Parsing Tensegrity Structure Specifications for Simulation Across Platforms

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Problem Statement

Goal: Enable tensegrity structures originally simulated in NTRT to be simulated in PushMePullMe 3D.

Approach: To parse structures encoded in YAML notation into DXF notation.

A tensegrity structure is made up of struts under compression, suspended in a network of cables under tension.

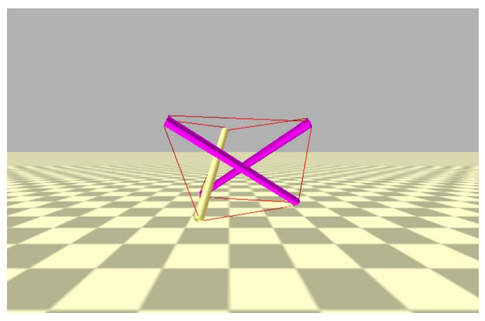
NASA Tensegrity Robotics Toolkit (NTRT)

An open-source collection of C++ and MATLAB software modules for the modeling, simulation, and control of tensegrity robots. It takes specification coded in YAML format.

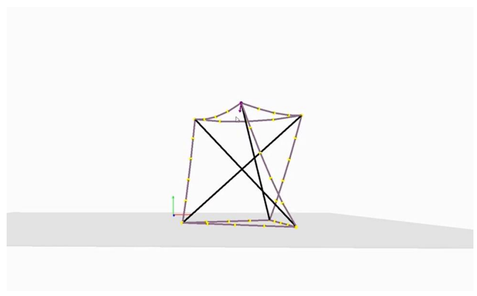
PushMePullMe 3D

A 3D simulation software which can be used for more than just tensegrity structures, it takes input from DXF files.

3 Prism built using sticks and rubber bands



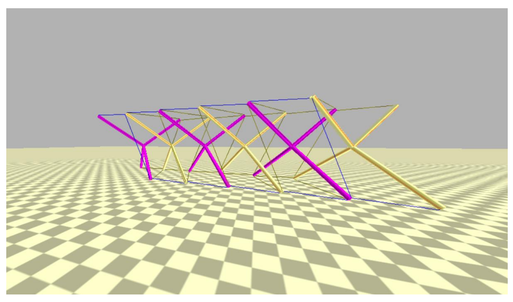
3 Prism in NTRT

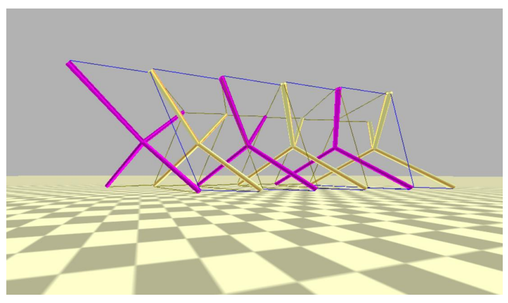


3 Prism in PushMePullMe

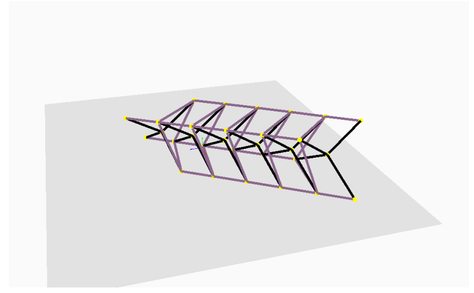
```
nodes:
  bottom1: [-5, 0, 0]
  bottom2: [5, 0, 0]
  bottom3: [0, 0, 8.66]
  top1: [-5, 5, 0]
  top2: [5, 5, 0]
  top3: [0, 5, 8.66]
pair_groups:
  prism_rod:
   - [bottom1, top2]
   - [bottom2, top3]
   - [bottom3, top1]
horizontal_string:
   - [bottom1, bottom2]
   - [bottom2, bottom3]
   - [bottom1, bottom3]
   - [top1, top2]
   - [top2, top3]
   - [top1, top3]
vertical_string:
   - [bottom1, top1]
   - [bottom2, top2]
   - [bottom3, top3]
```

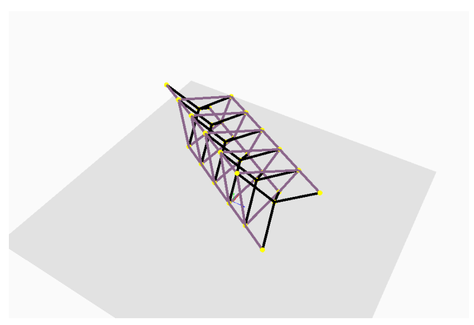
3 Prism in YAML notation





Tetrahedral Spine in NTRT





Tetrahedral Spine in PushMePullMe

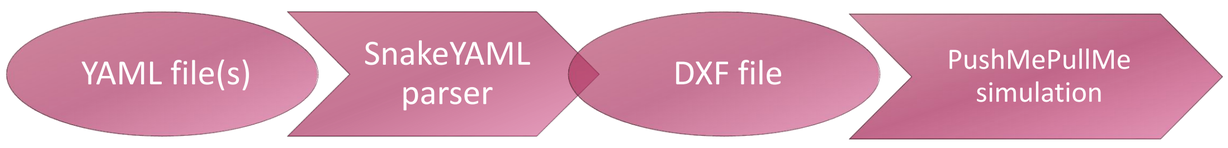
```
substructures:
   t1/t2/t3/t4/t5/t6:

path: ../Basestructures/Tetrahedron.yam
l
   offset: [0, 0 , -12]
bond_groups:
 string:
   t1/t2/t3/t4/t5/t6/node_node:
    - [front, front]
    - [right, right]
    - [back, back]
    - [left, left]
    - [right, front]
    - [right, left]
    - [back, front]
    - [back, left]
```

