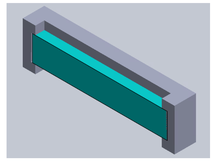


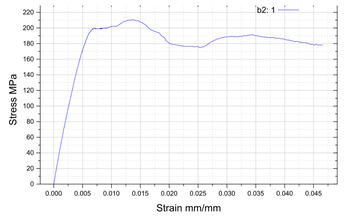
RESULTS

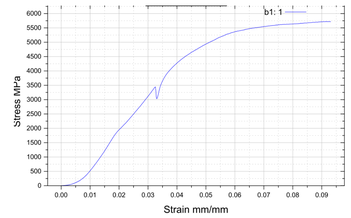
STIFFENER PART

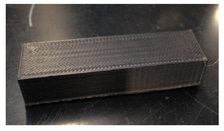
Bending stiffness test showed that part with COTS item was much stronger than a reference purely 3D printer part.





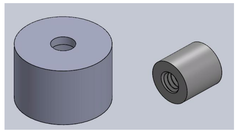


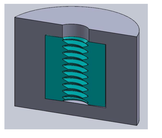


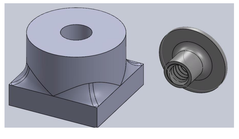


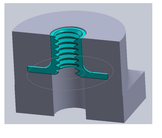
SCREW INSERT

Part printed using the ADD_IN printer was able to withstand a greater pull out force than the reference 3D printed part









FORCE SENSOR

Electronics fully functional after printing