For this project, we were required to find a better way to test high frequency vibration wear of a specimen. To do this we utilized magnetic bearings to provide our sponsor with a better method of testing for this mechanical wear. Using a magnetic bearing would serve as our device that’s able to test vibrational wear of up to 1000Hz at an amplitude of only 0.25mm. We were able to design a test rig that could utilize LabVIEW files we created in order to achieve this. This technique proved to be a more effective way of testing the mechanical wear in two dimensions, in comparison to the apparatus our sponsor is currently using at their facility.

### Design and Methods

- The basis for our design solution relies on our implementation and operation of a magnetic bearing to create the low amplitude high frequency motion required by our test rig.
- Our design solution includes a control system with Copley 423 amplifiers that drives current through the coils of the magnetic bearing and induces a magnetic field, resulting in motion in the metal core placed inside of the bearing.
- This motion is how we wear the test specimen. By placing the specimen in contact with a moving piece fixed and subjected to the movement of the metal core creating frictional wear in the x and y dimensions on the specimen.
- The fixture allows for a variable load to be applied from above to adjust the rate of wear between the specimens.
- Non-contact displacement sensors are placed on the XY axis of the bearing to further visualize and record accurate movement of the moveable interior core to verify the accuracy of how the input signal translates to mechanical frequency and wear patterns.
- The above figure 6 depicts the front panel of our control program as accessed by a user wishing drive current through our amplifiers.
- It allows for selection of the frequency of the waveforms, and thus frequency of motion in our iron core, and variation in phase shift between the two output waveforms to allow for circular and elliptical wear patterns.
- To visualize the path the iron core will take the provided XY graph depicts the wear pattern as dictated by phase shift.

### Results

- Figure 7 shows the output current waveforms of each of our four amplifiers to their respective bearing quadrants.
- Opposite quadrants (blue and yellow, green and purple) are seen to be the inverse waveform of each other, indicating a smooth linear application of oscillating force along the respective x and y axes.
- The two sets of opposing quadrant represent the x-axis and y-axis, and the observed 90 degree phase shift between the two axes indicates a circular motion, as intended.
- Note that the current is always greater than 0 A, as a negative current still creates an opposing force.
- As such, we biased our current output so that the difference of the absolute values of current through the coils of opposite quadrants was zero.

### Conclusions

- Our test rig was able to successfully test for vibrational wear at a frequency of 1000 Hz.
- Potential for increased frequency of vibration.
- Ability to further customize wear pattern of iron core on specimen.
- Further improvements and testing possible for load application on specimen.
- Needed solution for keeping iron core from contacting pole faces.
- Potential for magnetic levitation of iron core in future iterations.

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