A Dataset for Aftermath Victim Detection Behind Walls or Obstacles Using an UWB Radar Sensor

D.Uzunidis[(1)], E. Margaritis[(2)], C. Chatzigeorgiou[(1)], C.Patrikakis[(1)], S.Mitilineos[(1)]

(1) Dept. of Electrical and Electronics Engineering, University of West Attica, Athens, Greece (smitil@uniwa.gr)

(2) School of Pedagogical and Technological Education, ASPETE, Athens, Greece

We employ a commercially available Ultra WideBand (UWB) radar sensor to detect victims behind large obstacles, such as walls and doors. Using this radar, we have created an openly accessible dataset with 15 hours of data records for a number of different scenarios. We also introduce and apply a novel and of low complexity method which attained a more than 95% accuracy in victim detection.

The challenge

First Responders (FR) need tools for the detection of trapped victims during or after a catastrophic event with the following characteristics:

a) reduced cost, in order to equip as many as possible members of the FR unit, reducing in this way the detection time of trapped victims

b) easy to use, lightweight and fast deployable, in order to be deployed easily by any FR team member regardless his/her body shape and gender

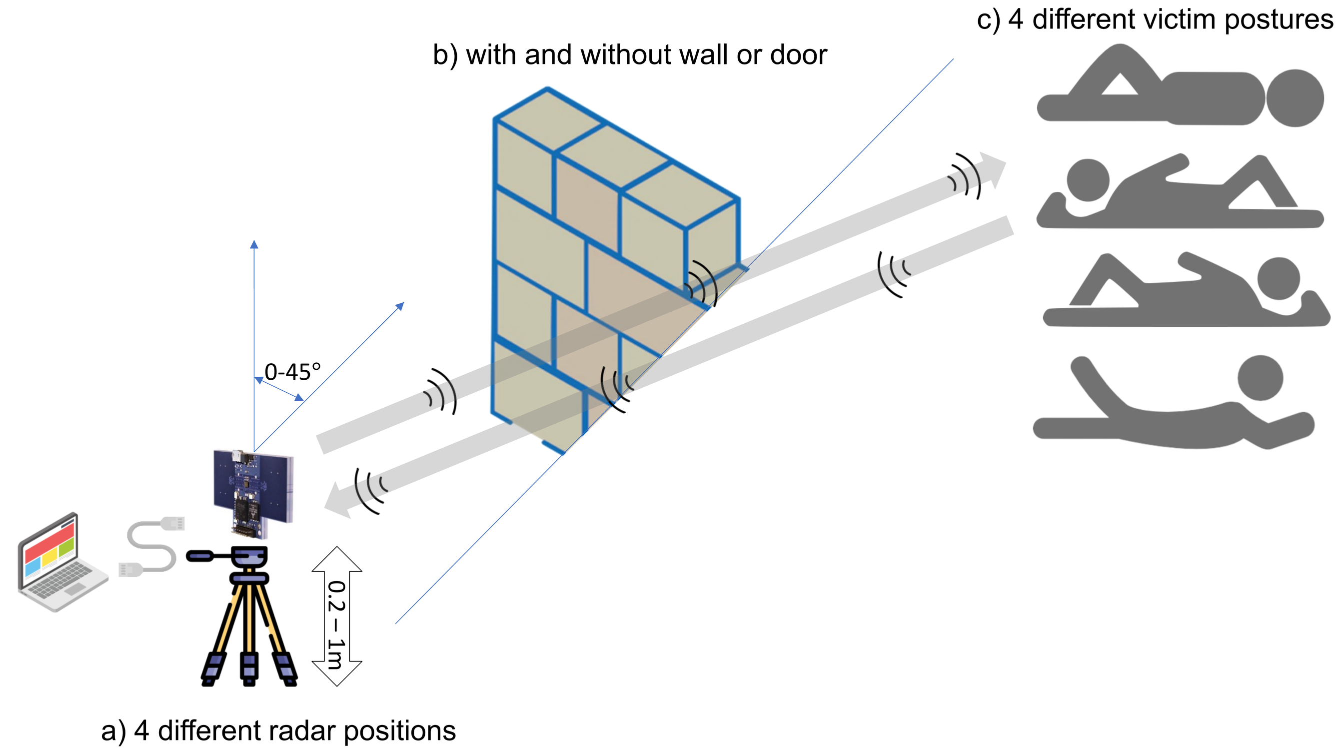
c) high accuracy, in order to minimize the possibility of misguiding the FRs, e.g. when a victim is not present within the area of observation

