150 is in communication with an unmanned ground vehicle (UGV) 170, which UGV 170 communicates with one or more associated unmanned aerial vehicles (UAV) 180 or drones. The security personnel or user 101 is equipped with a helmet 104 complete with an augmented reality (AR) protective eyewear (or heads-up display, HUD 110), which HUD 110 has communication down-links from the UGA 170 and UAV 180. The UGV 170 also serves as a home and docking station for the UAV 180, for eg., for battery recharge. The hand-operable controller 150 is, preferably, mountable on a Picatinny rail 152 located on the weapon 102; the hand-operable controller 150 can also be hand-held and operable in the hand of the user 101. The hand-operable controller 150 has buttons 162,164 for which the personnel/user can select modes for communication with the UGV or UAV, a joystick 160 for navigating or homing the UGV or UAV, and a button 154 programmed to execute predefined navigation of the UGV or UAV. Additional buttons 156,158 are provided for controlling speed, directions and hover of the UAV 180. The hand-operable controller 150 may also include 3D-sensors 166 whose outputs vary with direction of tilts for controlling directions and speeds of the UAV 180. Some of the buttons 154,156,158,162,164 and the joystick 160 on the hand-operable controller 150 are shown in FIGs. 1B and 1C. With ARES, the UAVs 180 are deployed to take videos or photographs of a target area 202 (field or confined environment/built-up) or OoI (object of interest) 204, for pre-mission or during a mission operation; these videos or photographs are stitched together (for eg., with a graphics stitching module 280), thereby allowing the target area 202 to be mapped and OoI 204 to be located; ARES 100 thus provides an unmanned system for information or intelligence gathering to provide real-time or substantially real-time situational reconnaissance; with information/ intelligence gathered, the personnel/user 101 becomes aware of obstacles or danger/enemy positions and is enabled to assess real-time situations, for eg., in a combat or rescue mission. With high-levels of situation awareness and substantially real-time information, ARES 100 ensures safety of personnel deployed and minimises possible collateral damage to equipment. The substantially real-time information is processed with an algorithm or AI rules-based algorithm 205 to provide planned or suggested routes for the user to reach the target area 202 or OoI 204 in a more effective or efficient and safe manner, as illustrated in FIG. 11. Such situation awareness also allows mission plans to be reviewed, adjusted or updated as situations play up.

[0026] Navigation in built-up or urban areas: built-up areas present a different set of challenges involving navigation. In the city core, normal terrain features depicted on maps

[0052] As described above, the HUD 110 system being provided with multi-modal control mode 140, namely, brain signals 141, gesture 142, voice 143 and manual 145 input, which are inputted to a command integration unit. FIGs. 4A-4B show the default UI 132 including the multi-modal control 140. For eg., in response to the command integration unit, the UAV 180 executes an autonomous command signal and incrementally updates its state; for eg., by executing a predetermined distance in a predefined direction in steps from a present position. In another eg., by executing an "up" autonomous command signal, the UAV moves up a predetermined altitude in steps from its present position. With this autonomous control, during a critical moment, a user can continue to hold the weapon or tool 102 with both hands, with eyes-out and staying vigilant whilst navigating the UAV, UGV, UUV. This autonomous control with predetermined motion and direction is distinguished from the real-time control provided by outputs from the IMU. Further, the user 101 has a choice of initiating a voice control 143 (where a certain degree of sound is acceptable), gesture control 142 (using hand signals or inertia of a wearable device), brain sensory control 141 (during silent watch) or manual input 145 that is linked to the hand-operable controller 150. Each of these four controls has respective characteristics of response time, accuracy and sensitivity, and they augment each other (instead of creating redundancies). In this way, the command integration unit is driven by a dominant control mode in one particular state according to its characteristic response time, accuracy, sensitivity and environment compatibility, thereby dispensing with any need for command error correction. This also prevents commands from two different modes being treated as two distinct commands, which would result in undesirable movements of the UAV, UGV, UUV, for eg., when the beginning part of a command stream from a mode with short response/process time catches an ending part of a command stream with longer response/process time. In one embodiment, the command integration unit operates on a rule-based mechanism or AI algorithm 205 (for eg., by comparing a current state of the UAV,UGV, UUV with the state of the UAV,UGV,UUV when command signals were received).

[0053] In addition, sensitivities of the different input modes of control are different; for eg., some input modes are error-prone to the environment, such as, noise level and lighting condition, whilst other modes are subject to mental distractions. A command priority weighting unit determines the most appropriate dominant command generated from the four control modes.

[0054] In the multimodal control 140, priority weighting unit is given to the control mode which gives the highest sensitivity under a particular environment. For eg., in an environment where brightness is low, gesture control 142 will be given low weightage in generating the dominant command signal. However, the user can over-ride the command mode. A reason for giving the user this authority is because the user 101 is often able to assess the most suitable dominant control mode in a given environment. For eg., the user can switch to use brain sensory control 141 for commanding the UAV,UGV, UUV in an environment where voice control 143 was given the highest priority and a noisy environment could cause a false signal to mix in.

