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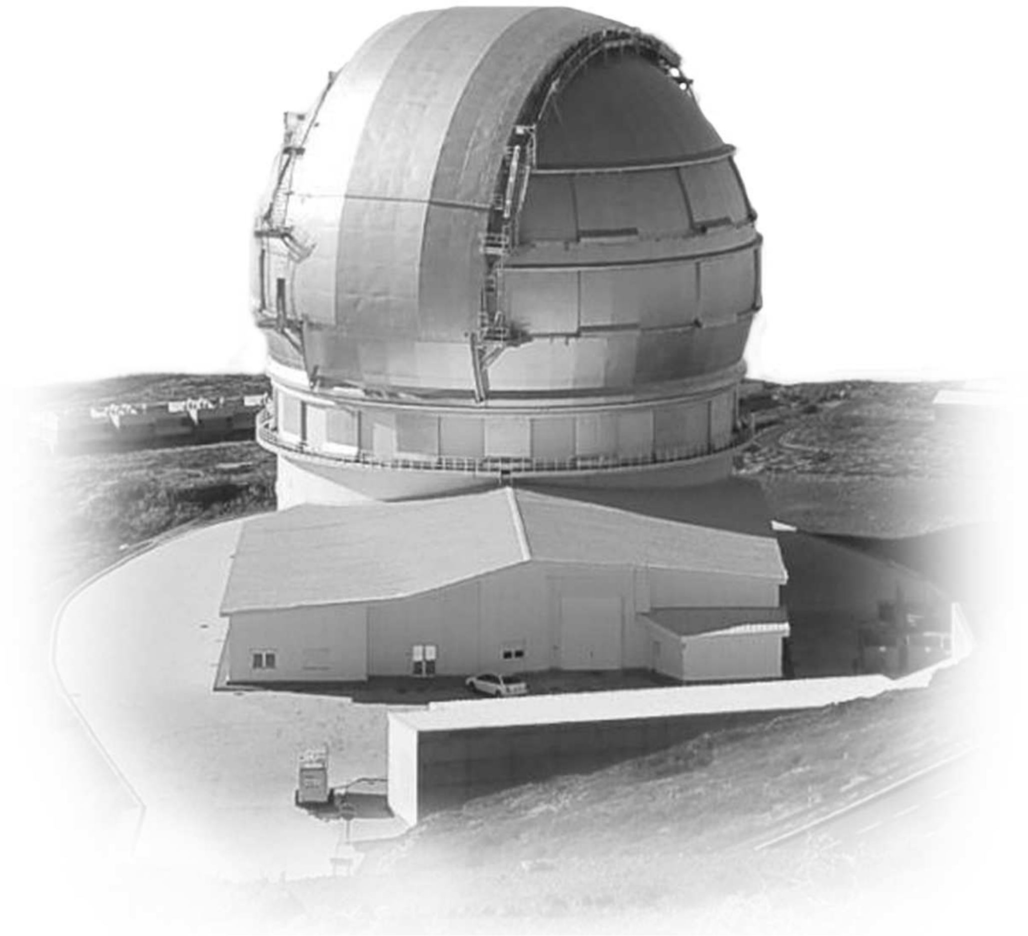

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Digital all-sky cameras VII: Putting the camera into operation

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This seventh paper about the development of a digital all-sky camera, built around a Canon EOS 350D, Sigma 4.5mm $f/2.8$ EX DC fisheye lens and liquid crystal optical chopper, describes the constructed system and the first half year of operation.

1 Introduction

This series of papers describes the design of a digital all-sky camera. Details about the design and the underlaying requirements can be found in earlier papers in this series (Bettonvil, 2006a; 2007a; 2007b; 2009a; 2010; 2011b) and two related papers (Bettonvil, 2007c; 2011a). In the present paper, we look into the actual construction of the system, and we evaluate the first six months of operation.

2 Hardware description

A full description of the final design of the camera can be found in the 5th paper of this series (Bettonvil, 2011a). Figure 1 shows how the completed system looks. The whole system is built in three separate boxes. The heart is formed by a Canon EOS 350D body with a Sigma 4.5 mm $f/2.8$ EX DC HSM circular fisheye lens and a liquid crystal shutter from LC-TEC in between the camera body and the lens (Bettonvil, 2010).

