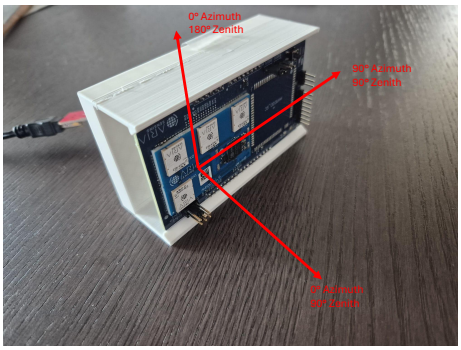
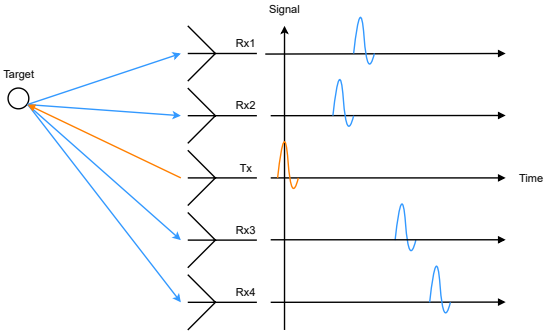
Precise UWB radar for collision detection

Leica Geosystems AG produces precise laser scanners, which are mounted on industrial robots to get a three-dimensional scan of a target. The industrial robot follows a pre-programmed path and has a possibility to collide with the target. In order to prevent such collisions, a precise ultra-wide-band radar was evaluated for possible use in a collision detection system.



Aria Sensing AHM3D UWB Radar module mounted on a development board with the axes marked.



Different time of arrival of the signal at the antennas leads to the angel of arrival of the echoe.

Collision detection

The industrial robot on which the laser scanner is mounted moves up to 2 m/s and very close to the target in order to minimize the time to scan an object. The target can have complex geometries, for example car bodies where parts of the exterior and interior needs to be scanned. Because of this, the collision detection system has to be able to get three dimensional information of the position and velocity of obstacles in the robots vicinity.

UWB impulse radar

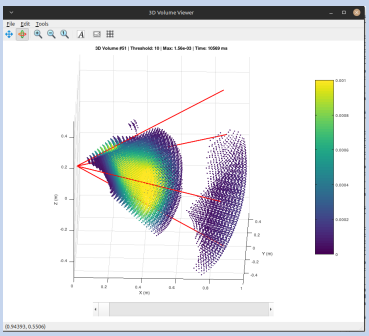
The proposed sensor technology for the collision detection system is a ultra-wide-band (UWB) impulse radar. An impulse radar sends a short radio signal and listens for a returning echo, calculating the distance from the time of flight. The shorter the duration of the pulse, the higher its bandwidth is. With a higher bandwidth, the distance resolution of the radar improves. UWB systems operate at bandwidth greater than 500 MHz which allows for good distance resolution, but reduced maximum distance.

Beamforming

Instead of a single directional antenna which can only scan a small area of space and needs to be physically moved, an array of multiple static antennas is used. The resulting radio signal can be electronically steered into a area of space, called beamforming. The inverse is also true, and due to different angels of arrival at the antenna elements, the position of the echo can be evaluated. Using a rectangular arrangement of antennas, the three dimensional position can be estimated.

Results

The reconstructed image can be visualized in a three dimensional plot with a pixel grid. The color of each pixel represents the intensity of the echo received from that point in space.
The tests showed that the distance resolution is mainly dependent on the bandwidth and could only reach up to 9 cm. The angular resolution is dependent on the arrangement of the antenna array and can be optimized. Velocity determination is possible with either the Doppler effect or evaluating the delta of the position between frames.



Project Team:
Nico Neiger

Client:
Leica Geosystems AG, Unterentfelden

Coach:
Prof. Dr. Mathieu Coustans