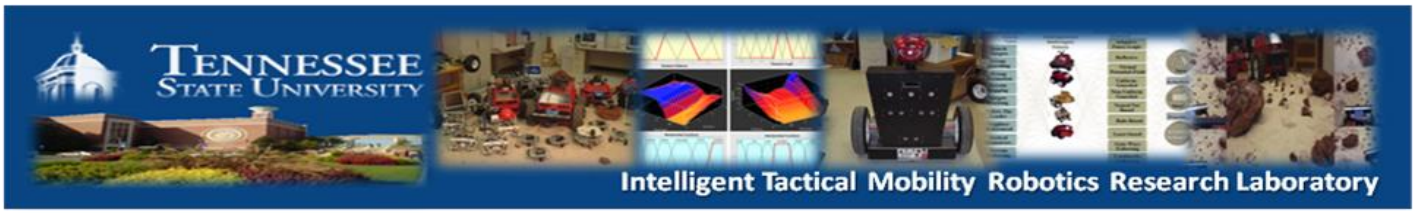
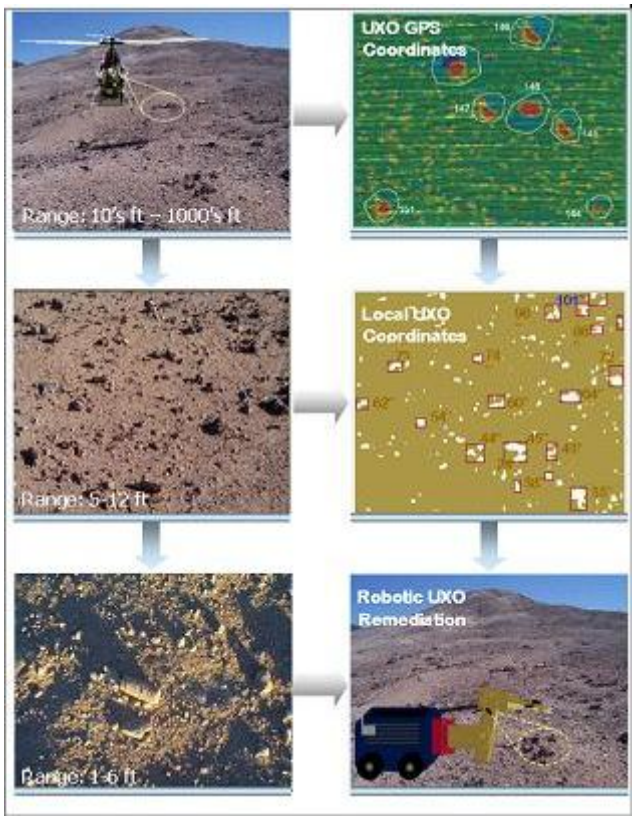
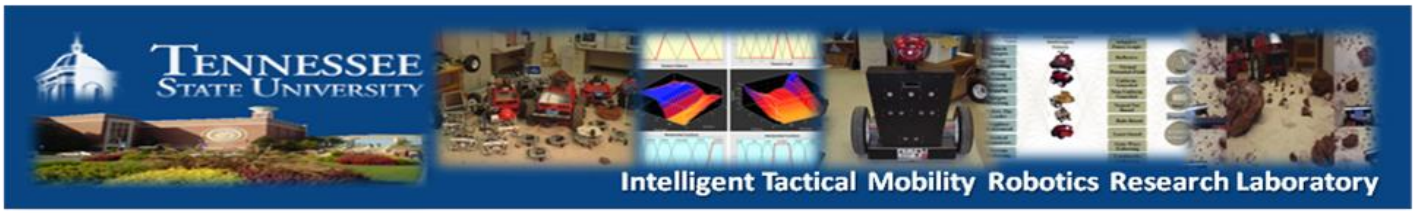


UXO Detection, Characterization, and Discrimination For Intelligent Telerobotics Remediation

