CLAIMS

1. A system (100) for mapping and tracking ground targets of interest, comprising at least one unmanned aerial vehicle, UAV (102) and at least one Synthetic-Aperture Radar, SAR satellite (104) in Low Earth Orbit, LEO, wherein each of the UAVs (102) and the SAR satellites (104) include on board sensors for acquiring imagery data for the ground target **characterized in that:**

at least one data relay satellite (106) in Geostationary Equatorial Orbit, GEO in operative communication with the UAVs (102) and the SAR satellites (104) capable of obtaining a plurality of imagery data for the ground targets and capable of sending flight path co-ordinates and the on-board sensors' pointing requirements to the UAVs (102) and the SAR satellites (104); and

at least one user control center (108) in operative communication with said data relay satellite (106) for transmitting commands for controlling the UAVs (102) and the SAR satellites (104) and processing a plurality of sensory inputs received from the UAVs (102) and the SAR satellites (104) to map and track the ground targets,

wherein said data relay satellite (106) establishes a ground target specific communication with a user control center (108) and its associated UAVs (102) and SAR satellites (104) for continuous feedback and control of the UAVs (102) and SAR satellites (104) for the ground target mapping and tracking irrespective of their distances from the user control center (108).

2. The system (100) as claimed in claim 1, wherein the at least one UAV (102) and the at least one SAR (104) include a position and time determination module; and a communication module, wherein said position and time determination module having a GPS or Galileo satellite network receiver for determining in flight position of the UAVs and the SAR satellites by interfacing with a Global Positioning System, GPS (110) and/or Galileo Constellation; and said communication module for data transfer.

3. The system (100) as claimed in claim 1, wherein said user control center (108) having:

a communicating device for establishing communication with the data relay satellite (106) for communicating with the SAR satellites (104) and the UAVs (102) by involving data relay capabilities of said data relay satellite (106);

at least one data storage hardware and server for processing and storing sensory data; and

an antenna and transceiver for communicating with said data relay satellite (106), wherein said antenna is at least one of a X-band, a Ku-Band and a Ka-Band antenna.

4. The system (100) as claimed in claim 1, wherein the on-board imaging sensors of the UAV (102) are selected from the group consisting of hyperspectral sensors, thermal infrared sensors and Light Detection and Ranging (LIDAR) sensors.

5. The system (100) as claimed in claims 1 and 2, wherein the communication modules for data transfer associated with the UAVs (102) and the SAR satellites (104) communicate with said data relay satellite (106) for uplink operation and downlink operation using communication links selected from the group consisting of Ka-Band, X-Band and laser optical links.

6. The system (100) as claimed in claim 1, wherein said data relay satellite (106) communicates with the user control center (108) using communication links selected from the group consisting of X-Band links, Ku-Band links and Ka-Band frequency links.

7. The system (100) as claimed in any one of the claims 1 to 6, wherein said user control center (108) executes at least one functional element for configuring and calculating flight path of the UAVs (102) and the SAR satellites (104) by comparing the GPS coordinates of each of the UAVs (102) or SAR satellites (104) controlled under the system with ground track coordinates provided by the user and

synchronizing the timing and position information received along with the GPS coordinates for the each UAV (102) with the timing and position of the satellite (104).

8. The system (100) as claimed in claim 7, wherein said user control center (108) comprises Proportional Integral Derivative controller for deriving the UAV position and velocity information from the GPS coordinates to determine rough course and altitude adjustments as well as flight stabilization parameters for adjusting UAVs position and calculating its flight path.

9. The system (100) as claimed in the claim 7, wherein the functional element executed by said user control center (108) is adapted to align the flight path of each UAV (102) with each other UAVs associated with the system (100) using ranging techniques.

10. The system as claimed in claim 9, wherein the ranging techniques involve using a 3-Dimensional positional coordinate for a UAV (102) with respect to the other UAVs in the formation and the range limits between these UAVs set in accordance with the user instruction prior to each mapping activity.

11. The system (100) as claimed in the claim 7, wherein the functional element executed by the said user control center (108) is adapted to dynamically reconfigure and recalculate the flight path for the UAVs (102) and the SAR satellites (104) each time a GPS coordinate is received.

12. The system (100) as claimed in anyone of the claims 1 to 11, wherein said user control center (108) is further adapted to execute functional element for determining the pointing requirements of each UAV (102) by adjusting yaw, pitch and roll angles by taking into account the UAVs velocity, altitude, flight angle as well as sensor parameters such as swath width, ground sampling distance, pixel size and jitter threshold.

13. The system (100) as claimed in the claim 12, the functional element executed by said user control center (108) is adapted to calculate the SAR satellite roll, pitch and

yaw angles in formation with the UAVs based on its position, orbital velocity, altitude and sensor parameters such as swath width, ground sampling distance, pixel size and jitter threshold.

