

Image Processing: Critical to Hubble Discoveries

Lucas Divine & Chris Lavin
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Welcome to the Hubble

The Hubble Space Telescope was deployed into space in 1990, but its conception took place in the 1940's. The Hubble is a masterful telescope designed with long term space observation in mind. It has three cameras, two spectrographs, and many guidance sensors to capture high resolution images of astronomical objects. It is 43.5 feet long, weighs 24.5 thousand pounds, and orbits the earth every 97 minutes¹. It was deployed into low-Earth orbit, which is about 380 miles off the earth. This allows it to view space 10 times better than any telescopes on earth. It also allows the telescope to see wavelengths that the Earth's atmosphere filters out. The Space Telescope Science Institute handles most of the research and day to day operations of the Hubble. It is operated for NASA and other Astronomical organizations. The images that the Hubble captures require a great deal of image processing before they are useful. This report will go over the various techniques used to create the incredible Hubble images that the public has been seeing over the last decade.

The Hubble's Instruments

The Hubble Space Telescope has a variety of instruments to perform all of the necessary tasks that it needs to accomplish. Many of them allow for better image processing back on earth. There are many components designed to aid calibrating, focusing, and pointing the Hubble before any of the cameras can do their job. Software packages developed specifically for these purposes allow the control of the configuration hardware. Sensors allow for the reporting of the hundreds of parameters that the other components need to know. The Hubble is equipped with Fine Guidance Sensors (FGS) that are used for high speed

photometry, astrometry, and pointing of the telescope. They provide feedback used to maneuver the telescope and perform celestial measurements.

The main interests of Image Processors are the cameras and other key instruments that directly affect the Images that the Hubble Space Telescope is able to take. They consist of the ACS, NICMOS, STIS, and WFPC2².

- ACS: This is the Advanced Camera for Surveys. It is a third generation Hubble Instrument that includes three electronic cameras, or channels, for varying pictures. Each of the three channels (wide field, high resolution, and solar blind) has a filter wheel or two that allow each channel to detect large swaths of light across a huge spectrum of wavelengths. For example, the ramp filters on the filter wheels allow narrow or medium band imaging centered at an arbitrary wavelength. The ACS increases the discovery efficiency of the Hubble by a factor of ten.
- NICMOS: The Near Infrared Camera and Multi Object Spectrometer sees the universe at near infrared wavelengths at a higher level of sensitivity and in sharper detail than any other telescope. The infrared and near-infrared are the primary focus of the three cameras that make up the NICMOS.
- STIS: The Space Telescope Imaging Spectrograph provides spectra images at ultraviolet and visible wavelengths, probing our solar system as well as farther cosmological distances. Thus it acts like a prism to separate light into its component colors. It is a two dimensional spectrograph that blocks extraneous light and generates the spectra of many locations simultaneously.
- WFPC2: This is the current Wide Field Planetary Camera 2. There was a version 1, but the technology has been upgraded, and a version 3 is currently being developed. This camera is the workhorse behind many of