A preliminary design was started for a tensile stage that fits between the objective lenses and stage of the Olympus BX-15 optical microscope located in Mechanics Lab in Butterfield 101. This stage will be used to assist in the characterization of the constituents that are being used in the development of sustainable composite materials.

The objective I had was to build the microscope that:
1. Could fit under optical microscope in the Mechanics Lab
2. Used similar components (motor, LVDT, gear ratios) to the existing tensile stage so that the same controller could be used.
3. Designed to accommodate the existing range of load cells used by the existing tensile stage.
4. The Tensile stage profile needs to be small enough to accommodate the 1000x optics
5. Enable the use of multiple test fixtures including tension, compression, and bending.
6. Allow manual and motor displacement control

Introduction and Background
A joint effort is underway between researchers at Union College and RPI to develop sustainable materials that can replace synthetic plastics and organic fibers. This effort is an attempt to reduce reliance on diminishing and increasingly valuable nonrenewable petroleum supplies.

Materials development requires that the performance of the materials, their composites, and the interfaces between the constituents of the composite be characterized so designers can model their performance in structures. Characterization takes place at many levels, in this project the concern is with microscopically characterized.

To perform microscopic characterization the materials must be loaded while being observed under a microscope. At Union College there is no current capability to perform this type of characterization and therefore a tensile stage that can fit under the existing microscope in the Mechanics Lab needs to be designed and built.

Design
Mechanism
- Motor and hand crank transfer torque to worm shaft
- Worm shaft has right hand thread that drives two worm gears attached to lead screws
- Worm drive multiplies input torque by 30
- Dual lead screws have left and right hand thread that drives cross head in opposite directions with a force of 362.5lb each

Sensors
- Interchangeable load cells measure the force on the grips
- Linear Displacement Sensor with maximum displacement of 25mm track crosshead motion
- Bumper switches prevent crosshead overshoot
- Revolute joints eliminate eccentric loading
- Interchangeable grips allow various tests to be conducted

System Integration
To achieve 3D translational motion, the stage will be mounted on a Thorlabs manual stage (Figure 4). To stabilize the structure and prevent tipping, the manual stage will be bolted onto a block of metal placed on the table. Due to the likelihood of motor induced jerks on a cantilever structure, the microscope stage may be used to balance the hanging part of the tensile stage once the desired height is achieved.

Conclusions/Future Work
In conclusion, a miniature tensile testing machine compatible with the existing optical microscope in the lab (Figure 4) has been designed. More work needs to be done to stabilize the system and reduce vibrations. The next step is to purchase the mechanical components and get the machined parts fabricated at the Union College Engineering Lab. Assembling and testing will commence in the Fall as part of a senior project. In-situ stress tests will help us better understand how the microstructure of biopolymers affects their bulk mechanical properties.

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