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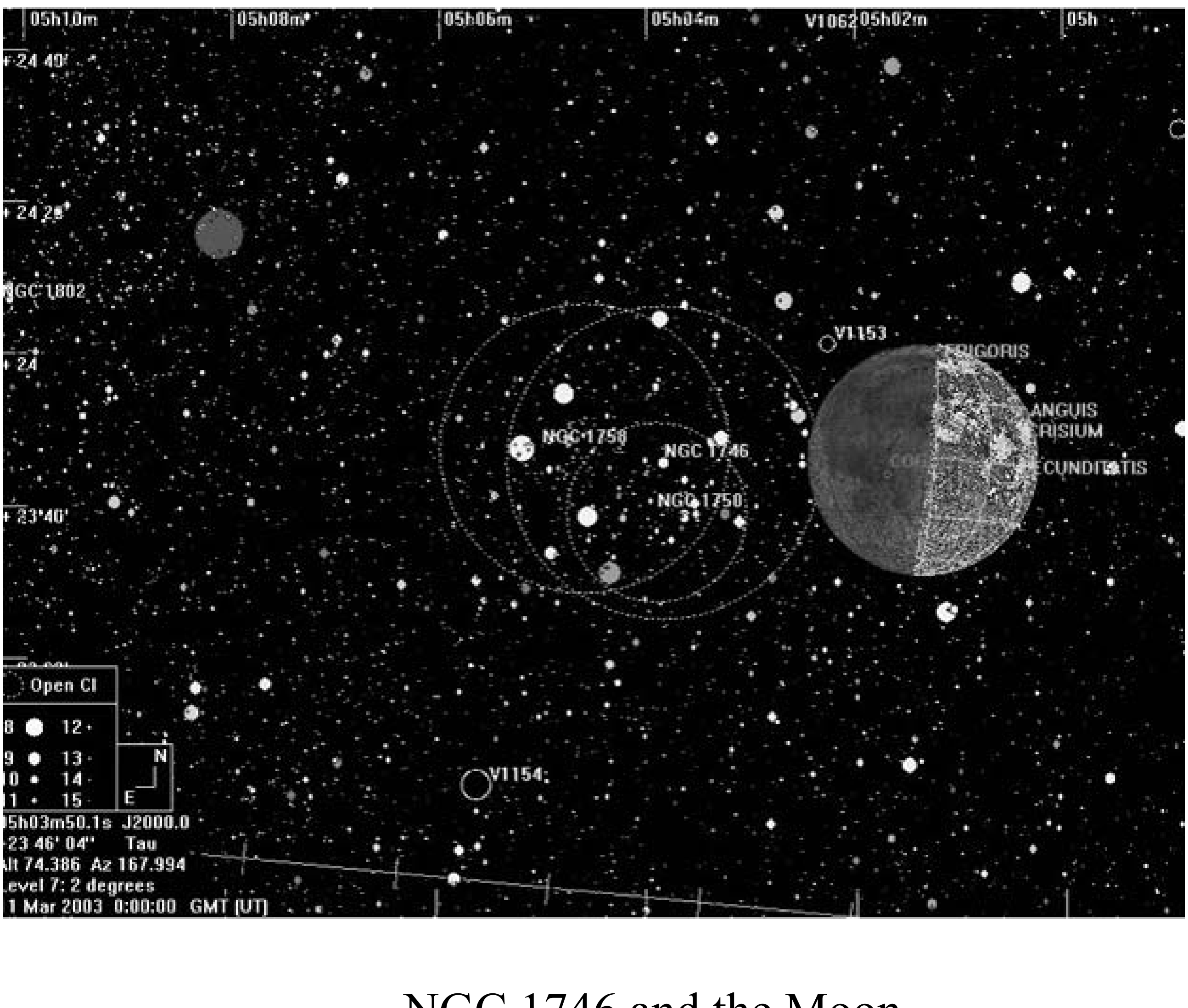

NGC 1746 and the Moon

In this Issue

ON THE COVER:

NGC 1746 and the Moon
11 March 2003

Graphic courtesy of:
Richard and Tatyana Wilds
Topeka, Kansas USA

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Please note: The date shown on the cover is for subscription purposes only and does not reflect the actual publication date.

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Graze Limit and Profile predictions US$1.50 per graze.
Papers explaining the use of the above predictions US$2.50
IOTA Observer's Manual US$5.00

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Two GPS Applications for Support of Graze Expeditions

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Introduction

The preparation and realisation of a graze expedition are demanding and time-consuming tasks. Low price GPS equipment can be helpful not only for the well known final position measurement of an observation point, but also for searching usable observation places and for the alignment of instruments.

Two GPS supported tasks are here described:

- Search of observations places with direct indication of the shortest (orthogonal) distance between a current position and the zero graze line
- Adjustment of an equatorial telescope mount to the local meridian

Both methods have been tested successfully using GPS II plus, GPS 45 and GPS12 from Garmin. Other products should be usable for these applications in a similar way.