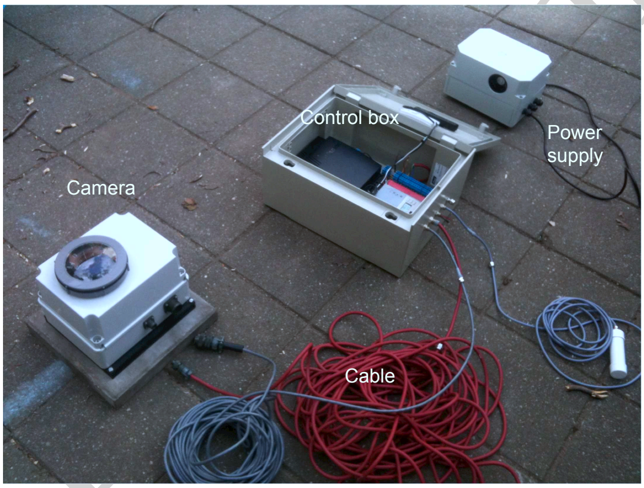

Figure 1 – General view of the camera system: camera enclosure, control box, and power supply.

The camera is mounted in an ABS IP66 dust and waterproof housing of size 22 cm × 16 cm × 15 cm and covered with a watchmaker's glass (see Figure 2). The

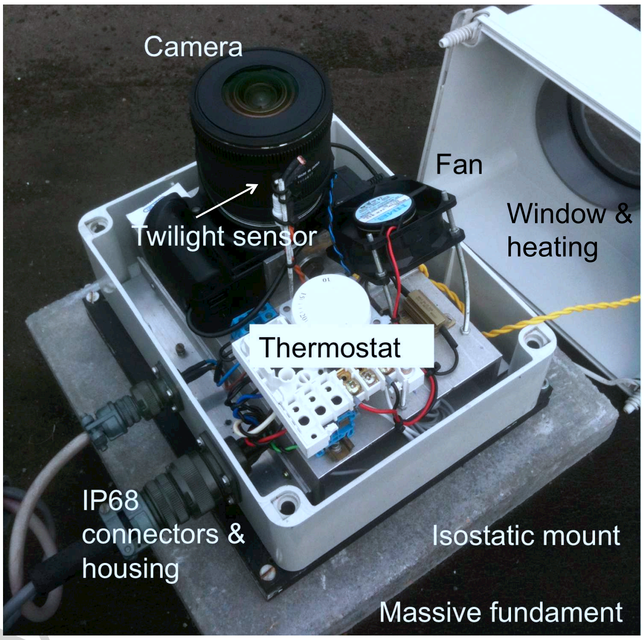

Figure 2 – The camera box, a weatherproof enclosure housing the camera.

glass is heated with heating wire that is mounted externally around the watchmaker's glass in order to prevent that the box heats up internally (which in turn increases camera noise). In order to protect the camera from frost in winter, a heater is mounted inside the box, which only switches on at temperatures below 5° C. Furthermore, a fan is mounted inside the box, which circulates the air. The air flow is directed towards the inside of the watchmaker's glass and helps protecting against condensation on the lens and the watchmaker's glass. During daytime, the fan is on too to prevent overheating in case of warm and sunny weather. Finally, a twilight sensor is mounted next to the fisheye. All other equipment is mounted in other boxes. IP66 connectors supply all power, control, and feedback signals. For safety, only low-power voltages are used. The entire box is screwed on an aluminum base plate which is isostatically secured on a second plate, ensuring precise repeatability after dismounting. This second plate a is fixed on a concrete tile.

