ACOUSTIC SENSING AND PLATFORM NOISE REDUCTION FOR GROUND AND AERIAL VEHICLES

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This paper presents results of using acoustic sensors mounted on a variety of mobile platforms to conduct sensor cueing of Reconnaissance, Surveillance and Target Acquisition (RSTA) imaging sensors. A major emphasis is placed on reducing the acoustic platform noise associated with ground and aerial vehicles using lightweight and inexpensive noise cancellation technology. Signal Systems Corporation (SSC) researchers, in cooperation with General Dynamics, Navy and Army personnel, conducted real-time sensor cueing demonstrations, platform noise surveys; exhaust muffler modifications; target data collections and laboratory signal processing data analysis. We discuss methods that optimally reduce the impact of platform noise on acoustic detection and tracking, using sensors mounted on a variety of vehicles. Platforms discussed include: M113 and HMMWV manned vehicles, Demo III experimental unmanned vehicle (XUV) and Aerolight, Dragoneye and Pointer unmanned aerial vehicles (UAVs).

When installed on vehicles, acoustic sensors provide target detection, tracking, classification and location capability. Acoustic sensors are: omni-directional; operate in all types of weather, time-of-day and terrain conditions. Acoustic sensors are intrinsically low cost and small, when compared to other surveillance methods such as Forward Looking Infra-Red (FLIR), radar, or Equipment Support Measures (ESM). Acoustic sensors are used to detect ground vehicles, aircraft, helicopters, unmanned air vehicles, gun and artillery firing, projectile explosions and speech from their passive emissions. The acoustic detections are used to cue narrow field of view imaging sensors, like FLIR, thereby improving search rates and detecting fleeting targets.

Platform noise reduction techniques and their effect on sensing ground vehicles and gunfire are discussed. Quantitative results are given for different configurations of mufflers, electronic cancellation algorithms, adaptive beamforming algorithms, sensor locations, and number of sensors. Substantial improvements in acoustic sensor operating ranges were obtained. Methods to reduce broadband noise are discussed, showing that optimal reference sensor selection, noise cancellation algorithm selection, adaptive beamforming and increased sensor count lead to improvements in platform noise reduction.

Unmanned Air Vehicles (UAVs) provide a unique capability for Future Combat System remote sensing. The agility and covertness of Small UAVs in low altitude missions makes them an ideal candidate for acoustic sensor suites. Under the Army's Robotic Collaborative Technology Alliance, and in conjunction with the Army's UAV noise measurement program, SSC acquired ground platform noise measurements on the Dragon Eye, Pointer and Aerolight UAVs. SSC then applied several noise cancellation techniques, developed from its ground vehicle research, and demonstrated that these techniques were successful in enabling the microphones onboard the UAVs to detect both simulated muzzle blasts and M60 tank movement. Platform noise reduction processing shows that detection ranges on the order of 300 meters are possible against ground vehicles and greater than 1000 meters for machine gun fire.