Sicurezza partecipata in Sanità: l’esperienza del Progetto Europeo REFIRE

LOCALIZZAZIONE INDOOR

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With the financial support of the Prevention, Preparedness and Consequence Management of Terrorism and other Security related Risks Programme European Commission – Directorate General Home Affairs
OUTLINE

◊ Indoor Localization

◊ Interest in Indoor Localization

◊ Robotic Approach

◊ REFIRE Scenario
  ◈ Requirements

◊ RLA – Rescuer Localization Algorithm
  ◈ Pattern recognition
  ◈ Fusion algorithm

◊ Tests
Indoor Localization

- Indoor localization refers to tracking objects in an indoor environment
- Symbolic Reference
- Coordinated-based Reference

The Next Big Thing
Interest in Indoor Localization

◊ Apple
  ◇ iBeacon
  ◇ WiFi SLAM

◊ Google

◊ Qualcomm, Nokia
  ◇ In Location Alliance

◊ Over 37 start-ups/753 investors
Trends Driving Ubiquitous Location

◊ Consumer Mobility increasing New Use Cases
  ◦ Always-connected, Always on, Aware
  ◦ Greater need for personalization and context

◊ Technology Advancements
  ◦ Not just GPS – hybrid of many positioning sources
  ◦ Greater accuracy – outdoors and indoors

◊ New Location-Based Business Models
  ◦ Global LBS revenue to reach $10.3B by 2015
  ◦ Advertisers, retailers, entertainment venues, and technology vendors trying to monetize location
IL use scenarios

◊ Navigation
  ◦ Finding places in large buildings
  ◦ Emergency situation

◊ People and property tracking
  ◦ Logistic

◊ User applications
  ◦ Social applications
  ◦ Shopping, indoor, parking assistance

◊ Advertising
Commercial Applications

◊ Location-Based Services

◊ Fingerprinting
  ◦ Measuring the intensity of the received signal (RSS)
  ◦ Fingerprint Data-Base

◊ Pros
  ◦ All AP’s, all devices
  ◦ Better performance

◊ Cons
  ◦ Measurements poorly correlated with range and highly susceptible to environmental changes
Law Enforcement Applications

◊ Personnel tracking

◊ Inertial Measurement
  ◊ Accelerometer
  ◊ Gyroscope

◊ Pros
  ◊ Sensors now widely available in many consumer devices
  ◊ Map free

◊ Cons
  ◊ System model
  ◊ Require initial position fix
  ◊ Drift
Robotica Autonoma & Fusione Sensoriale

Localizzazione Indoor

Robotic Approach

Proprioceptive Sensors

Exteroceptive Sensors + Maps

Data Fusion

\[ \begin{align*}
\mathbf{x} & \quad \mathbf{y} \\
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\end{align*} \]
REference implementation of interoperable indoor location & communication systems for FIrst REsponders

Remote Control Center Operators

Local Control Center - Coordinator

PILDs

Rescuers
First Responders

◊ Requirements
  ◦ No sensors on foot
  ◦ No hand devices
  ◦ No deployable devices

◊ System design
  ◦ Waist-mounted IMU
  ◦ Exteroceptive devices integrated with VHF radio
**Requirements**
- No active beacon
- No camera
- No WiFi-based system
- Scalability

**RFID**
- High performance UHF tags
- RFID reader
Proprioceptive Sensors

- **IMU platform**
  - Tri-axial accelerometer
  - Tri-axial gyroscope

- **Magnetometer**

- **Drift**
  - Calibration

- **System models**
  - Attitude – Heading
  - Displacements
  - Gait pattern analysis
Magnetometer Calibration

- Standard IEEEstd517-1974(R2010)
  - Accelerometer: Six-Faces test
  - Gyroscope: Angle Rate test

- Parameter calibration

Möbius Strip
Attitude - Heading

◊ Device Attitude (Gyros+Magnetometer)

◊ Heading First Responders
Displacement

- IMU Position
  - Foot mounted
  - Waist mounted

- Gait Analysis

- Step Detection

- Step length Computation

Courtesy of dune
Gait Patterns

- Still
- Walking
- Stairs up/down
- Lift up/down
Gait pattern recognition GUI

Discrimination Results

Walking
Walking
Stairs Up
Stairs Down
Patterns Recognition
Proprioceptive Localization
Exteroceptive Localization

◊ PILDs calibration
  ◊ PILDs encodes position

◊ Proprioceptive Localization Correction
Foot mounted IMU

Fine missione
Durata: 24 minuti
Percorsi: 422 metri

Courtesy of dune
Field Tests

REference implementation of interoperable indoor location & communication systems for Flrst REsponders

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Conclusion

◊ Recent development of Location Based Market

◊ RLA

◊ Test fields

◊ Communication standard
◊ Open platform
People

◇ **PhD Students**
  ◇ Federica Inderst
  ◇ Luca Faramondi
  ◇ Francesca De Cillis

◇ **Master Students**
  ◇ Matteo Bontempi
  ◇ Luigi Maurano
  ◇ Francesca De Simio

◇ **Undergraduate Students**
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Keep the gradient to the TOP
Many thanks for sharing your thoughts

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