

## Advances in Technology to Support Battlefield Acoustic Sensing

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*Note- The Opinions expressed in this paper are those of the author only and do not reflect any official view of the U. S. Government.*

More than 30 years ago, I attended my first NATO Research Study Group meeting in Vicksburg, MS. At that time, computers were rapidly becoming smaller, faster, and cheaper. Many of the battlefield acoustic systems had been discarded by the military because they were cumbersome and only worked sporadically. Several young folks on the RSG recognized that computers had the potential for acoustic systems smaller, cheaper, and more robust. After 30 years, many of the dreams based upon small, fast, cheap computers have been recognized. It is not likely that better programming, slightly faster chips, or greater memory will advance the utility of current battlefield acoustic systems very much. Now is a good time to look at how new technology breakthroughs might form the basis for battlefield “acoustics” in the future.



Photograph courtesy of ARL

Bass, H.E. (2006) Advances in Technology to Support Battlefield Acoustic Sensing. In *Battlefield Acoustic Sensing for ISR Applications* (pp. KN2-1 – KN2-8). Meeting Proceedings RTO-MP-SET-107, Keynote 2. Neuilly-sur-Seine, France: RTO. Available from: <http://www.rto.nato.int/abstracts.asp>.

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Col. Young has described for us some of the applications of unattended ground sensors for current operations. Indeed, the conflict in Iraq has once again proven the utility of acoustic sensors on the battlefield and has justified much of our past work. Software developments of the past decade coupled with small powerful computers have revived the old artillery location type systems of the past. Shown here is the UTAMS, an unattended mortar location system currently deployed in Iraq and Afghanistan. The software used in this system is somewhat more sophisticated than that available to us 30 years ago but the big gains are due to increased computational power on the battlefield.



Photograph courtesy of ARL

Even smaller smarter systems allow for gunfire location.

Several sniper location systems such as this one have been deployed with different levels of success.

These two systems build on a basic principle of surveillance and reconnaissance used by every grunt and hunter since the beginning of time. Use the ears to detect and localize a target then use they eyes for identification of the target and final aim point. This basic concept has always been recognized; only recently have we been able to implement the process in a machine. There are still opportunities to tweak the algorithms for target ID, etc. but this will result in small incremental improvement at best. In this talk, I will talk about the future. What do we bring to the battlefield of 30 years from now that will provide the soldier with the same opportunities to win that the mortar location array and sniper system have brought to the current conflicts.

Although present conflicts have proven the utility of acoustic sensors, these same conflicts have brought to our attention horrific gaps in our ability to provide soldiers with sufficient situational awareness to stay alive. When our soldiers first arrived in Afghanistan, too many were lost to mines, a plague that has been with us since the Civil War.