[0055] In the above description, navigation of the UAV,UGV,UUV can be autonomously controlled from the HUD 110 or switched to manual control at the hand-operable controller 150. Manual UAV, UGV, UUV control mode at the hand-operable controller is given the highest command priority due to less signal interpretation or interference error.

[0056] Also, in the above description, comprehensive mapping of the target area 202 or OoI 204 provides situation awareness about the frontline to the user. The user is appraised of the situation, weighs the risks and is enabled to make an informed decision by choosing possible routes to the target area/OoI. Additionally or alternatively, the user can communicate with the Command Centre 190 on choosing on the best possible route. It is also possible that the user relies on the AI rule-based algorithm 205 to recommend the best possible route or to rank the possible routes (as illustrated in FIG. 11) before making a final decision.

[0057] While specific embodiments have been described and illustrated for use by a security personnel, it is understood that many changes, modifications, variations and combinations thereof could be made to the present invention without departing from the scope of the present invention for use in civil rescue missions. For eg., the hand-operable controller, UAV,UGV,UUV can be used by a user to conduct surveys of a forest fire, of a building in danger of collapsing, of a building under contamination threat, etc. before or during which rescue personnel is deployed.

CLAIMS:

1. A tactical advanced robotic engagement system (ARES) comprising:

a heads-up display (HUD) mounted on a helmet of a user;

a weapon or tool having a one-hand-operable controller mountable on the weapon or tool; and

an unmanned ground vehicle (UGV) and an associated unmanned aerial vehicle (UAV) or unmanned underwater vehicle (UUV);

wherein: the HUD, the one-hand-operable controller, the UGV and UAV or UUV are in communication links, the one-hand-operable controller comprises two manouvre switches to select communication link with the UGV and/or UAV (or UUV), and the HUD further comprises a manual select button located virtually on a user interface (UI), which UI displays four multi-modal buttons, with the manual select button being linked to the one-hand-operable controller and is given a command priority over the other three multi-modal buttons, namely, a voice, a gesture and a brain sensory sensor, to execute autonomous control of the UGV and/or UAV or UUV, so that operation of the ARES reduces visual and mental cognitive loads on the user, enhances the user's situation awareness, enhances decision making with reduced risks, and allows the user to maintain mission-critical, time-critical or safety-critical readiness, thereby to achieve task effectiveness and mission success.

2. The tactical ARES according to claim 1, wherein the one-hand-operable controller further comprises a preset button for pre-set navigational control of the UGV, UAV or UUV and two buttons for programmable speed and directional control, with the two buttons being operable simultaneously for programmable hover control of the UAV or UUV, thereby providing quick response to effective navigation control to the user.

3. The tactical ARES according to claim 1 or 2, wherein the one-hand-operable controller further comprising a joystick for yaw and roll programmable control and homing of the UAV or UUV to the UGV, wherein homing allows the UAV to return and dock with the UGV for battery charging.

4. The tactical ARES according to any one of the claims 1-3, wherein the one-hand-operable controller further comprises 3D sensors, with outputs of the 3D sensors for gesture

control of the UGV and/or UAV or UUV by panning and tilting the one-hand-operable controller.

5. The tactical ARES according to any one of claims 1-4, further comprising a dead-reckoning algorithm and an AI algorithm, wherein the dead-reckoning algorithm allows the ARES to track and guide the user when GPS is ineffective in a built-up area, and the AI algorithm allows inputs from various sensors deployed in the UGV, UAV or UUV to recommend execution of a strategy plan to reach a target area or object of interest with low risks and high effectiveness.

6. The tactical ARES according to claim 5, wherein the dead-reckoning algorithm and AI algorithm functionalities are built into the HUD, UGV or a command centre.

7. The tactical ARES according to any one of the preceding claims, wherein the HUD mounted on the helmet comprises up-down and forward-retract adjustments to allow a better fit to the user according to the user's head and eyes profiles.

8. The tactical ARES according to any one of the preceding claims, wherein the HUD comprises a health and electric power monitor to notify the user with alerts in order to achieve mission success or to reduce mission failure.

9. The tactical ARES according to any one of claims 5-8, wherein the UGV, UAV and HUD have GPS sensors that provide positional nodes, so that locations on a GPS map can be determined with predetermined accuracies.

10. The tactical ARES according to any one of the preceding claims, further comprising a camera mounted on the UAV or UGV for taking photos or videos of a target area or object-of-interest, wherein the photos or videos are transmitted to the HUD or an associated command centre for stitching together by a graphics stitching module or algorithm to create a strategy map for mission planning.