HFIT – Heterogeneous Flow Interpreter Transducer

1. The Problem

Companies may incur higher than expected risks to space commercialization investments by not performing due diligence concerning the high likelihood that multiphase and multi-component flows, which are poorly understood for space deployments, will ultimately be required for sustainable operations.

Figure 1. Examples of space commercialization focus areas, and adjacent utilities, where the management of multiphase and multi-component flows in space is likely required.

Further, these same companies are subject to high opportunity costs by not investing early in the development of systems and methods to manage and perform multiphase and multi-component flows in space.

2. The Solution

An important part of the solution to successfully utilizing multiphase and multicomponent flows in space is our Heterogeneous Flow Interpreter Transducer (HFIT). HFIT an AI derived flow transducer that quantifies the behaviors of multiphase and multicomponent flows. HFIT is acceleration field (e.g., gravity, time-varying acceleration fields) agnostic and applicable to optically transparent flows, e.g., cryogens, refrigerants, and water.

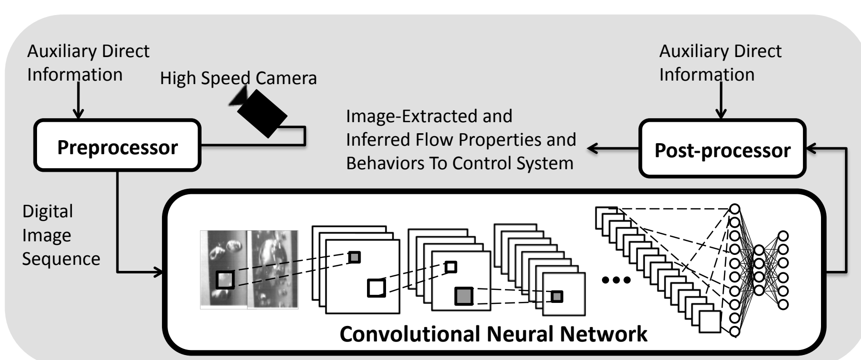

Figure 1. HFIT, patented (US 11,341,657) for general multiphase and multi-compositional flow sensing, comprising software processors and an imaging head

HFIT combines machine-vision methods, interchangeable application-relevant science and engineering theory, and high-speed imaging to provide high-accuracy phase-specific (or component specific) quantifications of multiphase and multicomponent flows in real-time. Such quantifications, by phase and component, can include volume metric flow rates, deposition and reaction rates, thermal dynamics, fluid-dynamics, raw count, rotations, distributions, positions, velocities, and accelerations, and other attributes.

Also, HFIT applies the relevant science and engineering theory to such observed flow features to compute associated energy, fluid-dynamic, chemical reaction rate, and other physical and performance outcomes in real-time, further facilitating high-precision process control and automation.

Key Contributions Over the State of the Art

- Can be programmed to recognize select phenomena and dynamical behaviors in transparent flows
- Observes instantaneous details, as opposed to time-averaged behaviors
- Observes spatial details as opposed to volume averaged behaviors, including relative positions, geometries, and rotations of phenomena
- Computes physical derivatives, e.g., velocity, acceleration, and growth rate, directly from frame-by-frame observations of relative positions and geometries
- Gravity and acceleration agnostic
- Applies to opaque and microscopic flows when the optical camera (the imaging head) is replaced with other suitable imaging hardware

3. Technology Readiness

Prototype Technology

1. Prototype code base
2. Performance tested using and air/water two-phase flow testbed

Status

1. Development funded by NASA SBIR Phase I (2019-2020)
2. Patented, US 11,341,657, 2022

4. Future Steps

- Develop demonstrators concerning problems of commercial interest
- Collaborate with commercial partnerships
- Provide licensing opportunities
- Develop products

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