1. Search of observations places

One of the most important points of a graze expedition is the correct positioning of observer stations in the expedition area, carefully planned and based on the predicted moon limb profile and the occultation geometry. The first task is the plot of the predicted graze line in a adequate map in order to estimate the best expedition area. The second step contains normally the use of an more detailed map, the plot of zero graze line and the fixing of desired distances to the zero graze line for the observation.

The next activity is the selection of usable observer positions in the terrain. This step may to be solved by a bureaucratic decision only based on the map information, by site inspection some days or weeks to the expedition or in a hasty last minute action several hours before the event starts. The bureaucratic decision is very risky because of map may be out of date.

The classic terrain activities include multiple repeated identifications of landmarks in comparison with map details, estimation of distances, estimation of positions (by map or by GPS), detection of differences between map and reality, looking for an usable observation point, plotting the selected point in the map, checking the wished distance to the zero graze line, correction due to altitude above sea level. So the terrain inspection or last minute selection is time consuming and has several sources of errors.

We can make a fast and exact estimation of the distance between the current position and the zero graze line in terrain by use (or more exactly: abuse) of the route function of a GPS receiver. This gives a significant acceleration for site inspection or last minute search for usable observation points. Follow the described steps to use this method:

Preparation:

1. Set the geodetic datum and the position format of your GPS receiver at the same geodetic datum and format as indicated in your graze prediction (figure 1).

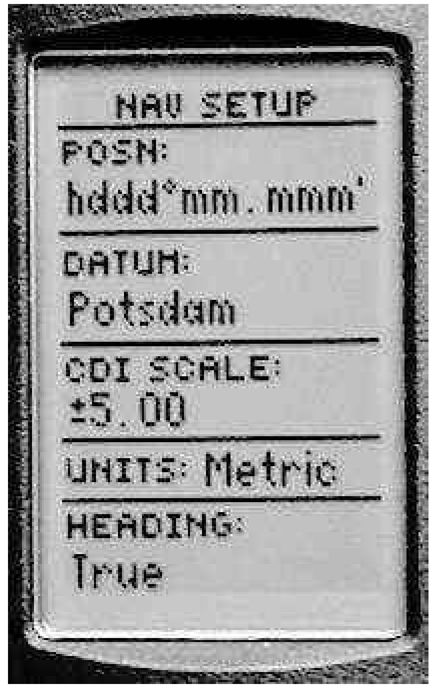

Fig. 1 Setup for geodectic datum and format

2. Create several (3 ... 15) waypoints in your GPS receiver, selected from your predicted zero graze line which adequately cover the planned expedition area (figure 2).

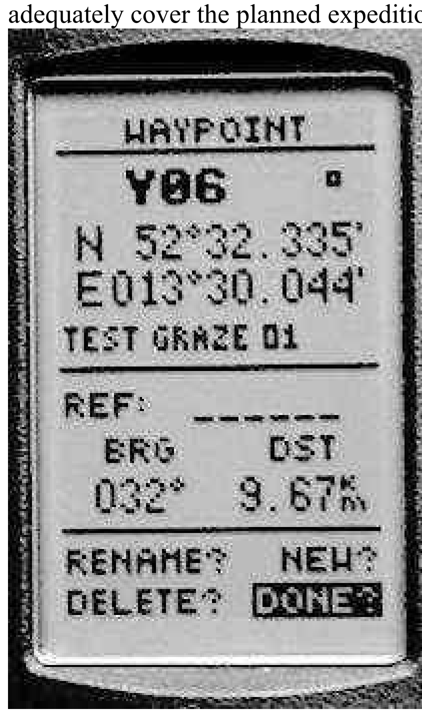

Fig. 2 A waypoint of the zero graze line

The density of these reference points should be selected considering the non-linearity of graze line.

Note:
After step 2 you may change the geodetic datum again, e.g. to a datum which is used in available local maps for navigation.

3. Create a route in your GPS receiver using the waypoints of graze line in the right order of longitudes (figure 3)

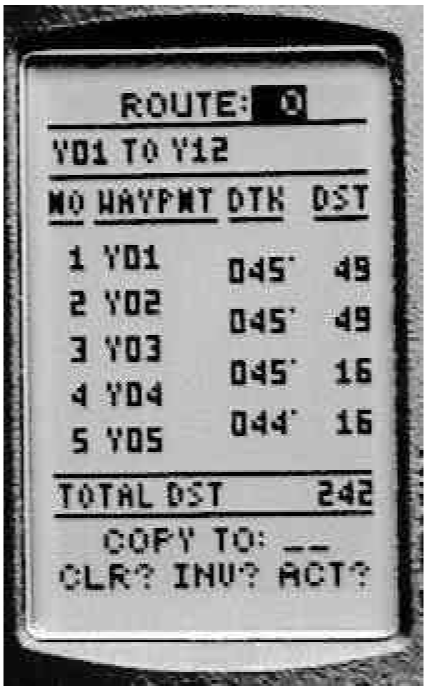

Fig. 3 Created route for zero graze line

Calculate the shifting factor k of zero graze line due to the altitude above mean sea level of an observation point based on the given geometry of occultation in the planned area. This factor can assumed to be nearly constant in an area about 50 ... 100 km and allows to estimate the distance d_h to the zero line at a position at the altitude h knowing the distance d_0 for the same position at the altitude 0 above mean sea level:

$d_h = d_0 + k * h$

Note:
This step has to be done also using other than GPS methods for preparation, especially if the expedition area is located in highland. The estimation of k is not covered by this paper.

