# **Weekly Report – W8 Spring 2023**

## **Task & Problem**

1. Coupling the dynamics of arms into the whole system;
2. Communication between MATLAB and Arduino;
3. Test the relationship between force/torque between pressure input for the pneumatic chambers;

## **Solution**

1. Coupling the dynamics of arms into the whole system

Now since we only have the dynamics of the arms only, according to the EOMs of the whole system, we have to put them together with the human’s in the future, the biggest challenge is that we have to change the size of the original inputs and outputs of the ode solver in simulation package from to . The size of original input could vary according to the order we set for the system (we have summarized about it in last week’s report).

If the inputs and outputs of ode solver is in row vectors, there is still a chance that we can add an intermediate transformation matrix with size ; however, the regulation of column vector makes it unrealistic to achieve, currently the only two methods I can come up with are listed as follows:

(1). I know there might exist some other second and first order terms related to the human’s motion, since we cannot unify their state variables, to move all of them to the right hand side of the equation in the format of external force/torque could be a possible solution;

(2). Or we can try to modify the state variable of the human with polynomial coefficients as well to unify the whole system, but in the current stage the human body can be seen as a rigid body, their degrees of freedom are defined differently. The polynomial coefficients are used to depict the bending angle and extension rate along the backbone axis (via some transformation matrices, they can be converted into position and orientation, or furthermore into specific position and velocities in the Cartesian 3D coordinates), in my understanding these coefficients can be seen as a constant for human (rigid body), maybe we can realize it somehow, it seems more promising than proposal (1), I need to talk to the author to consult some advice first and think about to fulfil it in the future.

**PS:** By forcedly converting the size of state variables could cause some other issues, such that if we use the post-processing functions to transfer the polynomial coefficients into position and velocities in xyz, for sure, the positions and velocities might not be related with all the coefficients, but the solution of these coefficients might be determined by others unused, the consequence of this action is unknown, so the conclusion is that to directly change the size of input and output of ode functions is a risk.

1. Communication between MATLAB and Arduino

The mission has been assigned to Charanjit, on Monday we will test it.

1. Relationship between force/torque generated by the arm and the pressure supplies

According to the description about the controller (first stage) in the research proposal, the torque/force supply provided by the arms is determined by the states (position and velocity) of the human, then we can tell and send command to Arduino board about how much pressure we should apply to both arms, however the relationship between torque/force and pressure input is unknown, I suppose currently the only promising method is to rely on the simulation package. No matter for which type of the input in terms of external force exerted on the tip or pressure input in each chamber, we all have a resultant configuration of the arm, we can compare that to achieve the same configuration, how much pressure input and force input (or torque) we need to supply, then we will get the relationship between them. The specific test plan is scheduled as follows:

(1). Change the geometry factor of the force sensor mounted on the end effector of the arm by elongating it without changing the mass of it so that the configuration will not be affected so much with additional mass. The reason for doing this is to verify if the pressure input and force/torque input will cause the same configuration, we need to compare the positions for both tip and force sensor, only one position is accurate, elongating the force sensor is to make the position change of force sensor more obvious otherwise it will be too hard to distinguish the position of the force sensor from the tip of the arm;

(2). Because the three chambers are not directly corresponded with x, y and z directions, in most cases, we have to pressurize at least two chambers, now I’m still testing on the relationship.