DIGITAL VIDEO TECHNIQUE
AS A NEW PART OF THE DWD OBSERVING NETWORK

Theodor Mammen[1], Dr. Uwe Wienert[2]

German Meteorological Service

[1]Frahmredder 95, 22393 Hamburg

Tel.: ++49 (0) 6690 2417, Fax.: ++49 (0) 6690 2499

Email: theodor.mammen@dwd.de

Kaiserlei 42, 63067 Offenbach

Tel.: ++49 (0) 8062 2816, Fax.: ++49 (0) 8062 3809

Email: uwe.wienert@dwd.de

Abstract

The project "Messnetz 2000" for the renewal of the systems in the observing network of the German Meteorological Service (DWD) includes techniques for the automation of visual observations. One part of this attempt are digital pictures and movies from video cameras for the remote determination of clouds, visibility etc.

The DWD today operates a network of 10 camera systems, mainly for evaluation purposes. Each system consists of one camera in a fixed housing and another camera on a Pan-Tilt (PT) device. The fixed camera is oriented westward and takes one picture every 15 seconds. Pictures from one hour are merged to movies in mpeg-code. For every PT-camera there is a site-dependent schedule for taking pictures of the upper half sphere and of some targets at different distances. The systems are Linux based, run fully automatic and all products are accessible via browser.

Some of the systems are situated at manned stations. For a one year period observers from a neighboring station coded clouds, visibility etc. based on pictures and movies. The results of local and remote coding were compared. Forecasters reported usefulness especially for aviation and made suggestions for improved siting.

1. Introduction

In the mid 90s the German Meteorological Service (DWD) started to replace old measuring systems of the observing network. This was accompanied by a significant reduction of observing personnel. So a main goal of the project "Messnetz 2000" was to introduce new sensors for replacing eye observations. New sensors like "Present-Weather-Sensor" are tested and will be introduced. Data from existing sensors like ceilometers will be processed by more complex algorithms to get e.g. cloud coverage.

Also in the last ten years the number and quality of web cams increased substantially. Therefore DWD started a small camera network (Weather-Observing-Camera-Network - WeBoKaN). The aims were to find out how this technique could supplement the new sensors and to get experience with such systems. Starting in 2000 a small network of 10 systems was set up with prospect of more systems.

2. System overview

The main requirement for the system was to provide pictures and movies as memomotion. Since there was no complete system available on the market and the schedule was quite terse, standard components (commercial-off-the-shelf) were integrated by DWD. Fig. 1 shows the main components.

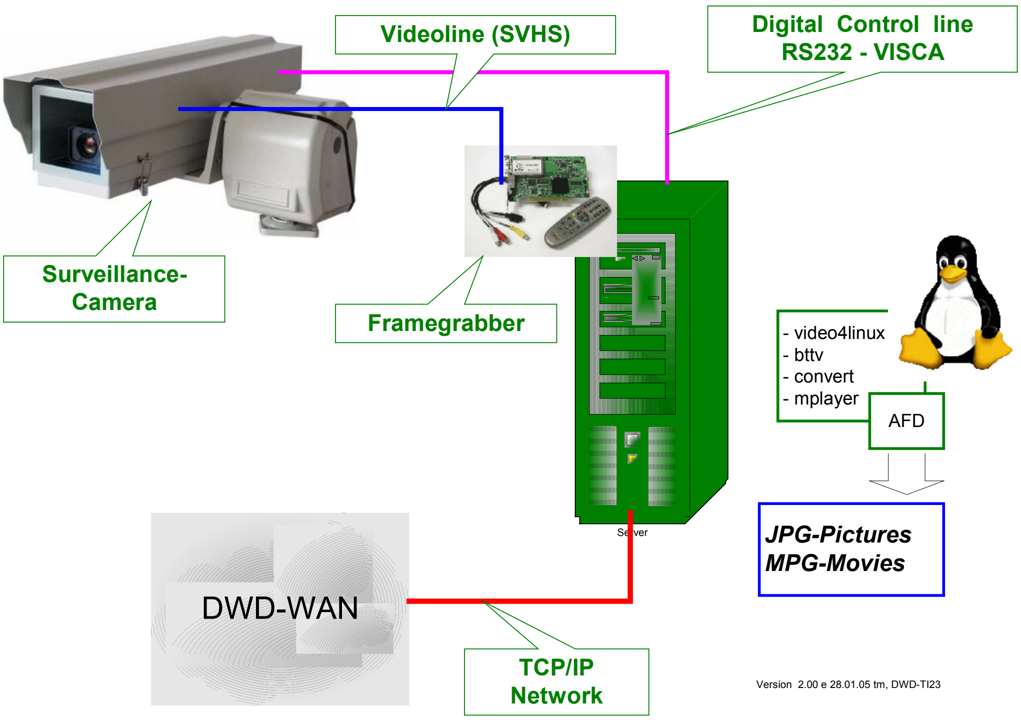


Fig.1: Main Hardware components of WeBoKaN.

The video signal (SVHS) from a Sony block camera is digitized in a Linux computer by a standard framegrabber and Open Source Software. Functions of the camera and the Pan-Tilt-Device are controlled over serial line busing the VISCA-Protocol. Since the movies need an update rate of the pictures of about 15 seconds, there is also a fixed camera. Here only parameters of the camera like focus can be adjusted, see Fig. 2.

The fixed camera points westward and about 20% of the image is below horizon as an optical reference for the users. The movable camera scans the upper hemisphere and zooms in some targets.