Proposed solution

The proposed solution addresses all these challenges as it incorporates:

a) a low cost and commercially available radar sensor, the X4M200 UWB radar sensor by Novelda, which operates in the X-band (8.0 – 10 GHz) using a transmitting bandwidth of > 1.5 GHz, a sampling rate of 17 samples per second and a distance step of 0.0514 m.

b) an algorithm that processes the received signal, and based on its standard deviation can detect the torso movement of the victim due to breathing with high accuracy for a number of distances and victim positions



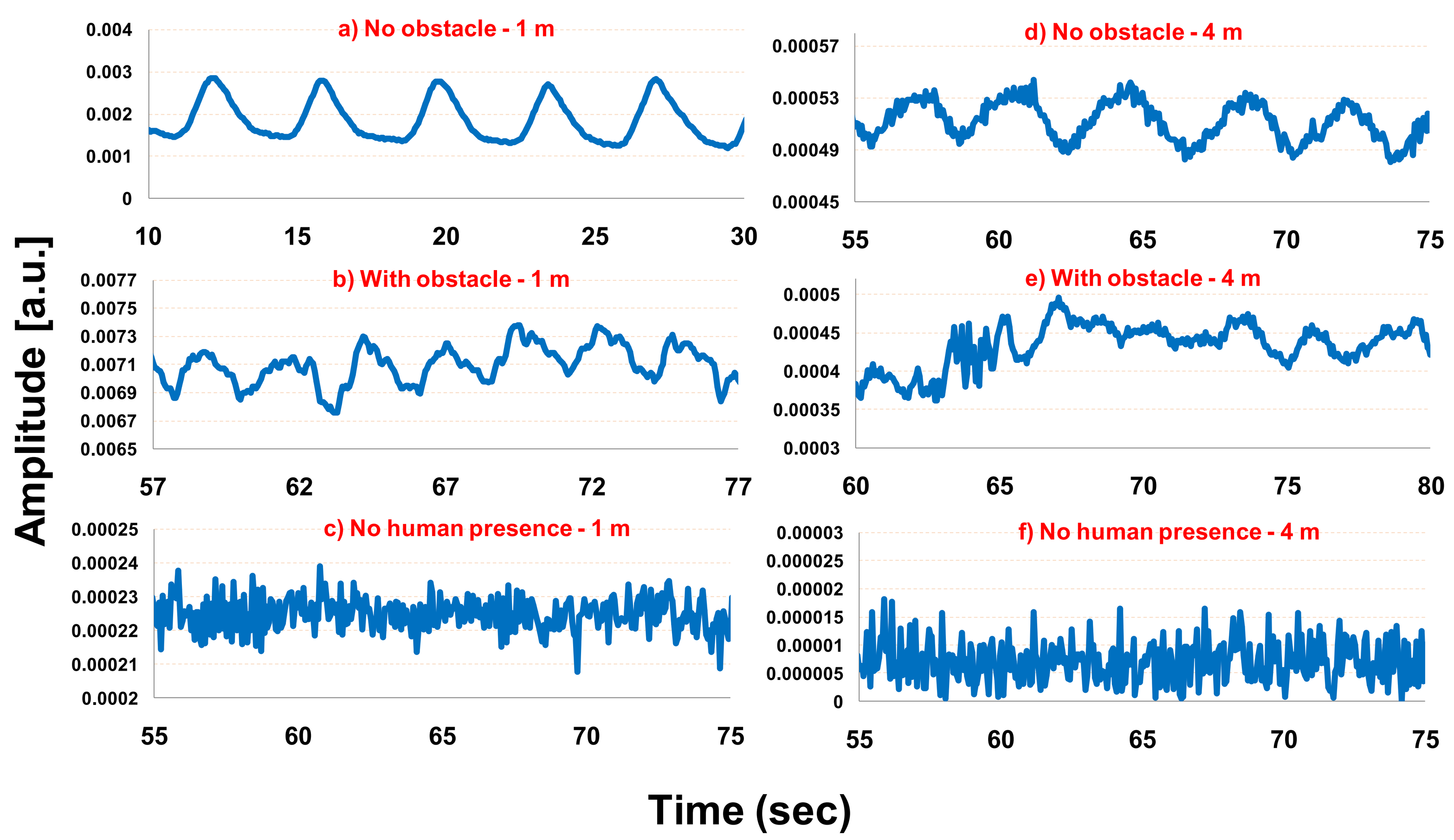
Collected dataset

The collected dataset is openly accessible in Zenodo and comprises about 7.5 hours of recording data from nine humans for various cases and more than 350 sessions, as well as an almost equal time of 7.5 hours from an indoor environment without any human presence.