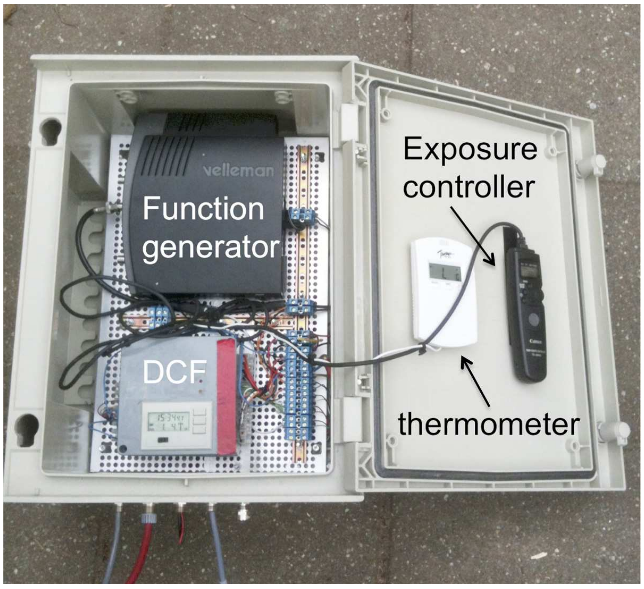

Figure 3 – The control box.

The second box (see Figure 3) accommodates the control electronics. Basically, the electronics consist of a combination of commercial items: a Canon TC80N3 timer controller, a computer-controlled pulse (function) generator for the operation of the liquid crystal shutter, a DCF clock, connected in series with the timer controller for periodic reference breaks in the star trails, the twilight sensor electronics board and purpose-built relay board to control the various signals. For an electronic scheme of the set-up and description of the items, we refer to Bettonvil (2011b). Several LEDs inside the box display the status of the system: availability of power (220 V), day/night status (twilight sensor), exposure status (through flash contact, which turns out to be a good tracer if the shutter is open and the camera is exposing).

Later on, also a GSM relay control module (Conrad) has been added, which sends on request the status of the shutter through via SMS text messages. GSM technology was chosen because it is more reliable than internet in a remote building, which depends on servers and routers. Finally, a temperature display is included which stores minimum and maximum temperature values as measured inside the camera box.

The third box houses all power supplies. This box was separated on purpose from the other boxes in order to limit the heat in either the camera box (to minimize noise) or control box (to keep the temperature of the pulse generator crystal close to room temperature where it is least temperature-sensitive). The box also houses a simple UPS, which powers the pulse generator in case of mains power cuts.

3 Initial experiences

At the time of the presentation of this contribution at the 2012 IMC (September 20–23, 2012), the camera was operational for just over six months. It is installed on the roof of the Old University Observatory of the Astronomical Institute of Utrecht University, located in the center of Utrecht, under typical light pollution conditions for a city, but giving a quite unobscured view on the sky (see Figure 4). The camera has been in operation every single night, regardless of weather conditions. Not a single night was missed so far. Maintenance, in practice meaning interchanging the memory card and cleaning the outside of the watchmaker's glass, is done once every 1–4 weeks. It turns out that the glass remains relatively clean, likely due to rain that removes dust periodically.

The maximum temperature measured so far was 47° C, and occurred on a warm summer day with ambient temperatures around 35° C. This did not result in damage to lens or camera. The heater element proves to work well and keeps the protection glass free from condensation. Some condensation at the inside of the glass has been noticed during daytime in fall, when the average ambient temperature starts lowering and at some point sinks below the dew point of the air in the hermetically sealed camera enclosure. The problem has been overcome by switching the lens heating on also during daytime time in the cold season, and optimizing the airflow of the fan inside the enclosure. Futhermore,

- it turns out that after a long time in sleep mode the camera does not always wake up out of standby mode. This was solved by automatically hard-power cycle the camera power daily at dawn;

Figure 4 – Installation on the roof of the Old University Observatory.

