Smart boots, fusion engine and aerial assets for enhanced situational awareness and safety in Search & Rescue operations

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Presentation Context

A next generation SAR toolkit is developed by INGENIOUS project (EU Horizon 2020) for collaborative response, which ensures high level of protection and augmented operational capacity in disaster situations

The main components that will presented are:

- Fusion Engine (FE)
- Smart Boots (SB)
- Modular Airborne Camera System (MACS)
- Multi-purpose Autonomous eXploring (MAX) drone
- Micro INdoor drones (MINs)

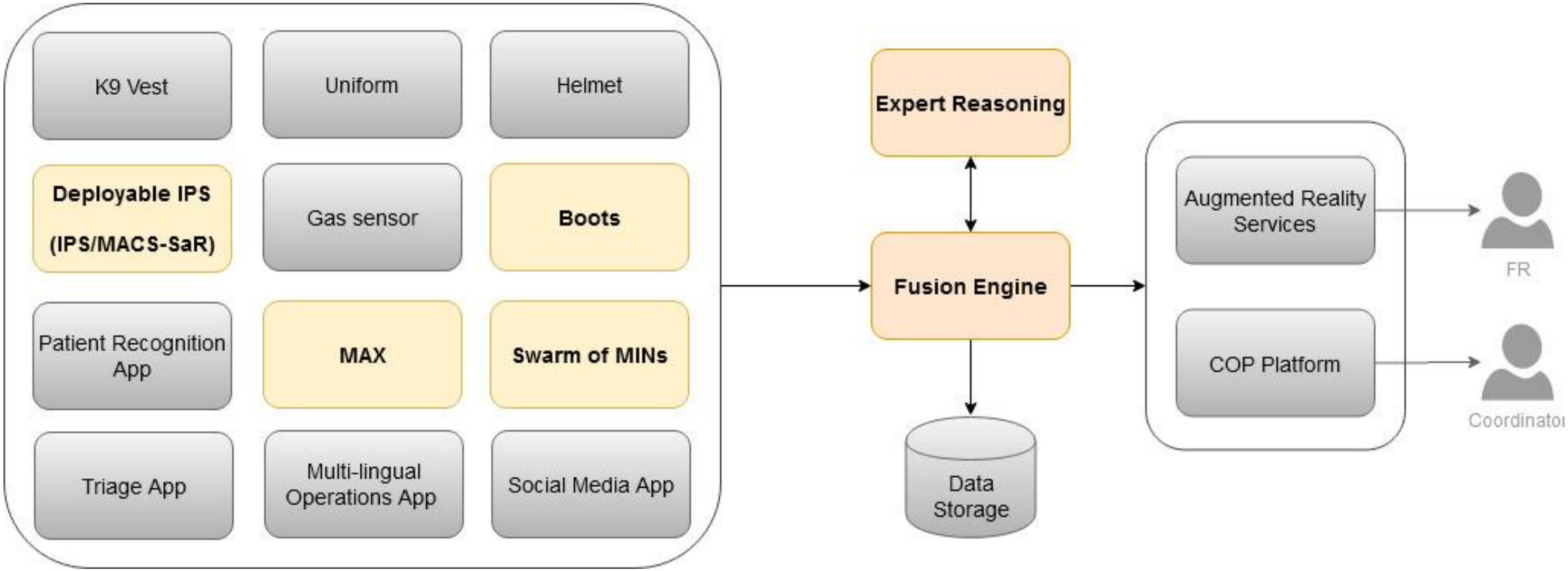
Fusion Engine

- FE is the focal point where all received data collected from the INGENIOUS sensors and applications are gathered, stored, and collectively processed
- Processing data sets, FE extracts valuable information regarding the tactical situation and the FRs' health status

Two main tasks:

- Collect, validate and store and forward data to the Expert Reasoning (ER) modules and remote services for decision support and early warnings generation
- Process and merge the collected data to create increased situational awareness and support decision making for the operation

Fusion Engine



Overview of the FE: Collect data, validate and store, perform fusion via smart algorithms and present them to FR and commanders for increasing their situational awareness

