CLOSE-SEARCH: accurate and safe EGNOS-SoL navigation for UAV-based low-cost SAR operations

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AGENDA

1. CLOSE-SEARCH consortium
2. Motivation
3. … a project that makes sense
4. Project description
THE CLOSE-SEARCH CONSORTIUM

<table>
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<tr>
<th>Coordinator</th>
<th>Institute of Geomatics</th>
<th>IG</th>
<th>ES</th>
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<td>Asociación de la Industria Navarra</td>
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<td>DEIMOS Engenharia</td>
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<td>Ecole Polytechnique Fédérale de Lausanne</td>
<td>EPFL</td>
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<td>Institut Cartogràfic de Cataluny</td>
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<td>Direcció General de Protecció Civil - Generalitat de Catalunya</td>
<td>DGPC</td>
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MOTIVATION: THE PROBLEM

SUMMER 1994: A TRAGEDY & A 15 YEARS DREAM
THE SOLUTION

INSTALL SENSORS (TIR,...) ON AN UNMANNED AIRCRAFT

- fly-&-scan over the area in search of body signals (heat,...)
- day-&-night
- even in inaccessible areas
- even in bad weather conditions

WHAT A GREAT & SIMPLE IDEA!
GENERAL VISION

CONTEXT

- SAR operations in **critical circumstances**: from outdoor sports to disasters.
- Broad range of situations: from t-distress calls (**t-DC**), to **tP-DC**.
- **Day-&-night** operations in rather **inaccessible areas**.
- **Fly-&-scan** over a region and detection of the body heat

>> identify disaster survivors or lost people
>> support the SAR search component in situations of just approximate knowledge of the search geographic area.

OPERATION: upon a loosely-georeferenced (**t-DC**) distress call

- The UAS/UA is transported to the emergency-area and launched...
- to scan the area with a TIR camera...
- following a predefined 3D flying path derived from 3D geospatial databases.
- TIR images are be transferred to the UAS/CS on-line via the UAS/datalink (or off-line upon return of the UAS/UA to the UAS/CS).
- The TIs are analysed in search of candidate locations for persons under search.
JUSTIFICATION: A CONCEPT THAT MAKES SENSE

Unmanned Aerial Systems (UAS) ARE USED FOR
DULL       DIRTY       DANGEROUS       DURATION       MISSIONS

UAS = (UA, DL, CS)

UNMANNED AIRCRAFT (UA)
DATA LINK (DL)
Line Of Sight
CONTROL STATION (CS)
Relais UA-SAT
SAT
"JUST" A TYPICAL UAV SURVEILLANCE MISSION

Unmanned Aerial Systems (UAS) ARE USED FOR

DULL       DIRTY       DANGEROUS       DURATION       MISSIONS

UAS = (UA, DL, CS)

UNMANNED AIRCRAFT (UA)

DATA LINK (DL)          Relais UA-SAT
Line Of Sight

AIR TRAFFIC CONTROL (ATC)

CONTROL STATION (CS)

SAT
# SOME CONCEPTS RELATED TO UNMANNED AIRCRAFTS

<table>
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<th>CONTROLLED AIRSPACE</th>
<th>UNCONTROLLED</th>
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<td>A</td>
<td>E</td>
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<td>C</td>
<td>G</td>
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<td>D</td>
<td>NO ATC or ATC does not know the traffic.</td>
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- ATC knows the traffic: who is where.
- **UA**: aerial vehicle with a remote human pilot (and possibly an autopilot).

**ELOS**: Equivalent Level Of Safety.

**SAFETY**: protection of
- the people on board of the aircraft,
- the other users of the airspace, and
- people and property on the ground.

**relevance of precise-accurate-reliable NAVIGATION among others**
MISSION CATEGORIES & ERROR BOUNDS vs CLOSE-SEARCH

UA mission categories

CIVIL
private
commercial
state

CLOSE-SEARCH

10^{-9}

10^{-7} (?)

10^{-6}

MILITARY
ABOUT THE PROJECT... JUST STARTED

Call: FP7-GALILEO-2008-GSA-1
Funding scheme: Collaborative Project – CP
Duration: 18 months / 2010-02-22 to 2011-08-22
Activity: Applications - 7.4.1 Exploiting the full potential
Topic: GALILEO.2008.1.1.1 (a) Use of EGNOS Services for Mass Market: Innovative Applications targeted to SMEs

CLOSE-SEARCH: accurate and safe EGNOS-SoL navigation for UAV-based low-cost SAR operations.
OBJECTIVES: GENERAL

To integrate in a small UA (helicopter), a TIR sensor and a multi-sensor navigation system (BA/RINS/GPS-EGNOS based) with an AIM capability, to support the search component of SAR operations in remote, difficult-to-access areas and/or in time critical situations.

To demonstrate the added value of a future multi-constellation augmented GNSS, like GPS/GLONASS-EGNOS or Galileo-SoL.

Target attributes:
- ultra-safe navigation (with geospatial information)
- overall low-cost

so it can be safely and massively implemented.

We envision a
- simple piece of equipment... available
- in ski resorts, tourist areas, mount. clubs and civil protection premises.
HUMAN BODIES IN RGB AND TIR IMAGES

S/T HEART-AND-SOUL OF THE CLOSE-SEARCH TECHNOLOGY

Safety of Life (SoL) SERVICE

GLONASS
GPS
EGNOS

GALILEO

EPFL
AIN
ICC
IG

INSTITUT DE GEOMÀTICA
INTEGRATED POSITION-VELOCITY-ATTITUDE DETERMINATION

\[ \dot{x} = f_1(x, \ell^1) \]
\[ x_{k+1}^- = \Phi_1(\ell^1)x_k \]

\[ \dot{x} = f_2(x, \ell^2) \]
\[ x_{k+1}^- = \Phi_2(\ell^2)x_k \]

\[ x_{k+1}^- = Ix_k \]

\[ g_3(\ell^3, x_k) = 0 \]
\[ g_4(\ell^4, x_k) = 0 \]
S/T METHODOLOGY AND ASSOCIATED WORK PLAN

PRINCIPLES:

- Modularity
- WP parallelism
- Progressive functionality
- Iterative-incremental development
A JUST STARTED PROJECT: 2010-02-22 KoM

THANK YOU FOR YOUR ATTENTION

QUESTIONS?

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also thanks to the

- European GSA (GNSS Supervisory Authority)
- Galileo Application Days 2010 organizers

MORE INFORMATION:

http://www.close-search-project.eu