Advanced Digital Signal Processing: Imaging and Image Processing

TECHNISCHE UNIVERSITÄT DARMSTADT

Exercise 4: Image Formation **Due date: 29.06.2015**

Problem 1 – Backprojection

In this exercise, you will implement a reconstruction algorithms for the simulated images in exercise 3. Before the image is reconstructed, the space of the final image has to be discretized.

a) Given the sampling frequency f_s and the wave propagation speed c, find a plausible value for the distance d_s between neighboring elements (resolution) in the discretized image.

The image I is reconstructed by

$$I(x,y) = \sum_{l=1}^{N_l} ss_l(t_d(x,y)).$$

where $ss_l(t)$ is the modulated received pulse compressed signal. The position in the scene is denoted by $x_l \leq x \leq x_h$ and $y_l \leq y \leq y_h$. For the implementation, proceed as follows.

b) For each ping and position in the discretized image space, compute the distances to the sensors, $d_x(x,y)$, $d_y(x,y)$, and the corresponding time delays $t_d(x,y)$.

c) Next, modulate the phase of $ss_l(t_d(x,y))$ by computing

$$ss_l(t_d(x,y)) = ss_{l,b}(t_d(x,y)) \exp\{j2\pi f_c t_d(x,y)\}. \quad (1)$$

Finally, compute $I(x,y)$.
Note: $ss_{l,b}(t_d(x,y))$ is the baseband signal corresponding to $ss(\tau_d(x,y))$.

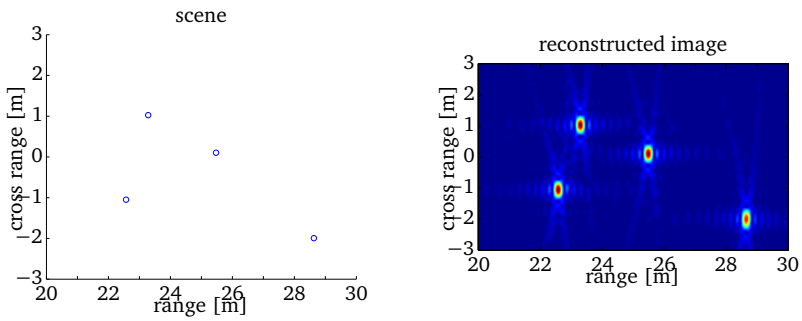

Figure 1: Original scene (left) and reconstruction (right).