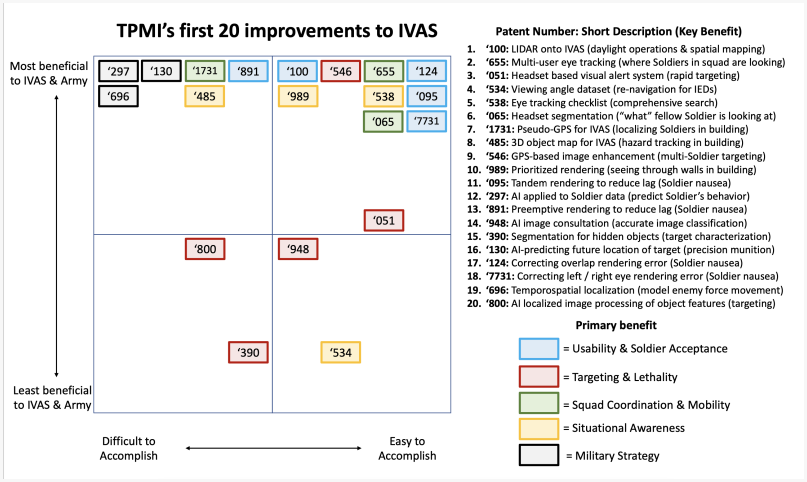
A Review of 20 Improvements to the Integrated Visual Augmentation System

Twenty Patented Technologies to achieve soldier acceptance, increased lethality, improved mobility, enhanced situational awareness & superior military strategy



A plot of 20 improvements to IVAS: ease of accomplishing improvement vs benefit to IVAS & Army

USA, August 14, 2023 /EINPresswire.com/ -- The Integrated Visual Augmentation System (IVAS) program Statement of Objectives states that the IVAS will "provide increased lethality, mobility, and situational awareness". Tipping Point Military Innovation (TPMI) is dedicated to developing a platform of technology to help achieve these milestones. This purpose of this publication is to review TPMI's first 20 patented improvements to the IVAS with 5 sections including: (1) usability / soldier acceptance; (2) increased lethality; (3) improved mobility; (4) enhanced situational awareness; and, (5) superior military strategy.

Section #1 Usability / Soldier Acceptance: The IVAS has faced some significant challenges relating to usability and Soldier acceptance including inability to operate in daylight and Soldier side effects. Fortunately, TPMI has solutions.

A major problem is the inability to use the IVAS in the daylight. An 3 August 2023 BreakingDefense.com article stated, "And with no ready solution in sight, it is uncertain when — or if — soldiers will be able to effectively use IVAS to train like they fight outdoors, or even inside buildings with doors and windows." TPMI's '100 patented technical solution to this problem places a LIDAR system onto the IVAS. Not only will this enhancement make the IVAS fully operational in bright daylight, but it will also achieve precision 3D spatial mapping (e.g., objects in the scene are more precisely characterized) improving situational awareness.

Another major problem is the well documented negative side effects that Soldiers have experienced while wearing the IVAS including motion sickness, disorientation, dizziness and

nausea.

A key source of these negative side effects is lag in image rendering. TPMI's patented solutions provide rapid 3D rendering to cut image lag, which is a well known source of nausea. Tandem 3D rendering ('095 patent) and preemptive 3D rendering ('891 patent) both accelerate rendering speed while maintaining superb image quality of the key items of interest.

