# Abstract

The presence of anti-personnel and anti-tank mines and other explosive remnants of war, such as artillery shells, grenades, rockets, bombs, and cluster munitions, is a serious global threat in areas of ongoing and past armed conflicts. For this reason, the issue of demining areas with mines and other dangerous objects is currently and will be of great practical importance in the coming years.

One of the effective technologies used in the search for mines is georadar technology. Ground penetrating radars are used to detect, localize, and image objects located in the near-surface layers of the ground. They can be installed on manned or unmanned vehicles, however, when operating in difficult terrain or inside buildings, handheld GPRs are often used. Obtaining valuable GPR images requires knowing the location of the GPR antenna at the time of transmitting probing signals, which in the case of a handheld GPR, in which the trajectory of the antenna movement is non-linear and variable speed, requires equipping the GPR with an accurate positioning system.

This dissertation concerns the development of a method for estimating the position and movement parameters of the HH-GPR (*Hand-Held Ground Penetrating Radar*) antenna, implemented in a positioning system using UWB (*Ultra-Wide Band*) radio modules. It presents the concept of such a system in which distance measurements are made and processed between UWB modules included in four base stations located around the search area and UWB modules placed in two mobile elements of the system.

Due to the specific shape of the scanning trajectory when using the HH-GPR radar, which resembles more arc fragments than straight line segments, and due to the nature of the antenna movement, which is analogous to the movement of a mathematical pendulum, this work proposes the use of modified equations describing such movement for modelling how the antenna is moved during each single scan. This model was then used to develop two filtration algorithms, i.e., the extended and unscented Kalman filter. For comparison purposes, the least squares estimation algorithm and two extended Kalman filters based on linear, kinematic dynamics models for motion with constant speed and constant acceleration were developed for the considered system.

The developed positioning system with various filtration algorithms was tested by simulation and experimentally, proving the two theses formulated in the dissertation. Namely, it has been shown that the use of UWB modules in a local positioning system enables the estimation of the position and motion parameters of the handheld GPR antenna with very high accuracy, with positioning errors not exceeding single centimetres. Moreover, it has been demonstrated that the use of the dynamics model based on a modified mathematical pendulum motion model in the Kalman filtering algorithms used to estimate the position and movement parameters of the handheld GPR antenna makes it possible to significantly increase the accuracy of position estimation compared to Kalman filters using kinematic models of object motion.