14. The system (100) as claimed in the claim 13, wherein the functional element executed by said user control center (108) is adapted to dynamically recalculate pointing of the UAVs and the SAR satellites for each time a GPS coordinate is received.

15. The system (100) as claimed in anyone of the claims 1 to 14, wherein said user control center (108) is adapted to execute functional element for translating the calculated flight path and pointing requirements into suitable flight and pointing commands to interface with the UAV (102) or SAR satellite (104) on-board avionics.

16. The system (100) as claimed in anyone of the claims 1 to 15, wherein said user control center (108) is adapted to process all the optical and radar imagery and sensory data obtained from the UAVs (102) and the SAR satellites (104) to produce precise 2D and 3D Digital Elevation Models (DEMs) and high resolution images.

17. The system (100) as claimed in claim 1, said user control center (108) comprises a user interface for displaying the precise 2D and 3D Digital Elevation Models (DEMs) and high resolution images in real time.

18. The system (100) as claimed in claim 1 and 17, said user control center (108) includes means to distribute the high resolution images to designated mobile handheld devices via encrypted broadband services offered by the data relay satellites (106) in GEO.

19. A machine-readable storage device incorporated in the user control center (108) as claimed in claim 1, said machine-readable storage device comprising a computer program product having functional elements operable to cause the user control center (108) to perform operations comprising:

- receiving ground co-ordinates of a ground target of interest from a user;

- controlling the user control center's (108) transceiver and antenna to communicate with at least one data relay satellite (106) for transmitting commands for controlling a plurality of UAVs (102) and a plurality of SAR satellites (104) to map and track ground targets;
- configuring and calculating flight path of the UAVs (102) and the SAR satellites (104) based on the received ground co-ordinates and the GPS coordinates of the UAVs (102) and the SAR satellites (104);
- determining the pointing requirements of each UAV (102) and SAR satellite (104);
- translating the calculated flight path and pointing requirements into suitable flight and pointing commands to interface with the UAV's (102) or SAR satellite's (104) on-board avionics;
- recalculating pointing of the UAVs (102) and the SAR satellites (104) each time a GPS coordinate of the UAVs (102) and the SAR satellites (104) is received at the user control center (108);
- processing various optical and radar imagery and sensory data obtained from the UAVs (102) and the SAR satellites (104) for a ground target to produce precise high resolution map images; and
- displaying the precise high resolution map images in real time on a user interface of the user control center (108) and/or designated mobile handheld devices.

CLAIMS

1. A system (100) for mapping and tracking ground targets of interest, comprising at least one unmanned aerial vehicle, UAV (102) and at least one Synthetic-Aperture Radar, SAR satellite (104) in Low Earth Orbit, LEO, wherein each of the UAVs (102) and the SAR satellites (104) include on board sensors for acquiring imagery data for the ground target;

   at least one data relay satellite (106) in Geostationary Equatorial Orbit, GEO in operative communication with the UAVs (102) and the SAR satellites (104) capable of obtaining a plurality of imagery data for the ground targets and capable of sending flight path co-ordinates and the on-board sensors' pointing requirements to the UAVs (102) and the SAR satellites (104); and

   at least one user control center (108) in operative communication with said data relay satellite (106) for transmitting commands for controlling the UAVs (102) and the SAR satellites (104) and processing a plurality of sensory inputs received from the UAVs (102) and the SAR satellites (104) to map and track the ground targets,

   wherein said data relay satellite (106) establishes a ground target specific communication with a user control center (108) and its associated UAVs (102) and SAR satellites (104) for continuous feedback and control of the UAVs (102) and SAR satellites (104) for the ground target mapping and tracking irrespective of their distances from the user control center (108).

2. The system (100) as claimed in claim 1, wherein the at least one UAV (102) and the at least one SAR (104) include a position and time determination module; and a communication module, wherein said position and time determination module having a GPS or Galileo satellite network receiver for determining in flight position of the UAVs and the SAR satellites by interfacing with one or more of a Global Positioning System, GPS (110) and/or Galileo Constellation; and said communication module for data transfer.

3. The system (100) as claimed in claim 1, wherein said user control center (108) having:

a communicating device for establishing communication with the data relay satellite (106) for communicating with the SAR satellites (104) and the UAVs (102) by involving data relay capabilities of said data relay satellite (106);

at least one data storage hardware and server for processing and storing sensory data; and

an antenna and transceiver for communicating with said data relay satellite (106), wherein said antenna is at least one of a X-band, a Ku-Band and a Ka-Band antenna.

4. The system (100) as claimed in claim 1, wherein the on-board imaging sensors of the UAV (102) are selected from the group consisting of hyperspectral sensors, thermal infrared sensors and Light Detection and Ranging (LIDAR) sensors.