Improvement # (Patent #)	Challenge	TPMI's Technological Solution	Impact (rationale)	Difficulty of implementation (rationale)	Recommended priority
1st (11,006,100)	#1 Inability for IVAS to conduct operations in daylight. #2 Limited scene sensing (spatial mapping of the surrounds of the IVAS unit)	LIDAR placement onto IVAS yielding a long-range, high-resolution, real-time 3D spatial map of the surroundings in daytime, nighttime and indoor environments	High Impact on Usability (daytime, outdoor operations with improved analysis of surroundings is critical for IVAS to be used in actual operations, not just indoor training)	Medium (Hardware & Software)	High
2nd (11,380,655)	Lack of coordinated targeting between multiple soldiers (e.g., 3 soldiers shooting at same target)	Multi-user eye tracking system so each Soldier can visually see where other Soldiers in the squad are looking	High Impact on Squad Coordination & Mobility (coordinated targeting and a coordinated strike with appropriately distributed fire power)	Easy (Software only)	High
3rd (11,093,051)	Rapid identification of target & accurate characterization of target	Coupling visual alert system with high resolution FOV in head display unit	Medium Impact on Targeting & Lethality (increases speed of Soldier characterizing target)	Easy (Software only)	Medium
4th (11,442,534)	Re-navigation to a previous suspicious target (e.g., a previously identified IED)	Novel dataset development comprising viewing angles linked to GPS coordinates with virtual viewing angle arrow indicator	Medium impact on Situational Awareness (virtual indicator of prior look angle increases efficiency & safety of EOD teams)	Easy (Software only)	Low
5th (11,442,538)	Performing a continuous survey of a Soldier's surroundings	Novel headset-based eye tracking checklist compares Soldier actual search pattern with optimum search pattern	High Impact on Situational Awareness (virtual indicator placement assures comprehensive search of Soldier's surroundings)	Easy (Software only)	High
6th (11,380,065)	Determining not just 'where' a Soldier is looking, but 'what' the Soldier is looking at	Correlating real-time segmented headset-sensor data to eye tracking metrics to determine 'what' structure is being viewed	High Impact on Squad Coordination & Mobility (coordinated targeting and a coordinated strike with appropriately distributed fire power)	Easy (Software only)	High
7th (11,341,731)	Understanding where each Soldier in a squad is located within an uncharted building in urban warfare	A novel drone placed, pseudo-GPS for localization of IVAS headsets in an uncharted building on a real-time 3D map	High Impact on Squad Coordination & Mobility (real-time 3D map of squad enables coordinated Soldier movements in uncharted building)	Medium (Hardware & software)	High
8th (10,973,485)	Entering an uncharted building with hazards (e.g., bombs, booby traps, enemy forces, etc.)	Using the pseudo-GPS system and sensor data from a set of IVAS units to develop a real-time 3D hazard map	High Impact on Situational Awareness (display of real-time 3D hazard map provides foreknowledge of hazards before a Soldier encounters it)	Medium (Hardware & software)	High
9th (11,709,546)	Efficiently alerting a Second soldier of a spot of concern during a recon mission	A novel GPS-coordinate based image enhancement (e.g., illuminating spot of concern) for display on each Soldier's IVAS	Medium Impact on Targeting & Lethality (instant knowledge of GPS coordinate allows the Soldier with the best view to rapidly engage)	Easy (Software only)	High
10th (10,766,989)	Alerting Soldiers of tracked virtual object hazards in building	Prioritized 3D rendering enables seeing through walls in urban warfare	High Impact on Situational Awareness (optimized display of hazards providing foreknowledge)	Medium (software)	High
11th (10,964,095)	IVAS-induced nausea due to image lag during 3D rendering	Tandem rendering divides 3D dataset and performs 2 different rendering techniques	High Impact on Usability & Soldier Acceptance (less lag will reduce Soldier nausea)	Easy (Software only)	High
12th (11,205,297)	Predicting the behavior of a Soldier (friend or foe) in battle	Novel AI method analyzes Soldier's head & eye metrics to predict reaction to stimuli	High Impact on Military Strategy (AI behavior model may help anticipate enemy's future action)	High (Complex software)	Low
13th (11,625,891)	IVAS-induced nausea due to image lag during 3D rendering	Preemptively rendering for left / right eye images for expected future viewing angles	High Impact on Usability & Soldier Acceptance (less image lag will reduce Soldier nausea)	Medium (Software only)	High
14th (11,003,948)	Rapidly determining a specific type of object (e.g., enemy vehicle)	Using AI to rapidly transfer IVAS-based imagery to the optimum imaging expert	Low Impact on Targeting & Lethality (rapid, expert consultation improves timeliness of targeting)	Medium (Software only)	Low
15th (11,058,390)	Characterizing a partially camouflaged object (e.g., vehicle)	Novel 3D segmentation algorithm enables isolation of partially hidden objects	Medium Impact on Targeting & Lethality (knowledge of target's 3D size and shape)	Medium (Software only)	Low
16th (11,179,130)	Determining the optimum location of where to strike a moving target (e.g., complex modular drone)	Using AI to model complex 3D structures to predict a future location of vulnerable spot(s) on enemy craft	High Impact on Military Strategy (new targeting approach could yield increased lethality with lower munitions)	High (Complex software)	Low
17th (10,964,124)	IVAS-induced nausea due to overlap error yielding confusing imagery	Dynamic filtering yields eliminates overlap error to realistically display virtual world	High Impact on Usability & Soldier Acceptance (realistic display of virtual world reduces nausea)	Easy (Software only)	High
18th (10,657,731)	IVAS-induced nausea due to left-right eye rendering error	Uses different 3D volumes for left eye compared to right eye to correct error	High Impact on Usability & Soldier Acceptance (realistic display of virtual world reduces nausea)	Easy (Software only)	High
19th (10,959,696)	Localizing an object (e.g., person) in a scene (e.g., village) over time	A precision 3D localization & AI prediction algorithm in a dynamic 3D volume	High Impact on Military Strategy (tracking and predicting enemy force movements)	Hard (Software only)	Low
20th (11,188,800)	Difficulty in spotting a camouflaged target (e.g., sniper in trees)	Using AI to perform localized image enhancement of target features	Medium Impact on Targeting & Lethality (improves visualization of subtle target features)	Easy (Software only)	Medium