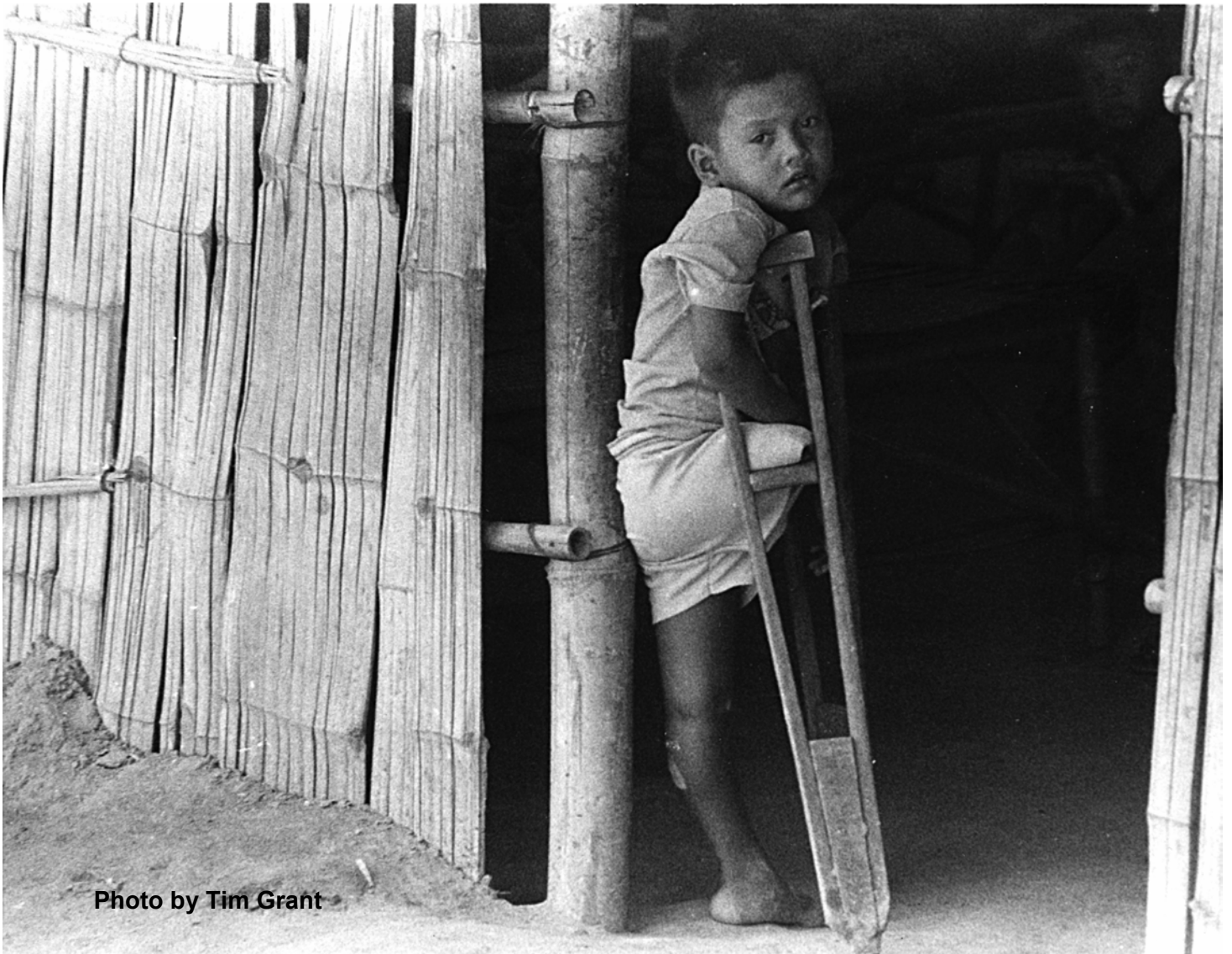


Photo by Tim Grant

This young man was never a combatant but the loss of limbs and lives to land mines is not restricted to our boys in uniform.

Now, in Iraq, we not only encounter different types of explosives buried in the roads, alongside the roads, and in buildings, we daily encounter car bombs and suicide bombers.

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**There seem to be mines and improvised mines everywhere.**

In Bosnia we attacked cardboard cut-outs because we could not identify real targets. And most of you recognize that we could not, and can not determine the presence of weapons of mass destruction from any distance. So yes, the past 30 years of the computer revolution has resulted in successes, but we face some real challenges. Not all of these can be addressed with acoustic or seismic sensors but neither can we throw up our hands and declare these are to be solved with other technologies. Today I would like to offer some ideas of where we go from here selecting just a few problems and emerging technologies – a challenge for the future.

In the last paper, Jim Sabatier described results from his work imaging buried land mines. The results he has demonstrated to date exceed any other technology for this application. When our army finally decides to get serious about protecting our soldiers from this menace, it will find that a technology is available to do so.

There is a more subtle feature of Sabatier's work. For the first time I am aware, he has truly fused information from different technologies. We usually think of sensor fusion in terms of a better computer program and God knows we have plenty of those. But think about this, the laser Doppler system Jim uses travels at the speed of light, attenuates very little over very great distances, and measures location of

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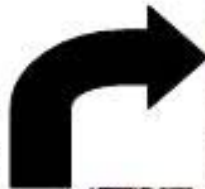
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targets and broad band motion up to and including engine vibrations. As a laser radar, the device can paint a picture of a target; as an LDV, it can determine the number of cylinders in the engine or just whether the engine is running. Behind foliage, vibrations can be detected by the vibration of surrounding leaves and if the device is operating in the infrared, the same detectors have the potential for painting an infrared image – all on a chip. What about superimposing a vibration image with the IR image. The thermally hot spots are likely vibrating at engine vibration frequencies and natural modes of the target. The great leap in the technology has been the development and field testing of a multiple beam instrument. So one can make an image of an area, optical and vibration image with a single glance, then move on to the next area. This technology probably represents the greatest leap forward for situational awareness since the introduction of computers on a chip.

