Robotics Project 1

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***Abstract*—A robotic system needs to carry out certain motions and encounter variant interactions to perform a task. In this project, we attempt to represent the 6-DOF motions and interactions in a coordinate system and simplify them in a a fewer DOF space.**

I. Introduction

THE paper explores the various DOF motions. Humans perform a plethora of manipulations daily. To make robots more widely useful, researchers have been trying to help robots learn these manipulation tasks and generalize them to different situations, to which the approach of teaching robots by providing examples has received considerable attention, known as programming by demonstration. In this project, we attempt to use said demonstrations and analyze the datas which are collected after performing them [1]. We were motivated to do this project from works done by PhD students at the Robot Perception and Action Labs in University of South Florida. We came across works which showcased the observations of manipulations as seen in daily household tasks and routines [2], [3]. The researchers identified key motions in the household that can be useful for learning and understanding. These papers helped us a lot while analyzing our own observations for the movements. We also came across papers which analyzed motions and trajectories [4], [5], [6], [7] which helped us visualize the motions ourselves.

II. Experiment

We collected datas from various motions in the Robot Perception and Action Labs. We then processed the acquired data using Matlab by performing a coordinate system transformation to represent the motion and force in the object the initial pose. For each task and each of its stage, we identify their principal moving axes or planes, rotating axis, moving and rotating oranges, and key via points coordinate system. We then compute the linear velocity and angular velocity (axis and angle velocity) for each time step.

III. Procedure

We followed the following procedure over the course of three weeks-

- Data Collection :-Perform the actions of beat, dip and mix.
- Preprocessing :- In order to identify the start and end times (as frames) for recorded videos, we used VirtualDub to view the videos by its frames.
- Processing - Using programs provided by the professor to visualize the data and observe and understand the motions and force for each task.

Course Name: Intro to Robotics. The work is supervised by Professor Yu Sun and TA David Paulius.

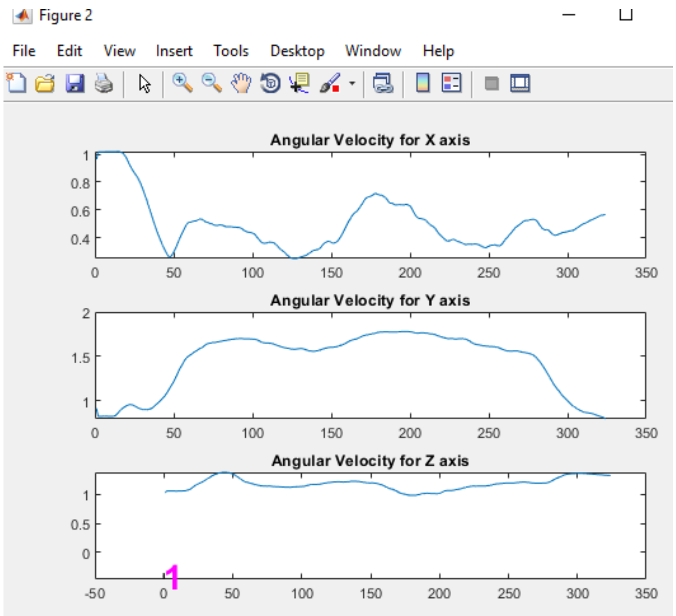

Fig. 1. Angular velocity of beat 1

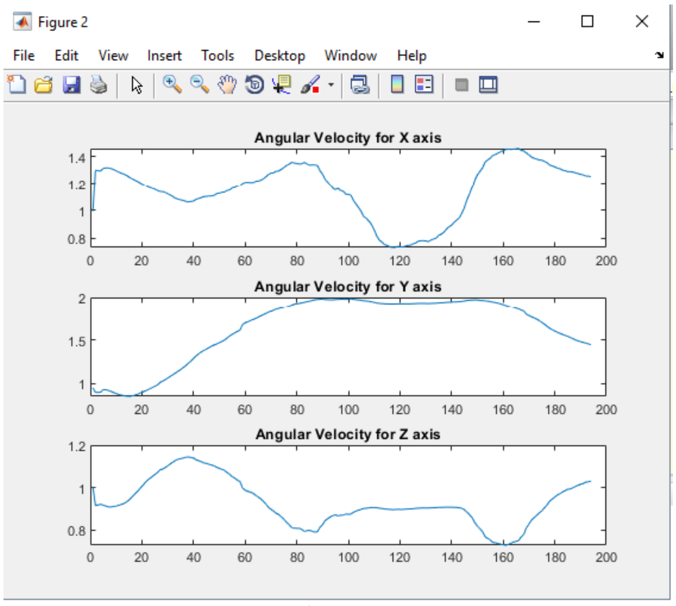

Fig. 2. Angular velocity of beat 2

IV. Observation

Upon examining the data points and linear angular velocities, we observed some interesting things.