Smart Boots

- SB monitoring the health status
- Smart operational FRs safety boots with use of custom-build electronic multi-sensor insoles
- Hosting several embedded sensors in the wearable insole form factor
- SB inform the FR or (via the FE) the team leader, in real time, about the health status of an individual team member while operating in the field
- Warning alert, based on information collected by sensors
- Sensors: accelerometer, gyroscope and magnetometer is used to determine FR orientation

Smart Boots

- Flexible force sensors measures the FR pressure on the insole and the force distribution across each foot
- Edge processing algorithms analyze sensor data to detect irregularities or inconsistencies and raising alerts
- Prolonged immobilization or asymmetric walking indicate injuries
- Excessive force combined with high g-forces indicate a dangerous fall
- The electronic insoles are battery-powered, charged wirelessly. The use of low-power electronics allows autonomy

Aerial assets

- Aerial assets enhance positioning and assessment unknown enviroments
- a combined on-ground –and drone multi-sensor system for FR real-time localization and rapid environmental mapping
- enhances FR orientation capabilities in the field (sounding, investigation and documentation of structural fault)
- The Integrated Positioning System (IPS) device, estimate position in action in a combined indoor and outdoor environment (performs a smaller scale environmental mapping). Easy to carry by FR

Modular Airborne Camera System (MACS)

- Modular Airborne Camera System (MACS) equips a vertical take-off and landing (VTOL) fixed-wing drone is deployed and provide large scale mapping
- Real-time mapping camera
- A dual-frequency GNSS (Global Navigation Satellite System) receiver including inertial-aided attitude processing (INS)
- A computer responsible for time synchronization, image acquisition and real-time image processing
- The system allows to capture up to 4 raw images per second (stored on a removable storage device)

MACS Camera system module mounted In front of the fixed-wings drone

Modular Airborne Camera System (MACS)

- Weight is 1.4 kg (including embedded PC, camera, IMU, GNSS receiver, GNSS antenna, power management and structure)
- A fixed-wing drone used as carrier providing a flight time of approximately 90 minutes at cruise speeds between 80km/h and 140km/h
- Travelling distance up to 105 km per battery charge. Maximum takeoff weight of 14kg
- Operate at wind speeds of up to 8 m/s and temperatures between 0°C and 35°C
- Capable of operating at altitudes up to 3,000 m above sea level

Multi-purpose Autonomous eXploring (MAX) drone

- MAX able to navigate and explore an environment completely on its own sending multi-sensor data (video, infrared images, gas sensor readings, temperature measurements, etc.)
- Creating 3D maps and locating itself in the previously unseen environment
- Keep track of explored and unexplored areas, optimize data collection and to highlight the parts of the buildings where MAX could not approach
- FRs have a detailed look inside the building

MAX under development

Multi-purpose Autonomous eXploring (MAX) drone

- MAX airframe size is 43 x 43 cm^2, with a payload capacity of about 600 grams
- Maximum flight time of a fully loaded platform of this size is to 10-15 minutes
- MAX sensors: a 360 degrees lidar (laser scanner), a forward-looking stereo camera and a number of sonars used for navigation and obstacle avoidance, visual and thermal cameras

Micro INdoor drones (MINs)

- MINs are small and disposable devices for indoor localization (GPS denied environment) of FRs
- Working in a swarm fashion (a group of MINs) enter the building and create a mesh network for localization of FRs using triangulation techniques
- The MIN size is 9 x 9 cm^2, weights 27 grams with a payload of 15 grams, 7 mins of flight
- UWB sensors (track the motion of an FR), Ranger sensor, an optical camera (for position estimation of the MIN)

The Crazyflie 2.1 platform used for the MINs

Conclusions

- The INGENIOUS components are developed for use in real- world SAR operations
- Enhancing situational awareness and safety of FRs
- Performance and Autonomy are requirements due to highly demanding environment on SAR operations
- The INGENIOUS project SAR Toolkit will provide such technologies, which are already prototyped and under ongoing lab and field tests

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Thank you for your attention

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