Table illustrating TPMI patents, key challenges overcome and recommendations

Another source of these negative side effects is improper integration of the virtual world with the real world (e.g., overlap error where nearby tangible objects do not appropriately occlude virtual objects in the distance). TPMI's '124 patented "dynamic filtering" technique eliminates overlap errors and provides seamlessly integration of the virtual world with the real world by filtering portions of virtual objects when line of sight is lost. Additionally, TPMI's '7731 patented technology can correct for left eye - right eye rendering errors, another source of disorientation, by providing two unique volumes for rendering (one for the left eye and one for the right eye). These technologies enable seamless integration of the virtual world and real world.

Section #2 Achieving increased lethality via advanced targeting: A 28 July 2023 DefensePost.com article stated, "Soldiers reportedly hit fewer targets and engaged more slowly when they wore the IVAS 1.0." While early IVAS versions have not improved targeting, the addition of TPMI technologies into the IVAS would have huge potential for improving targeting.

To be useful, the IVAS must help the Soldier more rapidly identification the target and more accurately characterize the target. TPMI's patented '051 technology couples a visual alert system with a localized high resolution zone in the heads up display's field of view. This technology integrates automatic target recognition (ATR) into the display of the IVAS in a way that is useful to the Soldier, enabling ATR technology to be better converted to small unit lethality and survivability.

Another scenario wherein TPMI technology can help is in detecting a camouflaged enemy. TPMI's '800 patented Artificial Intelligence technology performs localized image processing on target (e.g., a sniper in the trees) to improve visualization of the target features, which has potential to

increase small unit lethality.

Another similar scenario is the difficulty in defining the boundaries of a camouflaged object (e.g., an armored vehicle in the forest). TPMI's '390 patented segmentation algorithm would enable imagery obtained from multiple IVAS units from multiple angles to better define the boundary of camouflaged objects to improve object characterization, which is critical for mission planning and targeting.

During a reconnaissance mission, it is critical for a Soldier to be able to characterize an unknown structure rapidly and accurately. TPMI's '948 patented technology uses artificial intelligence as an intermediary to rapidly transfer IVAS-based imagery to the precise imaging expert who is best qualified to characterize the unknown structure. This rapid characterization improves decision making and targeting.

Finally, in close combat scenarios, when a first Soldier identifies a spot of concern, a challenge is alerting a second Soldier of that precise spot. TPMI's '546 patent provides a novel GPS-coordinate based image enhancement to be displayed on other IVAS units, which has potential to increase small unit lethality via rapid targeting.

Section #3 Achieving improved mobility via squad coordination: Whatever it be urban or rural warfare, the importance of coordinating efforts cannot be overstated. TPMI's technology platform has the potential to significantly improve squad coordination.

When Soldiers are spread out in an uncharted building, coordinating movements amongst Soldiers in a squad is highly challenging. In a 21 July 2023 article, TPMI discussed a novel drone system to place a pseudo-GPS system on the outside of a building and discussed an upgrade to the IVAS headsets to include specialized transceiver technology (TPMI's '1731 patent). This enhanced system would enable a real-time 3D map of Soldier positions within any uncharted building thereby enabling squad coordination even when there is no line of sight for tactical hand signaling. The pseudo-GPS system would also be able to display virtual objects, even if they are hidden behind real objects, which is critical for training missions.

