Common Data Fusion Framework for Space Robotics *and other applications*....

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Overall motivation

• Space robotics: in most cases, each new space robotics platform is single shot – both HW and SW.

• InFuse is 1 of several “building blocks” aimed at making space robots (in space and planetary) more standardized and eventually more affordable to develop.

• InFuse => **Common Data (or Sensor) Fusion Framework (CDFF)**

• **Space robotics**? Yes, but wider ambition.
InFuse project

- H2020 Space Robotics Technologies Cluster (COMPET-4-2016)
- 27 months project, 3.5 MEUR funding
- 6 partners:

- Completed in Jan. 2019
- Part of a cluster (SRC) of space robotics projects, supervised by the PERASPERA Program Support Activity.
What is InFuse (and what does it offer)

• InFuse is a SW framework including:
  1. A collection of **Data Fusion Nodes** (DFN) => elementary, modular data fusion functions (e.g. Kalman filter variations)
  2. Assemblies of DFNs into **Data Fusion Processing Compounds** (DFPCs) providing elaborated data fusion capabilities (e.g. 6D target tracking)
  3. A set of tools supporting the production of DFPCs from DFNs, their “vanilla” testing, their deployment, and their execution on a target platform
What is InFuse (and what does it offer)

InFuse allows composing sensor fusion methods and testing them in vanilla environment before deploying to target robot

- InFuse implementation is mainly C++ and Python based
- InFuse is not OpenCV (but uses OpenCV based algorithms and other popular perception / localization libraries in the form of Data Fusion Nodes)
- InFuse is not ROS (but may be deployed using ROS)
InFuse vanilla environment

CDFF “Vanilla Environment” for DFPC assembly and testing

Data Products Visualization Tool

Logs of Sensors Data for Replay

Sensors Data Flow

Data Products Management Tools

Scripts to compose and test DFPCs

VANILLA DATA FLOW CONTROL

DFPC 1

DFPC 2

DFPC 3

DFN1

DFN2

DFN3

... 

DFNi

ERF, March 2019
Deploying InFuse to a target platform

InFuse CDFF deployed onboard a robotic platform

TARGET ROBOTICS MIDDLEWARE

Data Products Management Tools

Data Fusion Orchestrator Tool

Decisional + Executive Layers

Functional Layer Components

Live Sensors Data

Sensors Data Flow
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DFPC1

DFPC2

DFPC3

I/F

I/F

I/F

I/F

Live Sensors Data

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DFPC Example 1: Model Based Visual Tracking (OT)

<table>
<thead>
<tr>
<th>DFNs</th>
</tr>
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<tbody>
<tr>
<td>KF Prediction</td>
</tr>
<tr>
<td>KF Correction</td>
</tr>
<tr>
<td>Edge Detection: Canny &amp; Sobel</td>
</tr>
<tr>
<td>Image Undistortion</td>
</tr>
<tr>
<td>Outlier filtering</td>
</tr>
</tbody>
</table>

Credit: DLR
DFPC Example 2: Visual Odometry (PT)

DFNs - LAAS
- FeaturesExtraction2D
- FeaturesMatching2D
- PointCloudReconstruction2D
- PerspectiveNPointSolving

DFNs - MAG
- StereoRectification
- StereoDegradation
- DisparityImage
- StereoMotionEstimation

Credit: CNRS and Magellium
DFPC Example 3: 3D reconstruction (PT)

DFNs
- StereoReconstruction
- FeaturesExtraction3D
- FeaturesDescription3D
- FeaturesMatching3D
- Registration3D
- PointCloudAssembly

Credit: University of Strathclyde
Use case: Planetary rover (Morocco analogue campaign, Nov/Dec 2018)
InFuse in terrestrial applications...?

Credit: DexROV

Credit: AAIR

Credit: Roboception

Credit: Bosch

Credit: Shell

Credit: Volvo
Where to find InFuse?

• InFuse is released and maintained as Open Source SW
• Git repository: https://github.com/H2020-InFuse/
• Continuous Integration setup (automatic builds and code quality check)
  • Using MISRA C and MISRA C++ coding guidelines
  • Using CPPCheck as static analyser
  • Using Valgrind as dynamic analyser
  • Using CATCH as testing framework
  • Using gitlab-ci As CI/CD server
Where to find InFuse?

- Documentation
- Contributed by many partners
  - Used by 30+ developers
- Developer documentation
  - Download and compile
    - Docker container
    - Natively
  - Unit tests
  - Install
- Contribute
- Tutorial
  - Readme.md
  - Links
Thank you for your attention

https://www.h2020-infuse.eu/

InFuse Git: https://github.com/H2020-InFuse/

PERASPERA: https://www.h2020-peraspera.eu/