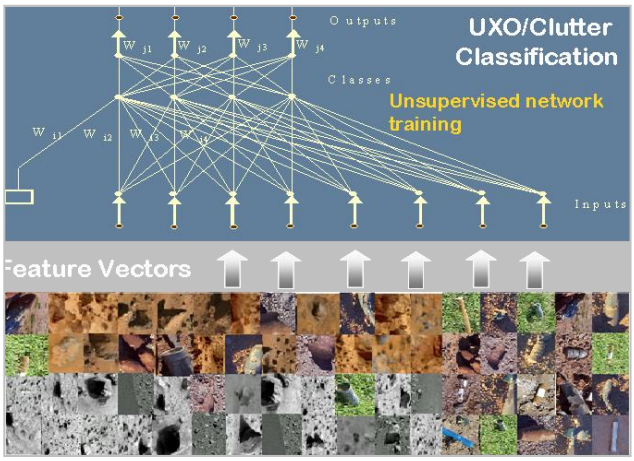
Many areas around the world are contaminated with unexploded bombs left from many battles fought. The United Nations Mine Action Coordination Center in southern Lebanon recorded 745 locations across the south where unexploded bombs have been found. Of the million estimated to be scattered around, so far 4500 have been disposed of, according to the Center. In United States, it is reported that thousands of acres of lands used from air-strike practices are contaminated with unexploded bombs and a serious danger to citizens. Prior to opening these lands to the public, it is necessary to survey these sites to ensure that any unexploded ordnance (UXO) has been removed from the site. Over the past 10 years, the DoD has invested in the development of geophysical sensors for the efficient subsurface characterization of these sites. Currently, commercially available UXO detection technologies provide at best 80 percent probability of UXO detection and approximately 40 percent probability of false positive responses. Hence, large costs are incurred during UXO site remediation due to the excavation of non-UXO anomalies such as range clutter.



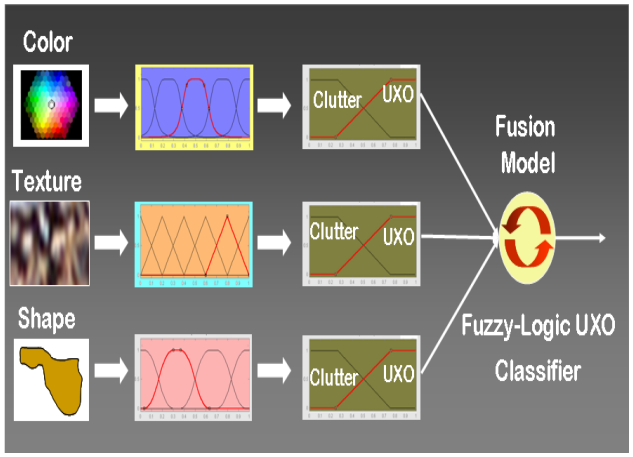
Tennessee State University (TSU) is currently leading an effort sponsored by the US Tyndall Air Force Base for the development of innovative technologies for the detection and discrimination of UXO. Research is conducted by Dr. Amir Shirkhodaie, professor of mechanical and manufacturing engineering department, and director of Center Excellence for Battlefield Sensor Fusion and Intelligent Tactical Mobility Robotic Research Laboratory. The project is involved with theoretical and experimental investigations of intelligent image processing techniques backed with data fusion techniques incorporating soft computing decision making and reasoning and robust pattern classifiers based on color, shape and texture. The objective of the project is to demonstrate applicability of intelligent telerobotic visual inspection techniques for UXO detection and remediation by means of soft computing techniques such as: neural networks, fuzzy logics, and generic algorithms. These soft computing techniques develop a core technological competency for robust characterization and discrimination of surface-buried UXO.