- Even though at first glance one would assume that the beat and mix activities are similar, looking through the angular velocity graphs(Fig.1, and 9), we found out that,

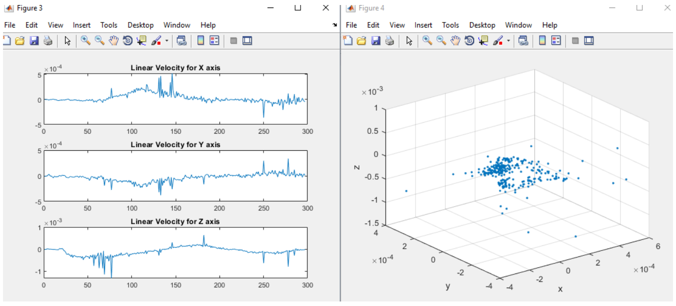

Fig. 3. Linear velocity of beat 1

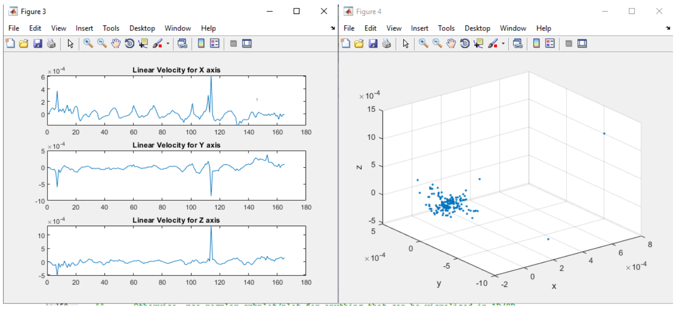

Fig. 4. Linear velocity of beat 2

despite having similar z-graphs, the mixing has greater frequency suggesting that mixing is faster than beating.

• Even though we can tell from common sense that dip motion is very different from the other two kinds of motions, it becomes even more evident from the graphs (Fig.9 and 10), as the angular motions possess no semblance with the other two graphs.

