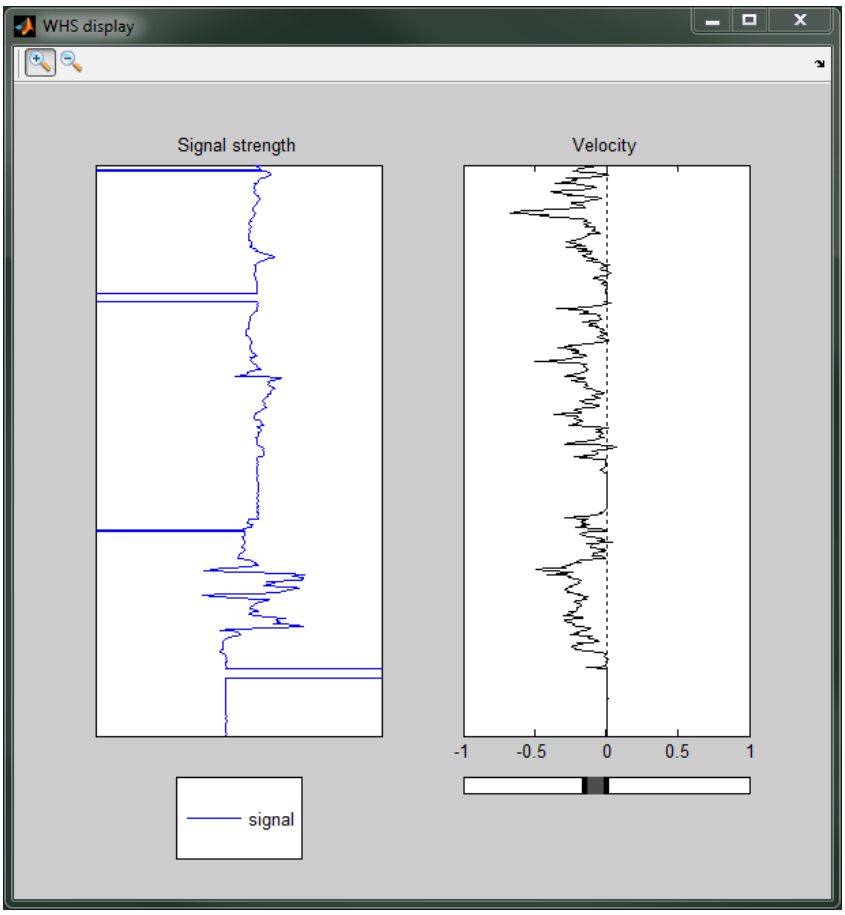
Welltec ESGI proposal

BACKGROUND

The Well Hardware Scanner (WHS) is a Welltec sensor tool, designed to help position the tractor as well as to scan particular items. The signal comes from measuring a magnetic field, which is distorted by the steel casing. Characteristic spikes or signatures show when the tool passes any significant feature. These characteristics are repeatable to a high degree, and can be used to recognize and compare features.
Simultaneously, the velocity of the tool is calculated. This is done by correlating buffered signals from neighboring sensors. The calculated velocities are combined (currently using a Kalman filter) to a single velocity estimate. This is then integrated to obtain an estimate of the position.



Welltec RD
July 12 2010

PROBLEMS FOR ESGI:

Assume that the casing structure lies between two surfaces of revolution.

#1

CONSTRUCT A MATHEMATICAL MODEL OF THE SENSOR and provide an analytical solution, maybe as a linearization/series solution and maybe confirm through simulation in COMSOL.
The model should be able to simulate the output of the sensor, given a casing structure.

The model will be used to answer answer questions about the relation between the measured signal and the physical properties of the casing. These questions will be specified further in the presentation on the Monday of ESGI week.

#2

WHAT IS THE OPTIMAL PLACEMENT OF SENSORS, with respect to the amplitude of the signal, the accuracy of the velocity estimate and the size of the smallest measurable inhomogeneity.

#3

THE VELOCITY ESTIMATE from the sensor-unit is calculated via a Kalman filter. The filter receives updates from the six neighbouring-sensor pairs. Each sensor pair provides a velocity estimate by correlating the signal from each sensor in the pair.
Is there a more accurate way to estimate the velocity?

#4

BREAKING THE ROTATIONAL SYMMETRY: Assume that the casing structure is rotationally symmetric, except for a perturbation in the angular direction, in the shape of a box-car function. The casing thus has an interval, at a certain angle, which is thicker than the rest.
What is the consequence for the measured signal as a function of the angle of the sensor with respect to the location of the perturbation?