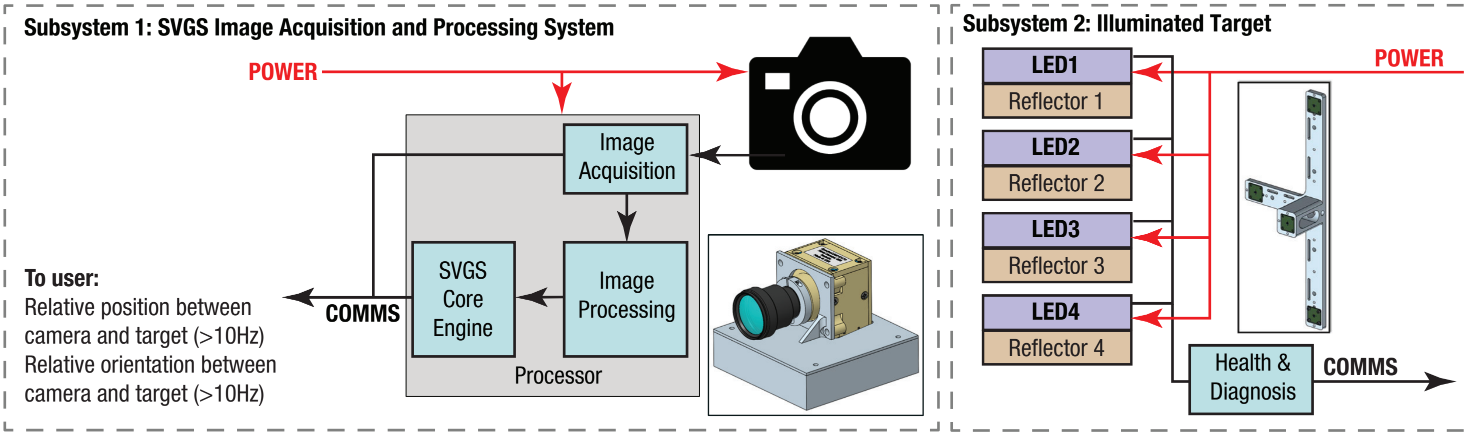
Smart Video Guidance Sensor (SVGS)

A Versatile Relative Pose Sensor

National Aeronautics and Space Administration



OVERVIEW

- Designed for resource constrained systems (e.g., CubeSats, small satellites, small landers) the Smart Video Guidance Sensor (SVGS) is a low mass, low-cost COTS implementation of the Advanced Video Guidance Sensor designed for Rendezvous Proximity Operations and Capture (RPOC); entry, descent and landing (EDL), intravehicular navigation, and GPS-denied navigation.
- Captures images using a camera and analyzes the pattern of the illuminated markers on the target spacecraft using photogrammetry techniques to determine the range and relative orientation (6DOF state).
- Available on both hobby grade (e.g., Raspberry Pi, Android) and high-end platforms (e.g., Xilinx US+MPSoC).
- Software implementations in Linux, FreeRTOS, and Android.
- Sensor range is customizable depending on target configuration.
- Projected SWaP for SVGS flight unit:
  - Size: 8.5x6.5x4.5cm
  - Weight: 250g
  - Power: 5W camera + 5W target

PROJECT STATUS

- Developed prototype implementation on Android smart phone and performed initial accuracy testing (2013)
- Implemented LED targets to improve accuracy and robustness (2017)
- Demonstrated formation flying in closed-loop control (3DOF) with Resonant Inductive Near Field Generation System (RINGS) ground demonstration at Florida Institute of Technology (2017)
- Enabled demonstration of electromagnetic actuation for formation flying in RINGS ground demo at FIT (2018)
- Ported SVGS software and capabilities from consumer grade platforms to high-end, flight qualifiable platforms (2019 – 2022)
- Demonstrated precision landing capabilities of SVGS on a multirotor platform in an indoor flight experiment as pathfinder for use of SVGS for EDL applications (2021)
- Integrated SVGS with Astrobee for flight onboard International Space Station (ISS) (2022)
- Outdoor landing experiment with more lander-like trajectory planned for 2022 – 2023.

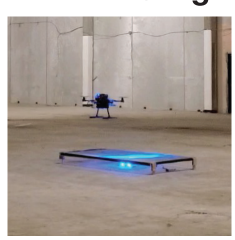
SVGS Platforms

Platform	Language	Operating System	Camera Interface	Target	Update Rate	Environment
Samsung S8	Java/C	Android	MIPI	LED/Retro	30Hz	Terrestrial
INFORCE 6640-820	Java	Android	MIPI	LED	20Hz	Terrestrial
Raspberry Pi 3	Java	Linux	Pi Cam	LED	10Hz	Terrestrial
Xilinx US+ MPSoC	C	FreeRTOS	GigE	LED	10Hz	Space (projected)
Qualcomm SDA845	C	Linux	MIPI	LED	10Hz	Space (projected)

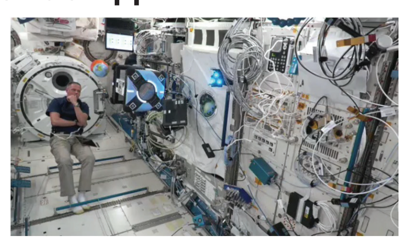
SVGS Accuracy

	0 – 3 meters	3 – 10 meters	10 – 20 meters
X,Y lateral position (m)	0.005	0.010	0.030
Z range position (m)	0.020	0.140	0.25
RPY attitude (deg)	0.6	1.4	3.2

On-going SVGS Applications



Precision Landing Pathfinder on Multirotor for EDL



ISS Intravehicular Formation Flight

Partnership between NASA Marshall Space Flight Center and Florida Institute of Technology

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