Tetrahedral Spine in YAML notation

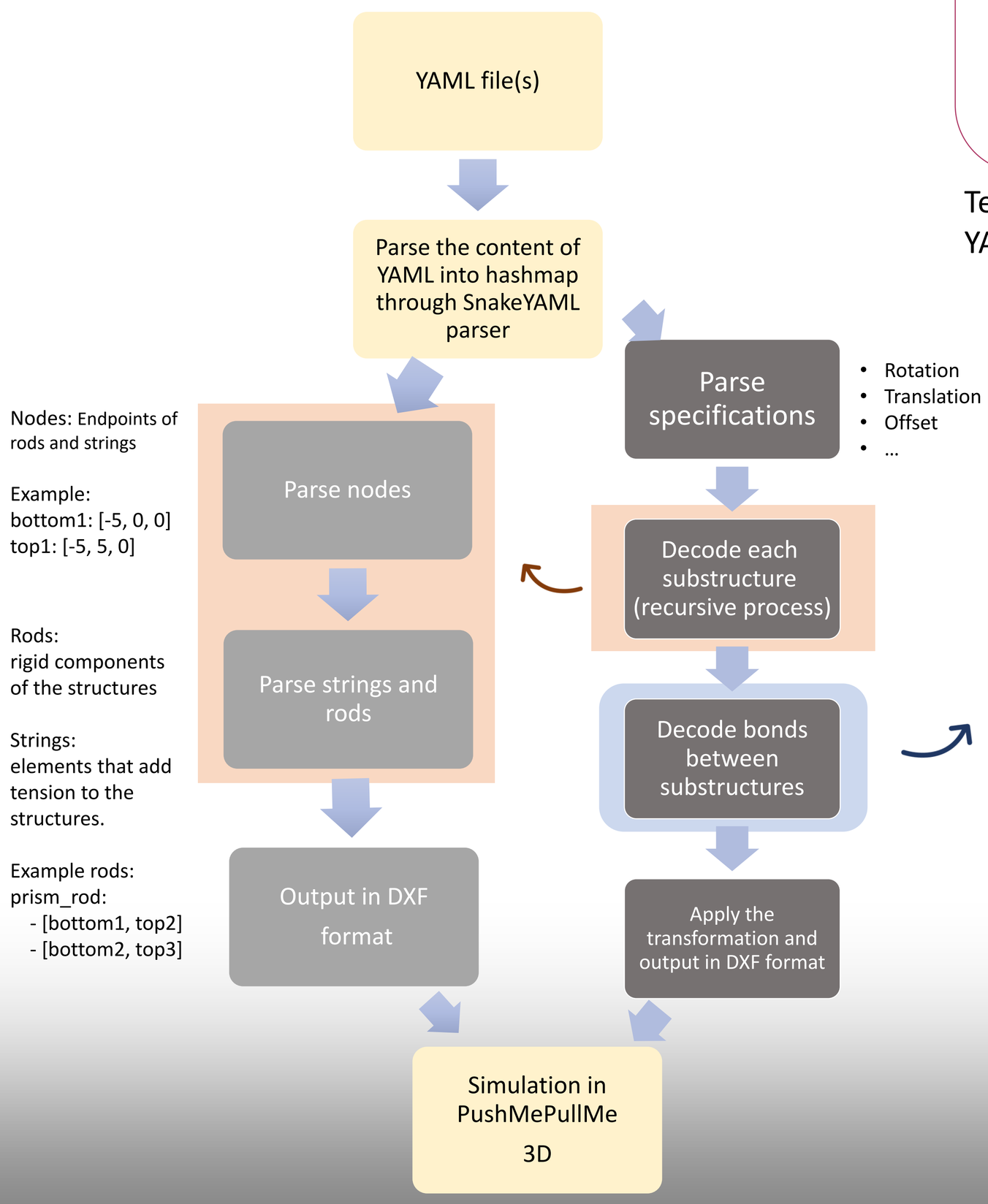
```
0
LINE
8
beam
10
0.0
20
100.0
30
-120.0
11
100.0
21
200.0
31
-20.0
```

A beam of the Tetrahedral Spine coded in DXF

Work flow

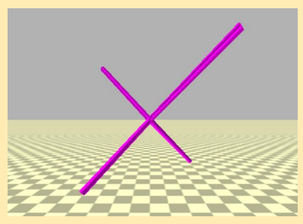


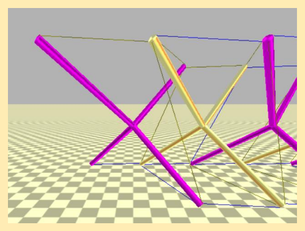
Implementation



Node-to-node bonds:

- Add strings or rods between existing nodes that weren't connected before

before 

after 

Node-to-edge bonds:

- Rotate and translate one of the structures to align one face to the corresponding face of other one.

Future goals

Implementing the parsing of face bonds in compound tensegrity structures. Translating YAML to formats used by other software including ArtiSynth.

Acknowledgments

Special thanks to Jack Qiao and Nuwan Perera for writing initial code; and to Jonah Eisen, Simon Kotwicz and Leif Raptis-Firth for creating the YAML notation