1 Introduction

In this report a micro radar system is utilized for surface classification. Specifically, a radar sensor is placed on the inside of a robot facing downwards, with the objective of distinguishing if the surface below is made of grass and dirt or not.

2 Radar system overview

The radar system used for this project is a 60 GHz radar developed by Acconeer AB.

An antenna transmits a wavelet signal towards an object of interest. After a brief period of time a second wavelet signal is generated and *mixed* with data from a recieving antenna. This procedure is repeated, every time slightly delaying the generation of the second wavelet and thus mixing with a different section of the incoming pulse.

Throgh this methodology we can effectively produce

2.1 The radar principle

The radar principle is at its core simple. A wavelet pulse $x_T(t)$ with some carrier frequency Ω is transmitted towards an object of interest.

etc etc..

2.2 Matched filter

something something desired frequency response of the recieving antenna.

In any radar system a good Signal-to-Noise Ratio (SNR) is a highly desired property. Finding a reciever frequency response which maximizes SNR is thus an important topic. Denoting the reciever output as $y(t)$ and the incoming waveform as $x(t)$ the output spectrum will be a convolution of $x(t)$ and the system impulse response $h(t)$, or conversely a multiplication in the frequency domain $Y(\Omega) = X(\Omega)H(\Omega)$. If we seek to maximize SNR at some arbitrary point in time T_M the power at that very instant is

$$|y(T_M)|^2 = |\frac{1}{2\pi} \int X(\Omega)H(\Omega)e^{j\Omega T_M} d\Omega|^2. \tag{1}$$

If we also have white noise present in the signal with spectral density σ^2 W/Hz the total SNR ξ is

$$\xi = \frac{|(1/2\pi) \int X(\Omega) H(\Omega) e^{j\Omega T_M} d\Omega|^2}{(\sigma^2/2\pi) \int |H(\Omega)|^2 d\Omega} \tag{2}$$

It can then be shown [reference] that ξ is maximized when

$$H(\Omega) = \alpha X * (\Omega) e^{j\Omega T_M}, \text{ or} \tag{3}$$

$$h(t) = \alpha x^*(T_M - t) \tag{4}$$

2.3 IQ demodulation

3 Feature selection

4 Classification

5 Discussion