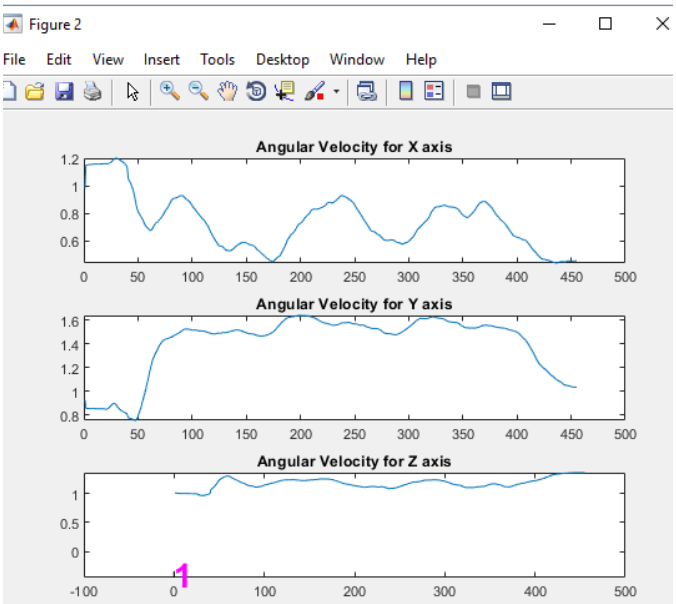

Fig. 5. Angular velocity of dip 1

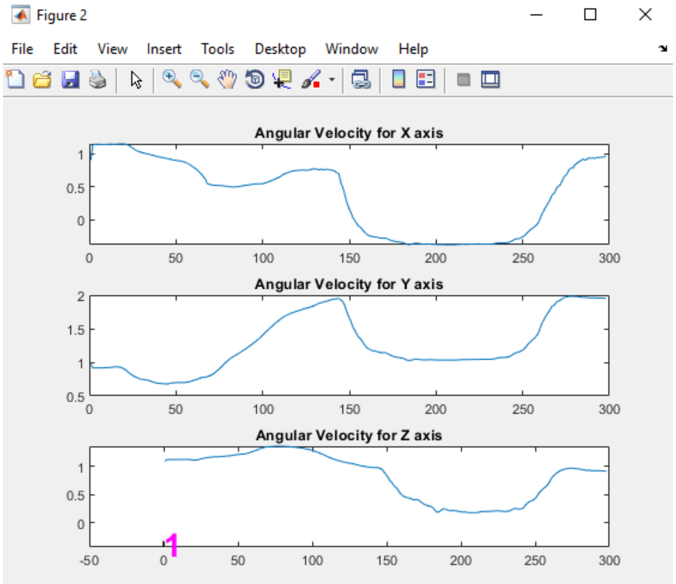

Fig. 6. Angular velocity of dip 2

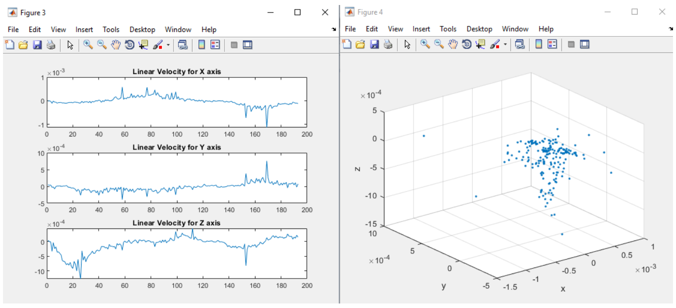

Fig. 7. Linear velocity of dip 1

• We can also determine from the graphs (Fig.2, and 10), that the principle axis for beat and mix is their Z axis.

•Although the linear velocity for all three movements looks similar to each other at first glance (Fig.3, 11, and 7), we can verify that the beating motion's velocity graph is almost a constant which indicates that the movement is very regular unlike mixing or dipping.

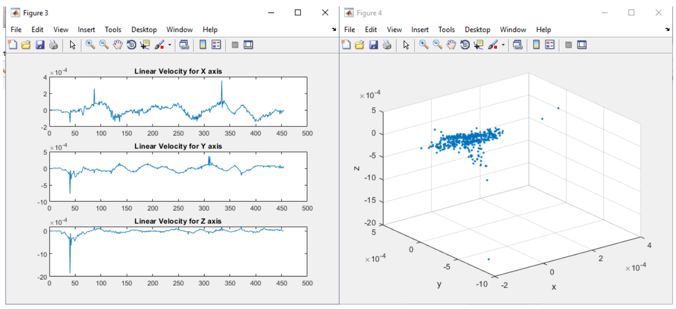

Fig. 8. Linear velocity of dip 2 .