The digital pictures are processed, e.g. tagged with metadata or a DWD logo and MPEG-Movies are encoded.

Fig. 2: Outside installation.

Then the products are sent to the WeBoKaN operation center in Hamburg by the Automatic-File-Distribution (AFD) software. Here a webserver application provides access to all products. A nationwide overview (Fig. 5) gives a synopsis and through links on the thumbnails a display of all products of one site comes up (as thumbs too).

Fig. 4 shows a zoom-series of a target. Using distinct targets at different distances it is possible to evaluate the visual range.

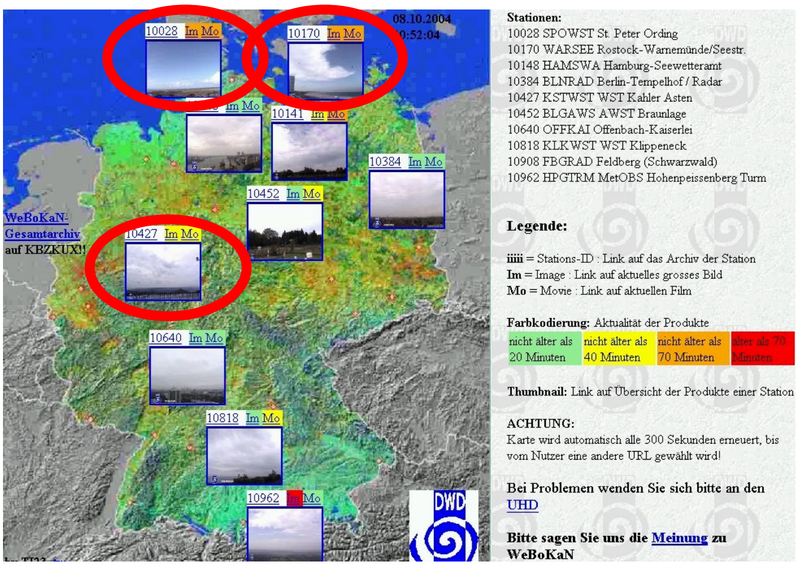
Meta information of each picture is encoded in the JPG-Header, to assure that the meta information can directly be used.

Fig. 3: Single picture with decoded header-information.

Fig. 4: Zoom-series of a target.

Parameters like temperature or precipitation yes/no are gathered by the Built-In-Test-Equipment (BITE), making it possible to control the wiper automatically and to do an automatic self check of the system.

3. Comparison of local and remote observations



As soon as the first system was installed the whole staff of DWD could access the products and check them for usability. Additionally comparisons between on site and remote observations of cloud amount, visual range, type and intensity of precipitation as well as state of ground were conducted.

The results were statistically evaluated.

Fig. 5: Nationwide overview with stations marked for comparison.

Evaluation of total cloud coverage Time period: 01.09.2003 to 31.08.2004											
WEBOKAN-Station: Rostock-Warnemünde						Remote Station: Kap-Arkona					
N Total Cloud amount SYNOP / WN Total cloud amount from WeBoKaN	0/8	1/8	2/8	3/8	4/8	5/8	6/8	7/8	8/8	9/8	Sum
0/8	198	20	3	0	0	0	0	0	0	0	221
1/8	52	186	21	2	1	0	0	0	0	1	263
2/8	5	105	81	26	4	0	0	0	0	0	221
3/8	0	51	130	69	23	7	1	2	0	0	283
4/8	0	13	25	57	76	35	7	2	0	0	215
5/8	0	6	20	39	107	105	61	11	0	0	349
6/8	0	4	11	22	40	128	257	153	8	0	623
7/8	0	0	0	7	6	28	111	648	100	3	903
8/8	0	0	0	0	0	2	8	165	1157	12	1344
9/8	0	0	0	0	0	0	0	3	8	31	42
Sum	255	385	291	222	257	305	445	984	1273	47	4464
Dif. > 1/8	5	74	59	70	51	37	16	18	8	4	
Dif. in %	1,96%	19,22%	20,27%	31,53%	19,84%	12,13%	3,60%	1,83%	0,63%	8,51%	
Sum (all Hits): 4464						ideal Hits 2808 or 62,9%					
Non-Hits: 342 or 7,7%						incl. +/- 1/8: 4122 or 92,3%					

Fig. 6: Comparison of local / remote cloud coverage determination.

In Fig. 6 an example of the comparison is given. The observers in Warnemünde created their SYNOP message as usual. In Arkona they used the pictures and movies of WeBoKaN to determine cloud coverage etc. Assuming a typical uncertainty of 1 octa, more than 90% of the values are in agreement. This is consistent with results from the other stations.

Generally it can be asserted, that the results are very good for cloud coverage and good for visibility, if there are good targets. They are not good for state of ground, as well as type and intensity of precipitation. All comparisons were done during daylight.

4. Noise reduction

At low brightness, e.g. at night, the noise in the pictures increases. This effect reduces the perceptibility of details and increases the file sizes, because the compression algorithms work worse. This can be overcome widely if a few pictures are averaged, see Fig. 7 and 8. Since the pictures and movies are available as files under Linux, they can be modified on site (before transmission).

Fig. 7: Night-picture single shot (80kB).

Fig. 8: Night-picture averaged (8 contributions, 45kB).

5. Outlook

The evaluation will be continued especially at low brightness and for state of ground observations. With the experience from 3 years of operation Hard- and Software will be tuned to complete the automatic observations of the other (new) sensors in the observing network of DWD.