Balsam Labs 2021
End of Year

Anthony Steel

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1 Projects

This year the lab pursued two projects:

1. A blender that sounds good
2. A robot that cooks for people

The blender was started to provide a source of income for the lab by 2024.

2 Blender

Why are blenders loud? A common answer would be that they require a reasonably powerful motor. By far the most common power drive for a blender is a univerisal AC brushed motor. This is a motor which uses graphite sticks called brushes to send the correct electrical signals to the motor to induce a rotating magnetic field. The process of sending these signals is known as commutation and because brushed motors use physical contact to accomplish it, they are inherently sound producing. One can remove this source of sound by using a permanent magnet (PM) motor. However, the cost of the blender is increased for two reasons. Firstly, the commutation must now be accomplished through electrical feedback and a motor controller. Secondly, because the speed of the motor must vary, the commutation signals must be generated by an inverter from a DC power supply.

In January 2021, a simple prototype was developed to test the sound reduction produced by using a PM motor instead of a universal brushed one. The prototype is pictured in Figure Blah. The prototype contained:

1. T-Motor
2. T-Motor
3. An external DC power supply.

Though this resulted in approximately 20dBA reduction on a sound meter at three feet, the sound being produced was still loud and unpleasent[1].

[1]It would be expensive and time consuming to build an anachoic chamber with exhaustive sound metering to produce quantitative sound measurment. Sound reduction measurement has been performed with a cheap handheld sound meter and subjective experience by ear. The final intent for the blender is to be a consumer product so the most important measurement is subjective perception of the sound.

The primary source of persistent sound was a result of a process called magnetostriction within the motor. Broadly defined, magnetostriction is a property of magentic and ferromagnetic materials that causes them to change their dimensions when they are magnetized. This change in dimensions causes resonance vibrations with the motor chassis and surrounding material which leads to audible sound. In order to reduce the sound produced by magnetostriction there are two options.

1. Engineer a new ferromagnetic material which inherently undergoes less magnetostriction from an applied current.

2. Produce the magnetic field which causes the least audible amount of magnetostriction.

Because the first option was deemed out of scope, the second was pursued.

Through experimentation, it was discovered that the audible noise generated by the motor was reduced when a smooth sine wave was sent as a commutation signal. The means of producing this signal was by a method known as Field Oriented Control (FOC).