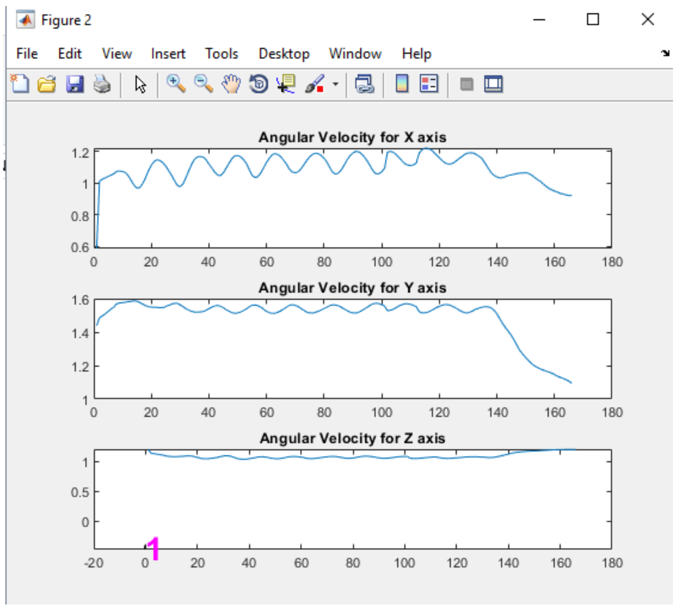

Fig. 9. Angular velocity of mix 1

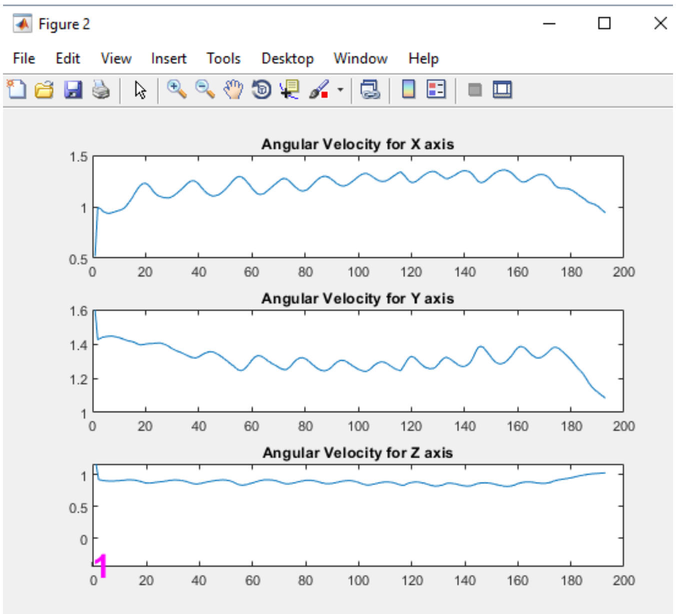

Fig. 10. Angular velocity of mix 2

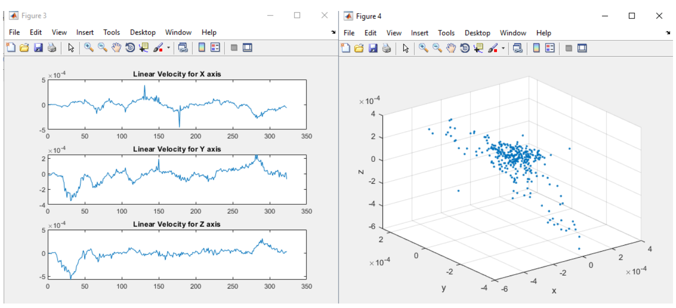

Fig. 11. Linear velocity of mix 1

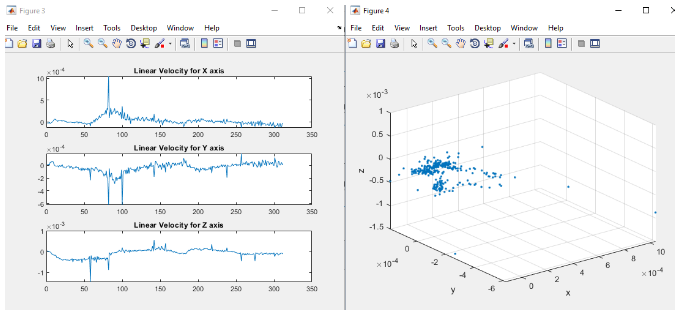

Fig. 12. Linear velocity of mix 2

V. Conclusion and Future Work

Through this project we learned how to model motions and interactions and further analyze them to come up with various kinds of conclusions. We understood the importance of creating and analyzing datapoints and it‘s significance in the field of robotics.

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References

[1] R. D. S. S. A. Billard, S. Calinon, “Robot programming by demonstration,” *Heidelberg:Springer Berlin Heidelberg*, 2008.

[2] D. Paulius, Y. Huang, R. Milton, W. D. Buchanan, J. Sam, and Y. Sun, “Functional object-oriented network for manipulation learning,” in *Intelligent Robots and Systems (IROS), 2016 IEEE/RSJ International Conference on*. IEEE, 2016, pp. 2655–2662.

[3] Y. Huang and Y. Sun, “A dataset of daily interactive manipulation,” *arXiv preprint arXiv:1807.00858*, 2018.

[4] ——, “Learning to pour,” in *Intelligent Robots and Systems (IROS), 2017 IEEE/RSJ International Conference on*. IEEE, 2017, pp. 7005–7010.

[5] ——, “Datasets on object manipulation and interaction: a survey,” *arXiv preprint arXiv:1607.00442*, 2016.

[6] Y. Huang, M. Bianchi, M. Liarokapis, and Y. Sun, “Recent data sets on object manipulation: A survey,” *Big data*, vol. 4, no. 4, pp. 197–216, 2016.

[7] Y. Huang and Y. Sun, “Generating manipulation trajectory using motion harmonics,” in *Intelligent Robots and Systems (IROS), 2015 IEEE/RSJ International Conference on*. IEEE, 2015, pp. 4949–4954.