HOW TO TURN A DSLR INTO A HIGH END FIREBALL OBSERVATORY

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Fireball camera networks enable the recovery of meteorites with orbital data and minimal terrestrial contamination. The scientific value of the physical and chemical analysis of each meteorite is increased due to the context provided by the orbital data, providing more information about the formation and composition of the Solar System than more contaminated chance finds without orbits. Camera networks photograph fireballs during their luminous flight as they travel through the atmosphere and the trajectories are reconstructed via triangulation using images from multiple geographically distinct stations.

We have developed a novel automated digital fireball observatory with a number of advantages over previous systems allowing the rapid deployment of the Desert Fireball Network (DFN) currently covering more than 1.5 million km^2 of the Australian Outback. Our new observatory uses a 36MP consumer DSLR camera, off the shelf components where possible and a liquid crystal (LC) shutter instead of a mechanical shutter resulting in greatly reduced cost, complexity, assembly time, size and power consumption.

The LC shutter is used to break the fireball trail into dashes for velocity calculation, after triangulation, as previous designs have done with mechanical shutters. However, the flexibility of the LC shutter implementation allows the fireball's arrival time to be encoded by modulating the dash length according to a De Bruijn Sequence [1] synchronised with GPS time.

An automated data processing pipeline is required to handle the huge amount of data produced by the DFN. Plausible events are parameterised producing a path and light curve for each image [2]. Light curves are then matched to the precisely timed De Bruijn sequence to find the absolute timing for the dash endpoints with millisecond precision. These points are triangulated for orbital calculations and mass estimation using the dynamic method [3] to produce a fall distribution for recovery.

The integration of the trajectory timing into the primary imaging system eliminates the need for a separate fireball detector subsystem (e.g. a photomultiplier); this novel technique, combined with the careful attention to manufacturing and assembly considerations during the design phase, has enabled the new DFN digital fireball observatories to be smaller, more power efficient and significantly more cost effective than previous designs. The observatories contain an SSD equipped x86 multi-core embedded computer for data processing, a hard disk drive up to 10TB for approximately one year of image storage, Ethernet, Wi-Fi or mobile data connectivity and only take a few hours to install and configure. The observatory, minus the camera, costs roughly the same as an entry level full-frame DSLR.

DFN observatories and the data pipeline are available for colleagues interested in establishing partner networks. Contact fireballs@curtin.edu.au for more information.

References: [1] De Bruijn N. G. and Erdos P. 1946. *Koninklijke Nederlandse Akademie v. Wetenschappen* 49:758–764. [2] Galloway M. J. et al. 2015 *(this conference)*. [3] Sansom E. K. et al. 2015. *(this conference)*.