**Weekly Report – W13 Fall 2022**

**Problem & Task**

1. Summary of the issues with existing self-derived simulation code and the reason for using “TMTDyn” package;
2. Schedule of studying the package “TMTDyn” and some aspects confirmed about applying this package.

**Solutions & Achievements**

1. Summary of the issues with existing self-derived simulation code and the reason for using “TMTDyn” package

Since the self-derived falling SRA simulation codes cannot be fully proved to be correct temporarily, the reasons are summarized as follows,

* The inertia matrix cannot be proved to positive definite using conventional methods, such as judging the positivity of its eigenvalues, trace and determinant even if we use exactly the same approach noted in textbook or papers;
* There still exists singularity issue at the beginning of the simulation which could be owing to the inertia matrix or Coriolis-centripetal matrix.

and this process has cost us too much time, on the other hand, we have already known the fundamental principles of deriving the governing equations (or dynamics) of multi-link SRA, modelling is not the main focus of our project compared to the control strategies, to this end, a more mature package called TMTDyn will be used for our simulation, more detailed information about the performance of the package in terms of different modelling methods, for example, (Euler-Bernoulli beam theory and relative states) EBR and (Euler-Bernoulli theory and absolute states) EBA. Compared with physical experimental results, the simulation ones were proved to be reliable in [1]. So we can simulate our model by importing our dynamics or fixing several parameters in this package if possible.

1. Schedule of studying the package “TMTDyn” and some aspects confirmed about applying this package.

(1). Schedule of studying the package “TMTDyn”

* Confirm the modelling method, since the method we used is based on piecewise constant curvature (PCC), to know something about the modelling method of this package will help a lot for us to modify the equation of motion (EOM);
* Conform whether the package can add some constraints and external forces according to our needs for simulation;
* If the modelling method of the package does not contain anything about PCC, how can we add some self-derived EOM;

(2). Some aspects or facts confirmed about the package

* There are 4 basic modelling methods known, series rigid-link model (SRL), Euler Bernoulli beams with relative states (EBR, piecewise constant strain model based on variable constant curvature), Euler Bernoulli beams with absolute states (EBA, similar to FEA method) and Reduced-Order model (ROM) respectively; Among these, SRL and EBR are the most potential ones as they are close to our method;
* Constraints and external forces can be added to the package for simulation in the latest version of the package, I have read this from the paper and lecture video of the author, furthermore details need to be discovered maybe in next week;
* The EOMs are derived in an individual function, if we have some special modelling methods in the future, we can confirm its original outputs first, then substitute the function by our own if necessary;

**Difficulty**

* The damping and stiffness coefficients of the SRA are determined by the properties of material in the package, which are different from those in Chase’s simulation, is it okay to use more direct parameters like Young’s Modulus?

**Plan**

* Next week I would investigate how to modify the constraints and external forces in the package, as in our falling SRA simulation, the SRA is released from a certain point in the space, so there must be a force acting on the end-effector of the manipulator;
* I will try to use SRL and EBR methods to do some simple simulations based on the examples provided by the author.