TABLE II. DETAILS OF THE CREATED DATASET

	Distance from the radar (m)	*Number of Sessions*	*Number of samples*
Without Obstacle	0.5 – 5.0	160	13,317
With Obstacle	1.0 – 5.0	191	15,083
No human presence	0.5 – 5.0	12	27,712
Total		363	56,112

An example of the amplitude of the received radar waveform for three representative cases is shown below.



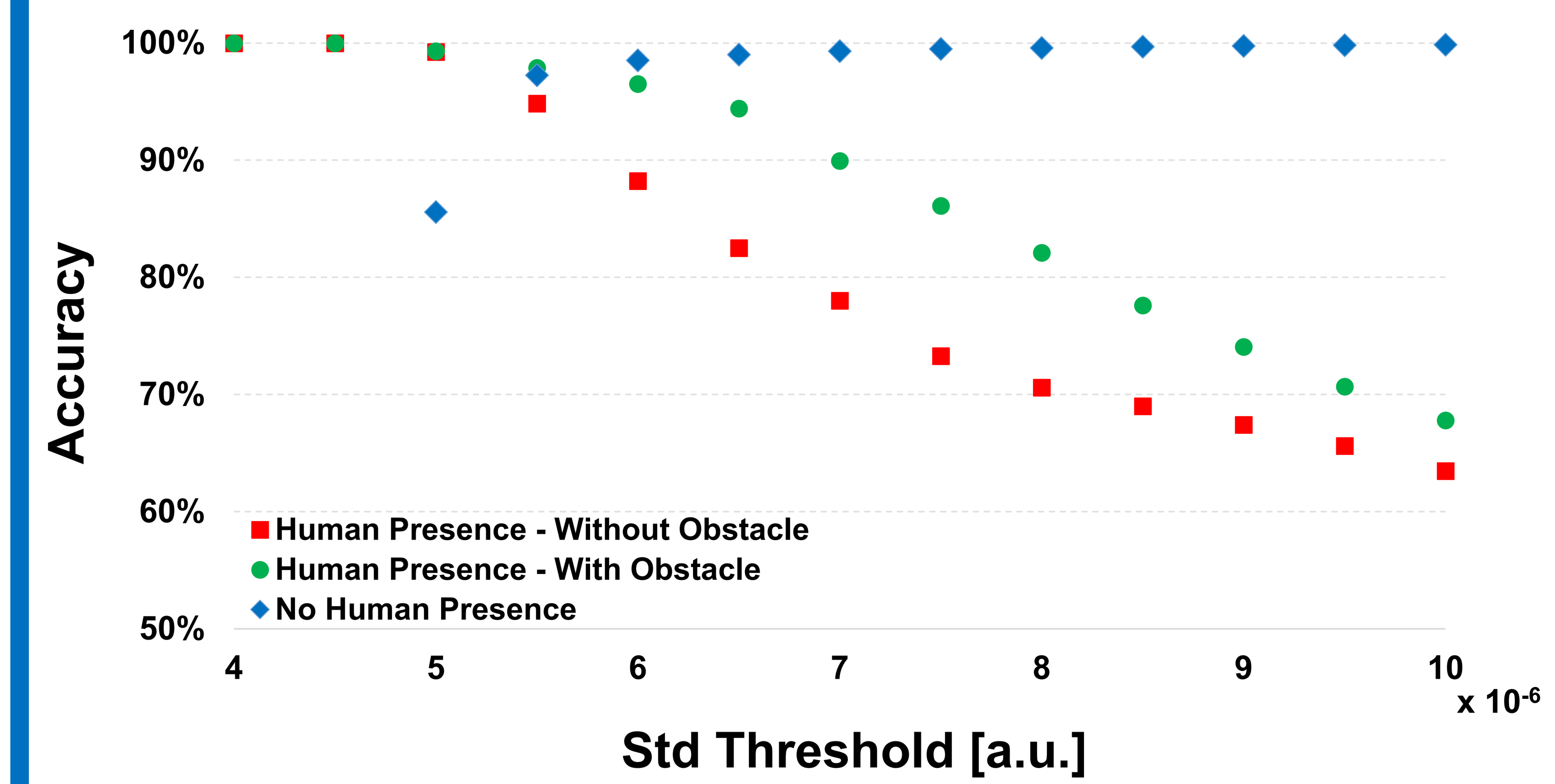
Algorithm for victim detection

For each received signal sample, noted as A(z,t), which is an array with a size of 109 x 102 (109 distances and 102 samples in time) we first estimate the standard deviation using the 102 values for each distance, which leads to 109 values of standard deviation. Then, we average over these 109 values to get the average standard deviation (one value for each sample). If this value clears a pre-specified threshold, human breathing is designated.

