The NASA Fireball Network All-Sky Cameras

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The construction of small, inexpensive all-sky cameras designed specifically for the NASA Fireball Network is described. The use of off-the-shelf electronics, optics, and plumbing materials results in a robust and easy to duplicate design. Engineering challenges such as weather-proofing and thermal control and their mitigation are described. Field-of-view and gain adjustments to assure uniformity across the network will also be detailed.
The NASA Fireball Network
All-Sky Cameras

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Requirements

• Low-cost
• Weather-proof including dew resistance
• Same field of view and sensitivity as existing University of Western Ontario cameras in our network
Subsystems

• Housing – PVC plumbing and transparent dome based on UWO design
• Camera - Sony HAD EX-based CCD video
• Power – 12v “brick” and twilight sensor
• Thermal control – fan, heaters, thermostat
• Mount – mast or flat roof
• Cabling – integrated power and video
• Other system components
  – PC running Linux and ASGARD
  – GPS receiver (USB connection)
  – Uninterruptable Power Supply
Housing

• 4 Inch diameter PVC pipe
  – Two 4” Canadian (flanged) cleanout plugs – machined for top and bottom
  – 4” NPT to 4” PVC hub inner
  – 4” NPT to 4” PVC hub outer
  – 3” PVC x 1.5” inner hub, cemented to bottom
  – Three 3” PVC shims to center above in bottom

• Acrylic dome

• Dome to pipe adhesive – Henkel PL Polyurethane window and door sealant
  – Selected after extensive testing of several urethane, silicone, and polyurethane adhesives

• Any joints must be caulked

• O rings must be covered with aluminum tape to protect from UV

• Install dessicant packs just in case
Camera

• Watec 902H2 Ultimate – based on Sony HAD EXview CCD

• Rainbow L163VDC4P 1.6 – 3.4 mm f1.4 zoom fisheye lens

• Adjustments
  – Shutter speed 1/30 second (1/60 second fields)
  – Gamma = 0.45
  – Manual gain control set to match sensitivity of existing UWO camera
  – Autoiris setting full CW to disable autoiris function
  – Camera focal length adjusted to give field-of-view identical to UWO camera
Power System

- 12v 2 Amp off-the-shelf power brick
- Twilight sensor based on CdS photocell and 555 timer chip. Powers camera during darkness.
Thermal Control

12 v micro-fan forces air toward dome over two 15 ohm 10 watt resistors in series giving 4.8 watts of heating

Normally closed thermostat opens to remove current to resistors at 85 degree F (30 C). This is above the maximum nighttime dewpoints in the southeastern U.S.

Timer switch turns off all power to the camera between 6am and 6pm local time

Active cooling would probably extend the lifetime of the cameras but this is very difficult

Daytime temperatures inside dome can exceed 110 F (43 C)
  - Watec operating temperature limit is 104 F (40 C)
  - Watec non-operating temperature limit is 158 F (70 C)
Cabling

• Integrated video coax and power
• No connectors are exposed to the weather
  – Weather-proof compression feedthrough is at the bottom of the housing
• Cable length tests
  – 125 ft cable has 1.7 volt drop under full load
  – 50 ft cable has 0.8 volt drop under full load
  – Video quality looks the same in each case
Mount

- L bracket attaches case to standard antenna mast
- Roof mount has proved to be very flexible for any flat surface installation
Summary

• The design is robust and inexpensive

• Primary issues:
  – Thermal – daytime heating is severe and no active cooling is easily achievable
  – Weather-proofing – caulking of joints is essential. Dome adhesive is critical
  – Camera lifetime – hot pixels develop with time which complicates data analysis (especially “plates”) and limits useful lifetime of cameras
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