

USER STORY

Electric Motor Temperature Estimation

- Most electric cars use permanent magnet synchronous motors (PMSM). The main motor components lack accurate temperature monitoring.
- High temperatures must be avoided at all times otherwise the consequences could be failing components like stator winding insulation which may melt and the permanent magnet could suffer from irreversible demagnetization.
- At the moment safe operation of the motor is ensured by oversized materials which increase production costs.
- A sufficiently accurate prediction model would therefore eliminate the need for sensor measurements to determine the permanent magnet temperature.
- Other methods have been used in Engineering to predict the temperature although classic thermal modeling requires expertise in Thermodynamics and suffers restrictions when applied in real time the applications
- Temperature control of the elements of the motor are important as high temperatures in the permanent magnet could demagnetize it damaging the motor irreversibly.
- By using linear regression model we can achieve a simple model with time-invariant properties which can be directly implemented in the real time control system of the motor.

Data Set Details:

Ambient: Ambient temperature is the temperature of the air surrounding the motor. This is the threshold point or temperature the motor assumes when shut off and completely cool. Temperature rise is the change within a motor when operating at full load.

Coolant: A coolant is a substance, typically liquid or gas that is used to reduce or regulate the temperature of a system. An ideal coolant has high thermal capacity, low viscosity, is low-cost, non-toxic, chemically inert and neither causes nor promotes corrosion of the cooling system. Some applications also require the coolant to be an electrical insulator.

While the term "coolant" is commonly used in automotive and HVAC applications, in industrial processing heat transfer fluid is one technical term more often used in high temperature as well as low-temperature manufacturing applications. The term also covers cutting fluids. Industrial cutting fluid has broadly been classified as water-soluble coolant and neat cutting fluid. Water-soluble coolant is oil in water emulsion. It has varying oil content from nil oil (synthetic coolant).

This coolant can either keep its phase or stay liquid or gaseous, or can undergo a phase transition, with the latent heat adding to the cooling efficiency. The latter, when used to achieve below-ambient temperature, is more commonly known as refrigerant.

Motor speed: The speed of a motor is defined as the rate at which the motor rotates. The speed of an electric motor is measured in revolutions per minute, or RPM.

Torque: Torque is a rotating force produced by a motor's crankshaft. The more torque the motor produces, the greater is its ability to perform work. Since torque is a vector acting in a direction it is commonly quantified by the units Nm or pound-feet.

I_d (Current d-component), i_q (Current q-component): d - and q -axis components of (a) the stator voltage and (b) the stator current. The machine was healthy, and operated at $\omega_e = 100$ Hz (200% rated speed), rated slip, with constant modulation index of $m = 0.975$.

PM: A permanent magnet (PM) motor is an ac motor that uses magnets imbedded into or attached to the surface of the motor's rotor. This article provides an elementary understanding behind the terminology, concepts, theory, and physics behind PM motors.

Stator yoke: Stator yoke temperature is measured with a thermal sensor.

Stator tooth: Stator tooth temperature is measured with a thermal sensor.

Stator winding: Stator winding temperature measured with a thermal sensor.

Profile id: Each measurement session has a unique ID. Make sure not to try to estimate from one session onto the other as they are strongly independent.

The data set has over 100,000 readings it's already cleaned and normalized. The initial stages of EDA I have explored the data, using visualizations that show the relationships of the variables.