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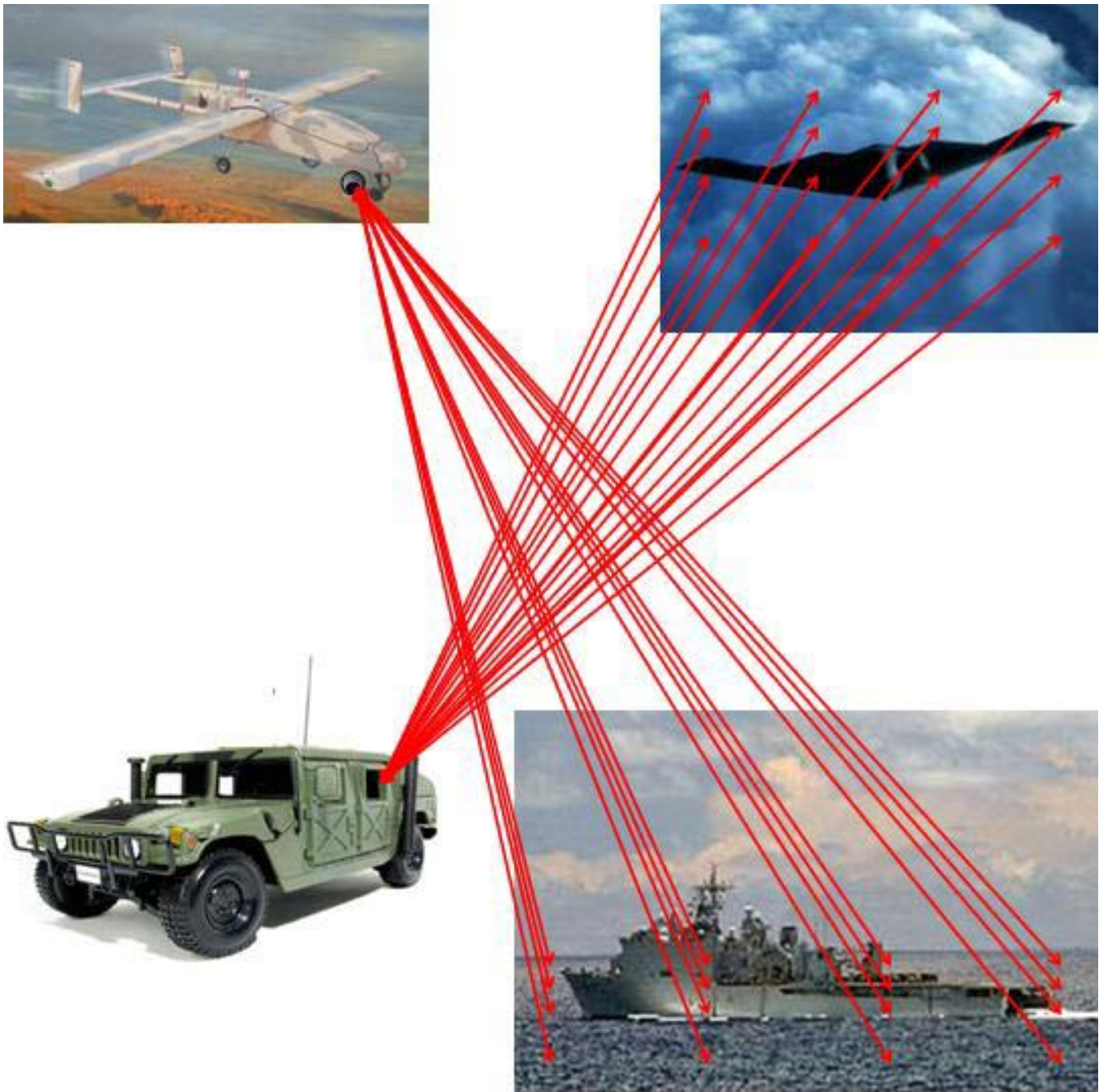


**Military  
vehicle under  
forest canopy**



In the above you could expand upon vehicles: From a fixed platform to a moving target 50 km distant, ranging and vibration measurements to identify the source have been made. Thinking about the use of microphones to detect helicopters, the Idv offers the opportunity to have a 'microphone' at the source to correlate with the local microphone. The mortar fire detector is currently slewing a gun, IR camera. Are there opportunities to slew a vibration camera.