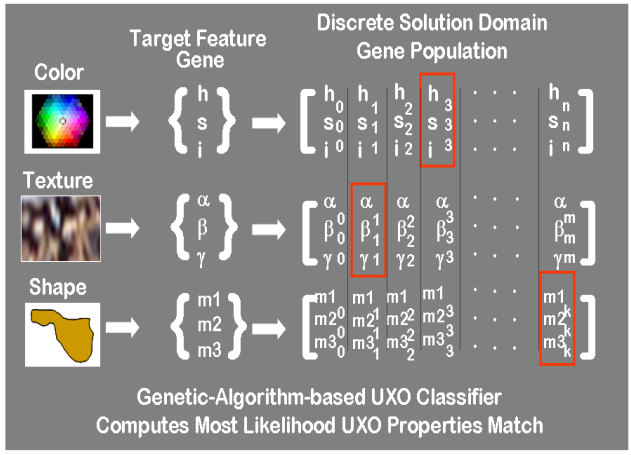
The approach is involved with coordination of Unmanned Aerial Vehicles (UAVs) and Unmanned Ground Telerobotic Remediation Systems (UGTRS). An UAV will scan contaminated test sites with onboard remote sensing devices and register geo-locations of potential UXO sites and generate a GPS-based grid map for communication to the ground telerobotic remediation systems. Using the GPS coordinates of UXO sites, one or more Unmanned Ground Vehicle (UGVs) may be deployed to the sites to assess the situation and clear the field. One objective of this project is to develop enabling techniques allowing an UGTRS to autonomously assess a contaminated area, localize and characterize exploded or unexploded ordnance, and identify potential unexploded ordnance by immediate remediation.



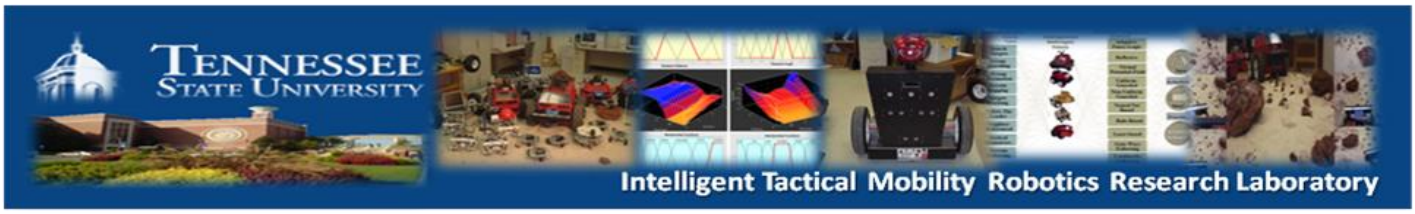
To accomplish this research objective, a telerobotic system equipped with multiple imaging sensors is designed. The robotic system performs an initial assessment of terrain and identifies the potential objects for further verification using soft-computing classifiers. Each classifier performs certain operation to verify the condition of ordnance. The Neural Network classifier is trained with a library of ordnance images and able to classify the object as either UXO or Clutter. On the other hand, the fuzzy logic classifier takes into account shape, texture, and color attributes of the object and classifies its as exploded or unexploded ordnance. Furthermore, the third classifier, namely, Genetic-Algorithm classifier is employed to perform the same classification operation based on statistical information of the test object. In this shown that by fusion of decisions from three classifiers high degree of reliability is achieved in proper classification of ordnance and hence minimize the false positive response of the system during telerobotic remediation process.



This project is undertaken at Intelligent Tactical Mobility Robotic Research Laboratory at Tennessee State University. For additional information, please contact:



Amir Shirkhodaie, Ph.D., Professor, Director
Center of Excellence for Battlefield Sensor Fusion
Tactical Mobility Robotic Research Laboratory
Mechanical and Manufacturing Engineering Dept.
Tennessee State University
3500 John Merritt Blvd., Nashville, TN 37209
Email: ashirkhodaie@tnstate.edu
Tel/Fax: 615-963-5396/5496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