Spatiotemporal Inferential Intelligence – SII™

1. The Problem

Too often machines are required to fail before you can do anything about it.

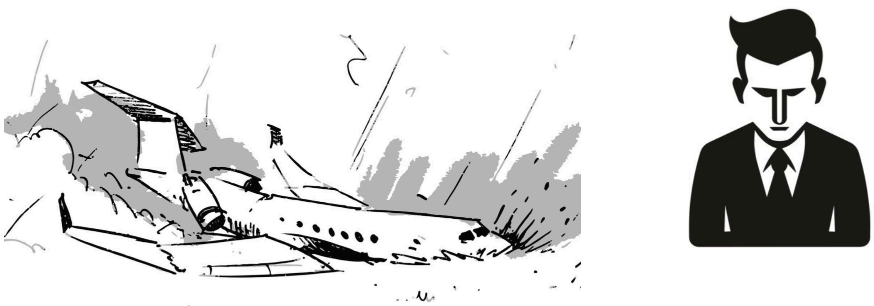


Figure 1. Illustration of a crashed commercial airliner and frustrated engineer

2. Innovation

Spatiotemporal Inferential Intelligence (SII™) is a new safety and autonomy paradigm in inferential sensing that enables aircraft and spacecraft to:

- Comprehensively anticipate and mitigate failures and degradations by inferentially monitoring the condition of an exceeding and unprecedented proliferation of systems and parameters
- Autonomously design and perform ad hoc in-space collision avoidance and rendezvous maneuvers by continuously inferring **all** the parameters of the applicable equations of motion for transition based on current and desired orbital conditions

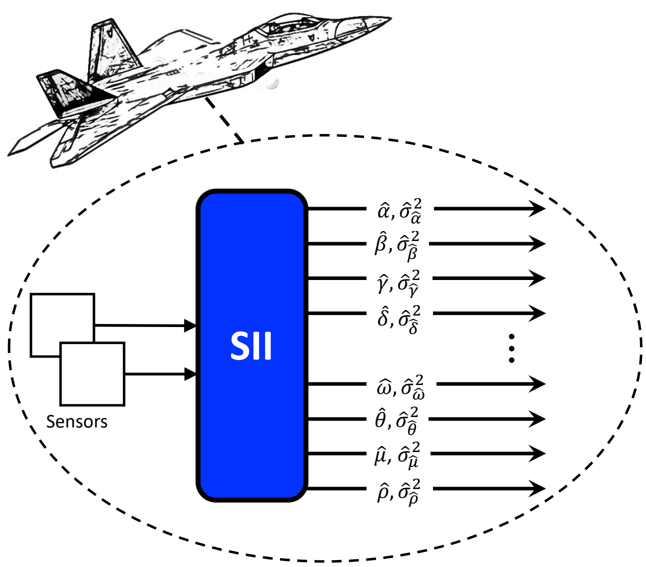
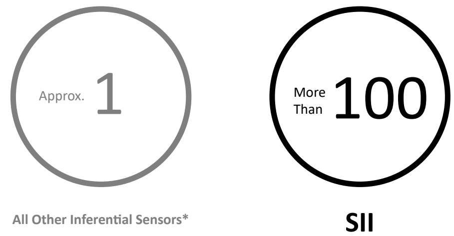


Figure 1. SII extracts an arbitrarily high number of time-varying physical parameter behaviors from only a few sensors, allowing unprecedented decision, control, and autonomy

Stratos Perception, LLC – info@stratosperception.co

2.1. Advantage Relative to the State of the Art (*Secret Sauce*)

Number of Parameters Inferred per Sensed Measurement



*E.g.,(State of the Art) Emerson, Honeywell, ABB, Siemens, General Electric (GE), Schlumberger, Rockwell Automation, Microsoft, IBM, SAP, National Instruments (NI)

Figure 2. Comparisons of SII's expansive parameter estimation capability to the state-of-the-art.

2.2. *Secret Sauce* in *Tech-Speak*

For nonlinear dynamical system $\boldsymbol{y}(t) = f(\boldsymbol{A}(t)\boldsymbol{x}(t))$, where vectors $\boldsymbol{y}(t)$ and $\boldsymbol{x}(t)$ are the system outputs and states, respectively, and matrix, $\boldsymbol{A}(t)$, comprises the time-varying system parameters, then (Equation 1) **SII** not only estimates $\boldsymbol{x}(t)$, but also estimates all elements of $\boldsymbol{A}(t)$ for any arbitrary size $\boldsymbol{A}$.

$$SII(\boldsymbol{y}(t)) \rightarrow \widehat{\boldsymbol{A}}(t)\widehat{\boldsymbol{x}}(t) \quad (1)$$

SII effectively treats a stochastic system with observations, $\{\boldsymbol{y}(t)\}$, as a superposition state, which, when measured, collapses to $\boldsymbol{A}(t)\boldsymbol{x}(t)$, with separable observable features $\boldsymbol{A}(t)$ and $\boldsymbol{x}(t)$.

This result is impossible for the prior state of the art, which may only estimate a few elements of $\boldsymbol{A}(t)$, roughly equal to the number of elements in $\boldsymbol{y}(t)$.

2.3. Additional Key Features

Feature	Benefits
Quantifies estimation uncertainties	Supports statistical analyses and compliance
Auto-tunes control systems in real-time to account for system wear, maintenance, manufacturing tolerances, degradations, and failures	Eliminates frequent inferential sensor software updates, over the life of the system, providing robust safety and reliability

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3. Seeking

Commercial partner and investment support for:

- Developing demonstrators concerning increasingly sophisticated problems
  - Field and software-model access concerning control and monitoring problems of commercial interest

CONTACT
Rube Williams, President/CEO
832-741-3239
info@stratosperception.co

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