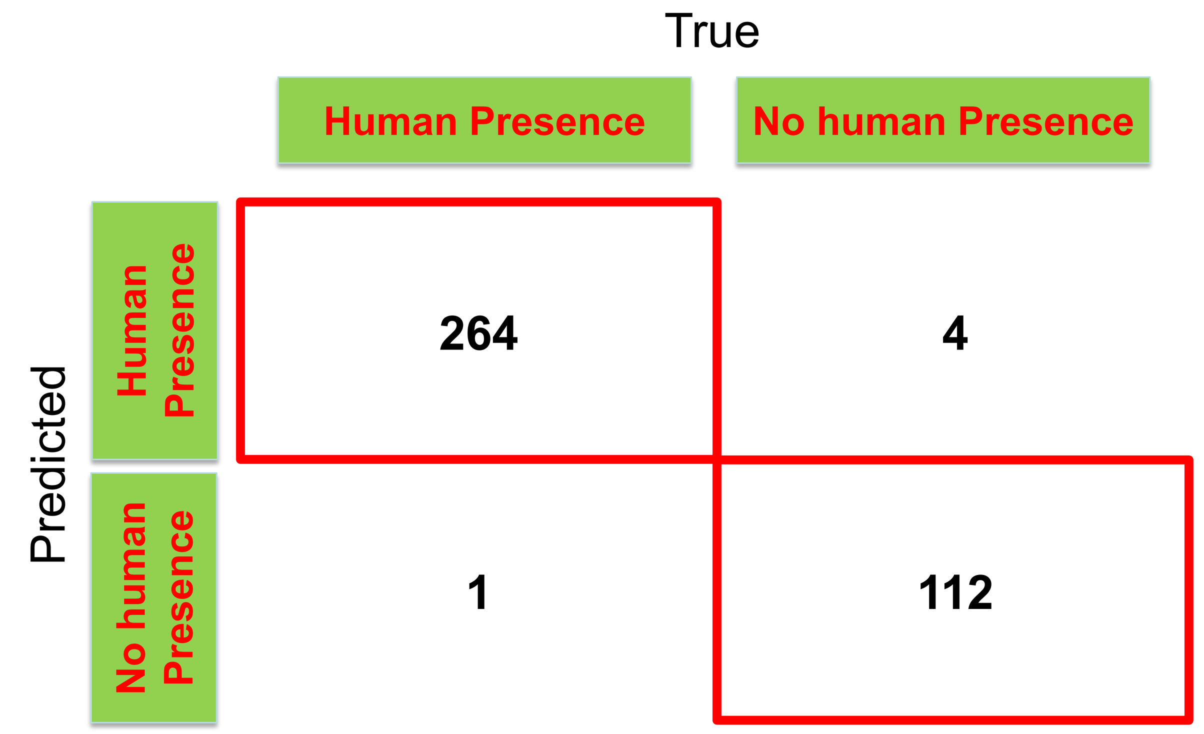
Results and conclusions

Regarding the accuracy of the proposed algorithm we can conclude that:

- the optimal radar placement for the detection of a lying victim is 20 cm from the ground
- the accuracy of the proposed algorithm in both true positives and true negatives cases exceeds 95%, which is a significant improvement compared with our previous work



- additional tests in three other places for various victim's positions, with and without the existence of a wall, led to an F1-score and accuracy greater than 98%.



Confusion matrix of the conducted tests in three places and with various victim positions.

This work has received funding from the European Union's Horizon 2020 Research & Innovation Programme under RESCUER project, Grant Agreement No. 101021836.