5. The system (100) as claimed in claim 1, wherein the communication modules for data transfer associated with the UAVs (102) and the SAR satellites (104) communicate with said data relay satellite (106) for uplink operation and downlink operation using communication links selected from the group consisting of Ka-Band, X-Band and laser optical links.

6. The system (100) as claimed in claim 1, wherein said data relay satellite (106) communicates with the user control center (108) using communication links selected from the group consisting of X-Band links, Ku-Band links and Ka-Band frequency links.

7. The system (100) as claimed in claim 1, wherein said user control center (108) executes at least one functional element for configuring and calculating flight path of the UAVs (102) and the SAR satellites (104) by comparing the GPS coordinates of each of the UAVs (102) or SAR satellites (104) controlled under the system with ground track coordinates provided by the user and

synchronizing the timing and position information received along with the GPS coordinates for the each UAV (102) with the timing and position of the satellite (104).

8. The system (100) as claimed in claim 7, wherein said user control center (108) comprises Proportional Integral Derivative controller for deriving the UAV position and velocity information from the GPS coordinates to determine rough course and altitude adjustments as well as flight stabilization parameters for adjusting UAVs position and calculating its flight path.

9. The system (100) as claimed in the claim 7, wherein the functional element executed by said user control center (108) is adapted to align the flight path of each UAV (102) with each other UAVs associated with the system (100) using ranging techniques.

10. The system as claimed in claim 9, wherein the ranging techniques involve using a 3-Dimensional positional coordinate for a UAV (102) with respect to the other UAVs in the formation and the range limits between these UAVs set in accordance with the user instruction prior to each mapping activity.

11. The system (100) as claimed in the claim 7, wherein the functional element executed by the said user control center (108) is adapted to dynamically reconfigure and recalculate the flight path for the UAVs (102) and the SAR satellites (104) each time a GPS coordinate is received.

12. The system (100) as claimed in claim 1, wherein said user control center (108) is further adapted to execute functional element for determining the pointing requirements of each UAV (102) by adjusting yaw, pitch and roll angles by taking into account the UAVs velocity, altitude, flight angle and sensor parameters.

13. The system (100) as claimed in the claim 12, the functional element executed by said user control center (108) is adapted to calculate the SAR satellite roll, pitch and

yaw angles in formation with the UAVs based on its position, orbital velocity, altitude and sensor parameters.

14. The system (100) as claimed in the claim 13, wherein the functional element executed by said user control center (108) is adapted to dynamically recalculate pointing of the UAVs and the SAR satellites for each time a GPS coordinate is received.

15. The system (100) as claimed in claim 1, wherein said user control center (108) is adapted to execute functional element for translating the calculated flight path and pointing requirements into suitable flight and pointing commands to interface with the UAV (102) or SAR satellite (104) on-board avionics.

16. The system (100) as claimed in claim 1, wherein said user control center (108) is adapted to process all the optical and radar imagery and sensory data obtained from the UAVs (102) and the SAR satellites (104) to produce precise 2D and 3D Digital Elevation Models (DEMs) and high resolution images.

17. The system (100) as claimed in claim 1, said user control center (108) comprises a user interface for displaying the precise 2D and 3D Digital Elevation Models (DEMs) and high resolution images in real time.

18. The system (100) as claimed in claim 1, said user control center (108) includes means to distribute the high resolution images to designated mobile handheld devices via encrypted broadband services offered by the data relay satellites (106) in GEO.

19. A machine-readable storage device incorporated in the user control center (108) as claimed in claim 1, said machine-readable storage device comprising a non-transitory computer program product having functional elements operable to cause the user control center (108) to perform operations comprising:

- receiving ground co-ordinates of a ground target of interest from a user;

- controlling the user control center's (108) transceiver and antenna to communicate with at least one data relay satellite (106) for transmitting commands for controlling a plurality of UAVs (102) and a plurality of SAR satellites (104) to map and track ground targets;
- configuring and calculating flight path of the UAVs (102) and the SAR satellites (104) based on the received ground co-ordinates and the GPS coordinates of the UAVs (102) and the SAR satellites (104);
- determining the pointing requirements of each UAV (102) and SAR satellite (104);
- translating the calculated flight path and pointing requirements into suitable flight and pointing commands to interface with the UAV's (102) or SAR satellite's (104) on-board avionics;
- recalculating pointing of the UAVs (102) and the SAR satellites (104) each time a GPS coordinate of the UAVs (102) and the SAR satellites (104) is received at the user control center (108);
- processing various optical and radar imagery and sensory data obtained from the UAVs (102) and the SAR satellites (104) for a ground target to produce precise high resolution map images; and
- displaying the precise high resolution map images in real time on one or more of a user interface of the user control center (108) and designated mobile handheld devices.