In an active firefight in a forest, coordinating targeting is challenging. A lack of coordinated targeting between multiple soldiers (e.g., 3 soldiers shooting at same target) could yield leave another target unattended to. Firepower must be coordinated. TPMI's '065 patent enables knowledge of not just ‘where’ a Soldier is looking, but ‘what’ the Soldier is looking at by correlating real-time segmented headset-sensor data to eye tracking metrics. Additionally, TPMI's '655 patent utilizes a novel multi-user eye tracking system for coordinated targeting, so each Soldier knows his target and can see what his squad mates are targeting. Coordinated targeting will improve squad mobility, lethality and survivability.

Section #4 Improving Situational Awareness: A Soldier faces all kinds of physical and mental challenges which can hinder a Soldier's ability to maintain situational awareness. TPMI's

technology platform enables a number of opportunities to improve situational awareness.

In urban warfare, entering into an uncharted building is fraught with challenge and risk. If the IVAS system is upgraded with TPMI's pseudo-GPS system and '485 patented technology, a 3D hazard map (e.g., weapons, booby traps, enemy forces) can be generated in near real-time for any uncharted building. This technology would enable enhanced situational awareness because Soldiers could be alerted to critical hazards before the hazards are encountered. Moreover, using TPMI's '989 patented prioritized rendering technology, hazards could be displayed to the Soldier in a clean, understandable fashion without causing information overload. Moreover, Soldiers would be able to see virtual object of hazards through walls or doors before they encounter the hazards.

For Soldiers on a reconnaissance mission through a mountainous region, performing a continuous survey of the surroundings is a difficult, but critical task. TPMI's '538 patent provides a novel headset-based eye tracking checklist enabling targeting metrics to aid the Soldier in achieving a comprehensive search. Another difficult task during reconnaissance is re-navigation to a previous suspicious target (e.g., a previously identified IED). TPMI's '534 patent novel dataset system comprising viewing angles linked to GPS coordinates is a critical advancement in re-navigation because its enables replay of previously searched viewing angles to enable increased efficiency and safety of EOD teams.

Improvement #5 Superior Military Strategy: The IVAS has potential, not just as a tool to assist the Soldier in conducting operations, but also as a data collection device to use in Artificial Intelligence algorithms, which could ultimately prove useful in military strategy.

For a dismounted squad moving through a village, a set of IVAS systems could collect a normative database on the hundreds or thousands village activities. TPMI's '696 patented AI technology could leverage this data to better understand force movements, localize where a target has moved over time and possibly even predict where a target will move within the village.

In addition to predicting movements of dismounted targets, TPMI's '130 patented technology could leverage IVAS data to model complex modular enemy craft (e.g., drones) to predict where a vulnerable spot on the drone will be at a future time point (i.e., the time point of arrival of the munition). By using this location of where to strike the target, increased lethality with lower munitions could be achieved.

Finally, the holy grail in warfare is to predict a Soldier's behavior in battle. An AI algorithm trained on the dataset in TPMI's '297 could be the closest we come to this. The '297 patent comprises novel data related to the Soldier including head position and orientation enabling the AI to learn how the Soldier reacts to external stimuli. Clearly, if behavior prediction is achievable, these predictions could be used against the enemy.

If the IVAS is upgraded with TPMI's technology platform, it will achieve usability in outdoor environments and achieve Soldier acceptance by eliminating the side effects of nausea and dizziness. It will increase lethality targeting through "visual augmentation" of the target. It will improve squad coordination and mobility through precision localization of squad members. It will improve situational awareness via advanced 3D rendering and by visual aids to help Soldiers perform a comprehensive search. Finally, Artificial Intelligence applied to TPMI's novel datasets could help predict object movement within a village, targeting of drones and possibly even Soldiers behavior in warfare.

TPMI aims to work with PEO Soldier to enhance the IVAS system by integrating these technologies into the IVAS system to make the program a major success.

About the author: Dr. Robert Douglas is a West Point graduate who: fought as an Infantryman in Vietnam with US units and a Vietnam recon company; worked in a combat development agency; studied nuclear war in the Joint Chiefs of Staff; patrolled in the desert for the UN in the Middle East with Russian war planners; and developed a system to assist Air Force space exercises. After leaving the service he spent over three decades in the defense industry rising from manager to vice president working programs ranging from sensors and missiles for Air Force aircraft to rubbing shoulders with Army scientists; to Army helicopters and combat vehicles as well as rapid target acquisition (RTA), night vision goggles and weapon sights.

Dr. Robert Douglas
TPMI
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