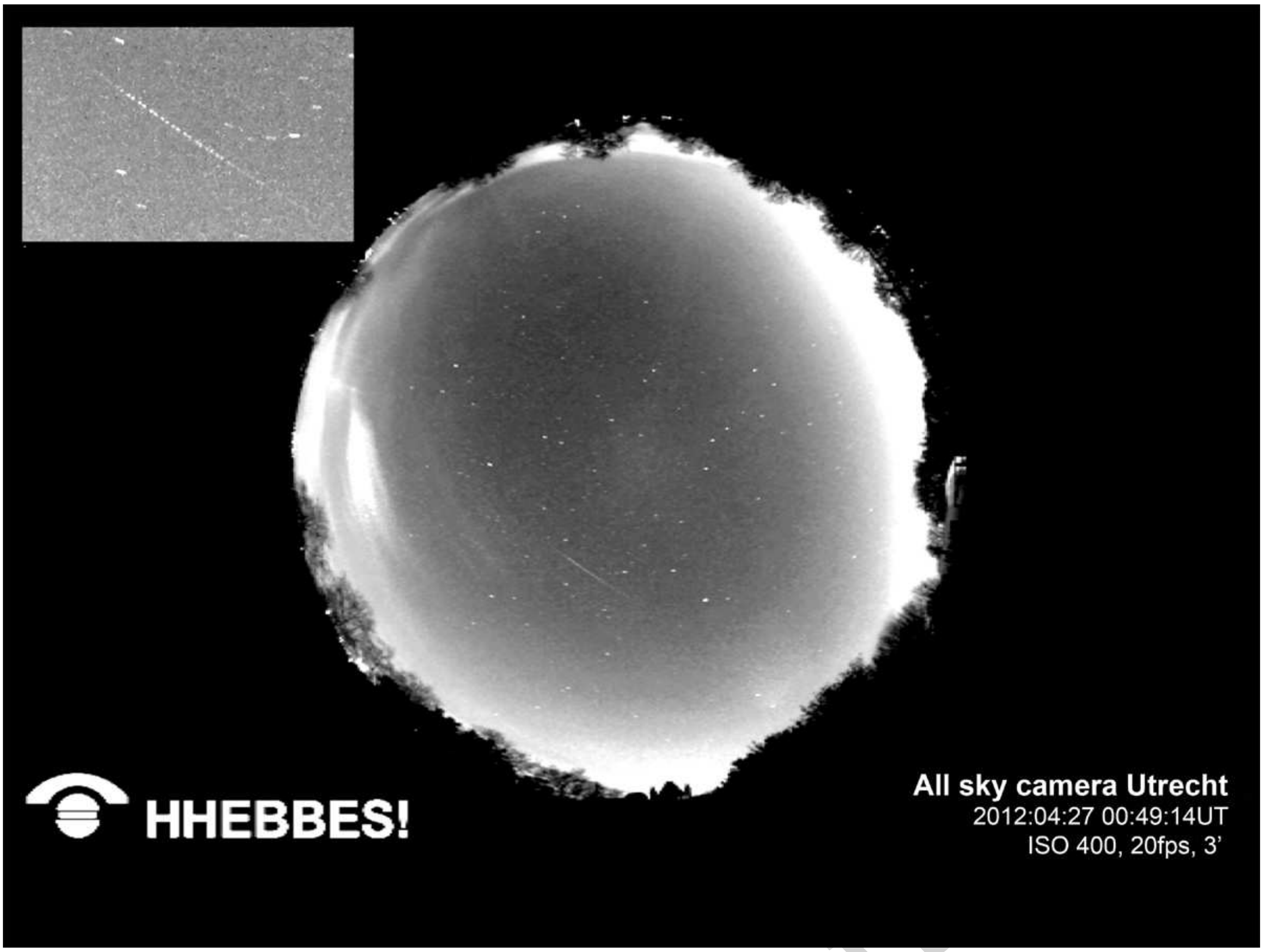

Figure 5 – Fireball, captured with the camera, showing fine detail in the fireball trail.

- a couple of times, the DCF clock stopped working, resulting in the loss of reference time stamps. Likely, the antenna signal was disturbed due to interference but a cause has not been found so far;

- it can clearly be seen that the noise level in summer is higher than in winter, which is due to the seasonal temperature variation. Although not seen as a primary problem, it could be improved with a Peltier cooler.

4 First results

During this first half year of operation, a dozen of fireballs have been captured, but so far none of them have been processed. Figure 5 shows a fine example.

5 Conclusions

The camera fulfills its goal as an automatic system and is now in regular operation. The system has been named HHEBBES![1]. Effort now will be put into completing of a data reduction pipeline and verifying the performance based on real data.

[1] Colloquial Dutch for "I have got it!".

During the conference, the idea arose of making the design available in the form of construction guidelines and a shopping list. This is seen as a great idea to spread this type of camera among a broad community. Likely, this will be done via a web page.

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