



Cold Movement

Interactive Dashboard Technology

CORE FEATURES

Cloud Hosted

Dashboard hosted through Heroku, allowing for quick, reliable access through the Internet.

Interactive graphical display

Graphs created using Plotly, enabling users to track data points over time by hovering over them, and hide graphs not needed at the moment.

Advanced Statistical Modeling and Analysis Techniques

Use of anomaly detection to pinpoint outlier data and normalization techniques to create a metric for how “normal” a data point is.

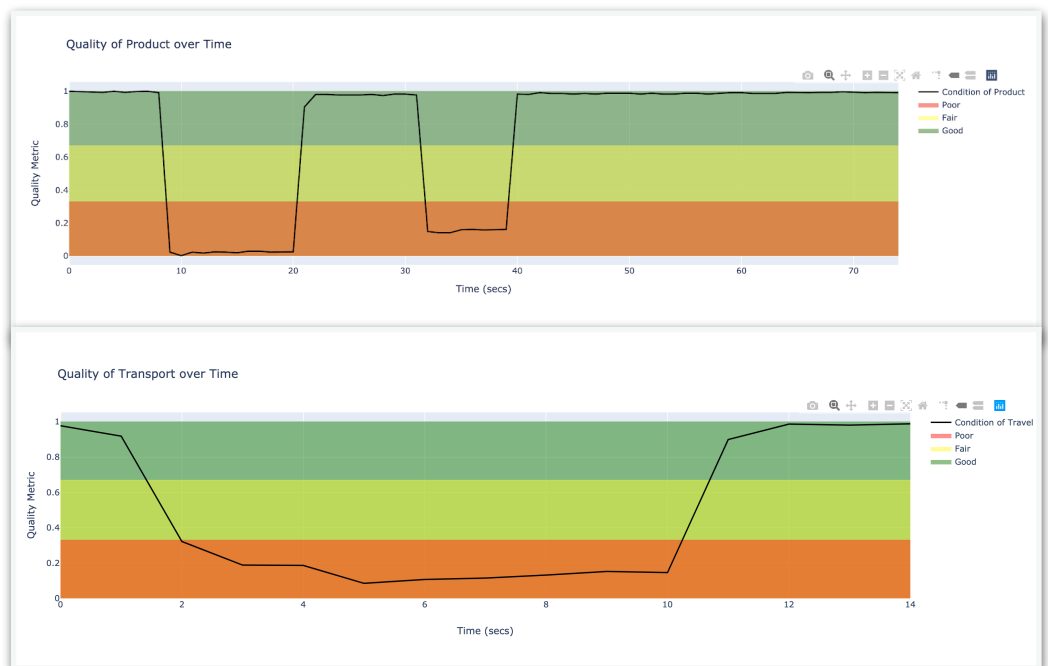
Cold Movement’s interactive dashboard provides a quick summary of the transport of temperature sensitive pharmaceuticals as well as an in depth look at the factors used to determine their condition during transit.

These factors are:

- Temperature
- Tilt angle
- Acceleration

Using interactive graphing technology and various statistical modeling and analysis techniques, maintenance personnel in distribution centers can quickly determine from viewing our dashboard of a potential emergency in the supply chain of life-saving oncology medication.

Summary Graphs and Statistics



A summary of the quality of the temperature sensitive drugs is the first visual on the webpage, and indicates based on how much the temperature of the drugs deviates from ideal temperatures the condition of the product. A second summary graphical visual indicates the quality of the transport of the pharmaceuticals, using a weighted average formula of the recorded acceleration and tilt angle of shipping containers. One can hover over the black line to determine actual metric at every second (this interactivity is a feature of every graph).



An In-Depth Look

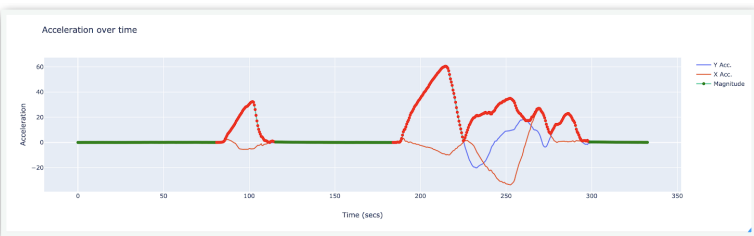
Feature-Specific Graphics

Temperature



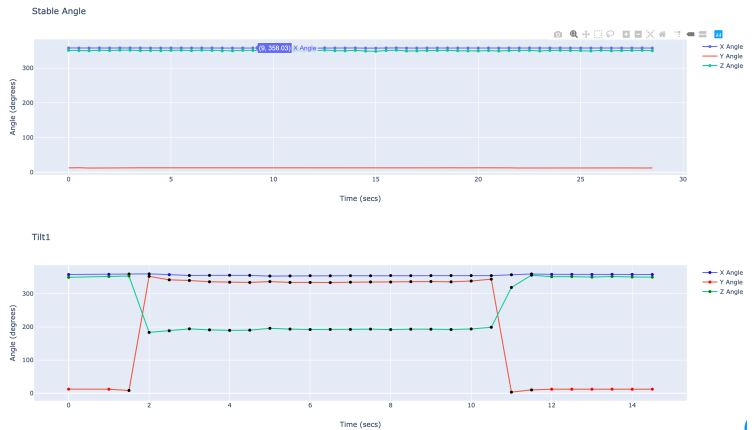
The temperature of the drugs is of primary concern and two visuals are meant to analyze object and ambient temperature to ensure that the product is in good condition. The first graph compares object and ambient temperatures and includes a range of ideal temperatures (centered at 65 degrees Fahrenheit). The second looks more closely at the difference between object and ambient temperature, flagging times in which the difference is an outlier with the red color. These times would alert a maintenance worker that this shipment of medication needs to be further inspected.

Acceleration



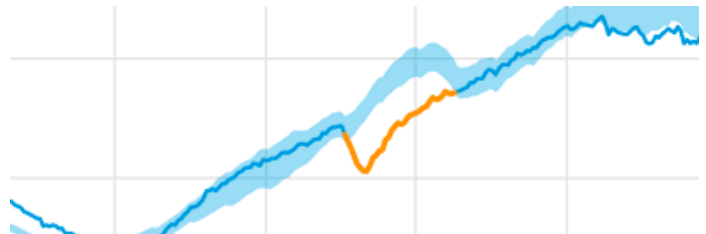
Acceleration is the final metric measured by Cold Movement sensors. The magnitude of acceleration is plotted over time above as a dark red and green line. The dark red represents anomalies and detected using a moving average technique which looks at where the change in moving average over time deviates significantly from the mean in the green sections. The moving average enables a more accurate indicator of outliers and perturbations than a simple average as the simple average by definition can only look at the data as a whole while the moving average looks at the data in chunks, hence being more intuitive in finding outliers.

Tilt Angle



Tilt angle is also measured with Cold Movement sensors, in the X, Y, and Z axis. The above graphic shows control group tilt angles in each axis over time for an ideal movement of medication. The graphic below shows a particular transport cycle in which perturbations are involved. Points where the tilt angle is statistically an outlier (with the control group used as the mean tilt angle to calculate this) are marked in black so that maintenance workers can detect such issues in transport earlier.

Moving Forward



In the future, an anomaly detection classifier model will be used to determine which points are "abnormal" and will take into account acceleration, as well as temperature, and tilt angle. This will provide a more accurate understanding of points in time where transport is not optimal. Live data processing from Cold Movement sensors will also be incorporated into the dashboard.