ONBOARD VIDEO

Preparation for RocStock, June 8-9, 2007

In preparation for Mudd II's first flights at RocStock, the test onboard video system 2.4 GHz BoosterVision camera and the 900 Hz mini-camera were dual-mounted onto a specially cut carbon-fiber board that could be extended and retracted from the avionics bay of Mudd II to look through windows of a mounted shrouding piece. The camera-mounting board extended and retracted by an axially-fixed machine bolt screwing and unscrewing a threaded hex standoff attached to camera-board. On either side of the camera board, there were spacers with dowel pins glued in that were designed to act as bearings. This design did not perform well in practice because of the following reasons: the parts for the scratch-made bearings could not be ordered with tight enough tolerancing; it was very difficult to assemble the mechanism accurately; even with JB welding and epoxy, the apparatus was too fragile. The apparatus would frequently jam during use and would have to be screwed and unscrewed. There was also significant risk of the apparatus breaking while it was retracted causing the avionics bay to be stuck inside the avionics section. It is recommended that future onboard video designs do *not* incorporate moving parts as they are hard to manufacture and assemble and usually present unforeseen complications.

The Mudd II avionics section was constructed out of a hybrid carbon-fiber and Kevlar composite. Due to the conductive nature of carbon fiber, the resulting tube surrounding the radio transmitter acted as a Faraday Cage and prevented any signal from being transmitted long-range resulting in no onboard video footage for these launches. Non-conductive airframe material needs to be used to not block live radio-broadcast video feed.

Preparation for LDRS, July 13-16, 2007

After RocStock, new onboard video system concepts were designed with the goals to be simplified and less prone to failure and to achieve two views (i.e. horizon and ground) with only one camera, as the E80 class rockets (Mudd III) will have at most one camera. Three designs (with variations) were developed. Alternative Design 1 involves having the camera mounted to the avionics bay looking out the side of the rocket with its field of view (FOV) split by an angled mirror attached to a shrouding piece. The mirror would provide a view looking down at the ground. To not block the cameras view but also to prevent bulkiness of the shrouding, the mirror would be exposed to the outside, with the risk of being scratched, broken on recovery, etc.

Alternative Design 2, or the "periscopic prism" design, involves a shaped piece of polycarbonate that would utilize internal reflection to achieve split vision. The motivation behind this design was to not expose a mirror to the environment while at the same time keeping the manufacturing process simple, as it was thought that the surfaces of the polycarbonate could be polished if scratched. Because of the camera's inability to protrude from the airframe, the size of the polycarbonate prism would be too large to adequately cover the camera's FOV. There are also issues with the fact that while most

of the reflected part of the camera's FOV would be full (i.e. total internal reflection), a significant percentage would not.

A concern about the two previous concepts mentioned was how assembly and usage of the rocket would affect alignment between the mirror or prism internal surface and camera. With this, Alternative Design 3 was developed where the camera would mount inside the shrouding and would be coupled to the mirror (i.e. the camera and mirror as one unit) via a specially cut polycarbonate board, similar to the previously mentioned camera card. The camera would look straight down while the mirror was angled to reflect a view of the horizon. A further advantage is that the mirror is mostly submerged in the airframe. This design was pursued as the proof of concept for split vision in rocket flight. Even after inaccuracies from the machining process, the design was very effective in achieving split vision, as can be seen in the short in-flight video of the Mudd II at LDRS.

The 900 MHz camera was used for the split vision proof of concept at LDRS with avionics section made out of polycarbonate. The 1-watt transmitter was mounted on the previously used carbon fiber avionics bay with the antenna orientated towards the nosecone for positioning constraints. While there were moments of interrupted transmission, it is unclear whether these were due to the conductivity of the avionics bay (e.g. Faraday cage effects) and not just the orientation of the rocket as it was being handled. For the most part, the signal was very clear until the rocket reached about 4000 ft. If the transmitter antenna could have been pointed down towards the ground, the signal might have been clearer to a higher altitude.

Onboard Video with CCD Cameras

After LDRS, a design was developed to accommodate the much larger BoosterVision CCD camera for split-vision onboard video. This BoosterVision CCD camera included a large square base that prohibited it from being incorporated into an AD3-type design because it is simply too large to reasonably fit inside a shrouding. Instead, AD1 was further developed to accommodate it. But as opposed to the original concept of AD1, the mirror is not attached to the shrouding but instead mounted to a piece that attaches directly to the camera lens by a set screw gaining the advantageous camera-mirror coupling feature of AD3. The shrouding attaches the airframe and partly houses the mirror holding piece, but is not mechanically fastened to it, to prevent complication in the manufacturing process.

A problem not solved in with this design (or currently any other) is sealing off the area directly behind the shrouding as that during flight this will be a low-pressure region and will possibly adversely affect the accuracy of the altimeter inside the airframe if the opening is not sealed during flight. A smaller CCD camera available from OEM Cameras will be compatible with AD3 and it is anticipated that AD3 will more easily incorporate a sealed feature.