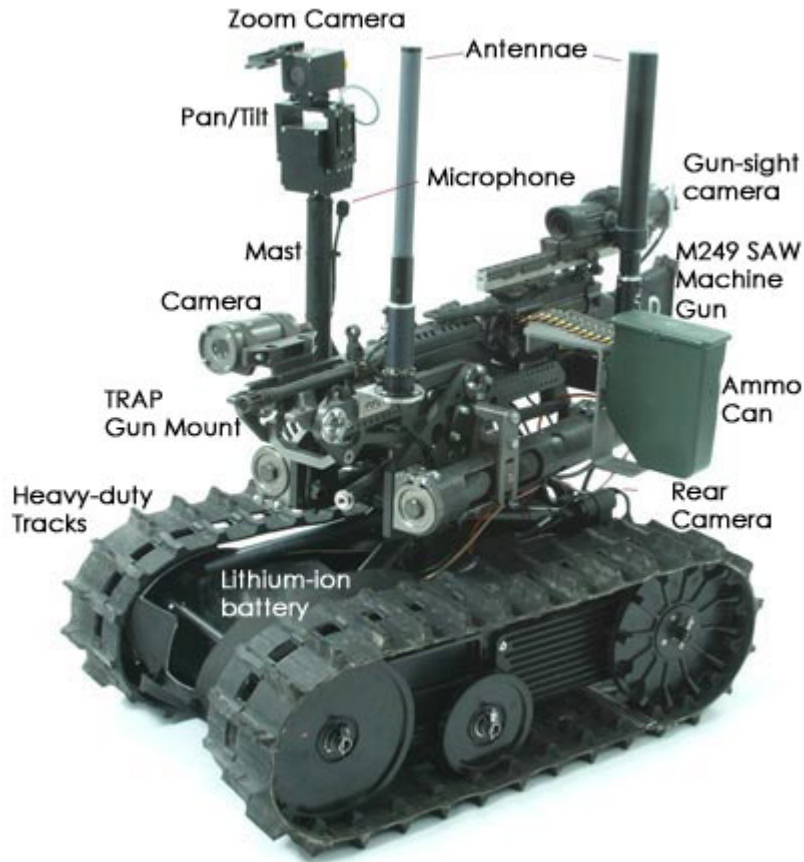
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You can say wow now. But let's move forward.

In the mid-60s, as a young Army officer I was responsible for surveillance drones. At the time, the large drones were flown with a stick but without vision. You could run into a mountain and never see it. The absence of smarts on board was a great detriment. But none the less these crude autonomous vehicles quite often collected information in areas too risky to send a human. Present conflicts have made several UAVs famous. Not only can the UAVs locate and identify targets, they can carry munitions and send video back to the local television station. This ability to fuse location, engagement, and PR into one platform has rapidly emerged as a huge force multiplier. If we can find a local contractor to launch and recover the UAVs, we can fight wars from the basement of the Pentagon!

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Foster-Miller Assault Talon

Probably not. That soldier on the streets of Bagdad will still be at risk in narrow alleyways or entering rooms where Predators do not fly.

But you can bet that those places have rats. And if a rat can squeeze through a small hole and get into every room in an apartment complex, sometimes in minutes or less, our small (not tiny but small) UAVs have the potential for doing the same. Then using their eyes and ears, and lets not forget the nose, they can tell us all we need to know to protect that soldier as he goes through the door. The challenge here is not so much the computers or algorithms as it is materials and micromachining that approach mother nature.

So there, for what it is worth, is my opinion. A better computer program is not going to give us the surveillance systems we need 30 years from now. We will have to package our physics differently and take advantage of the huge strides in micro and nano machining to continue to provide our soldiers a technological advantage.