Use of GPS receiver in terrain activity:

4. Switch on the GPS receiver. Set the GPS receiver at metric units as used in your predictions and maps.

5. Activate the route created in step 3 (figure 4), choose the map page (figure 5). The map shows roughly the situation of zero graze line and your current position. Especially you can clearly identify that your are on the wished side of the zero line.

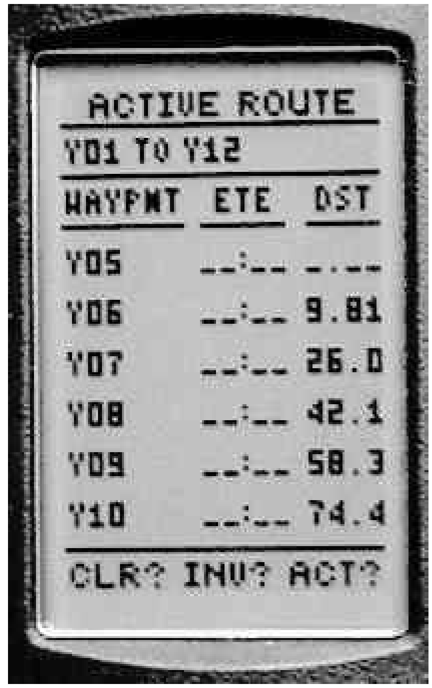

Fig. 4 Active route for zero graze line

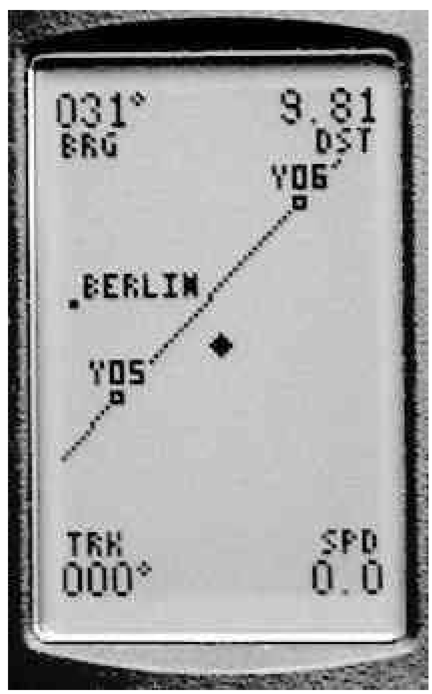

Fig. 5 Map page with current position and active route

6. Choose the highway page now (figure 6). The central thick point indicates your position. The central line of the highway indicates the zero graze line. The shortest (orthogonal) distance from the current position to the

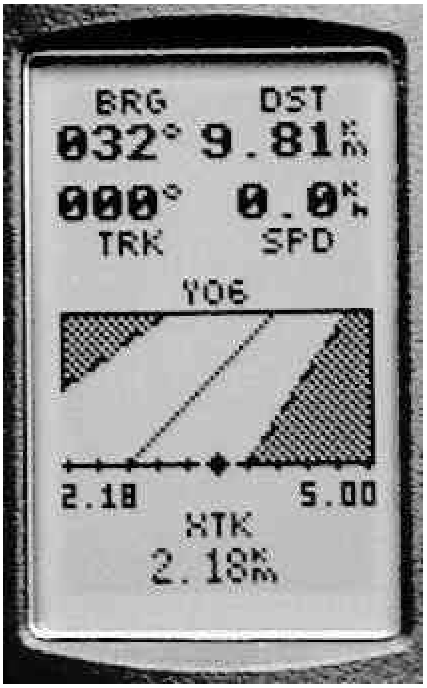

Fig. 6 Highway page

7. zero graze line is indicated at the bottom left (2,18 km). The displayed scale width (CDI) is indicated at the bottom right in this case. Indication of distance and scale width will be exchanged if you are at the other side of zero line.
   You may also make a graphic interpolation between the central point and central line of highway in order to get the distance to the zero line.
   Figure 4 indicates the distance once more as the XTK (Cross Track Error) value central at the bottom. This additional display is not available for GPS 45.
   The highway may be invisible when you have a large distance to the zero line but the numeric distance indication is always correct. Ignore any steer information on the display!

   Note:
   The indicated distance to the zero graze line is permanently updated when you move in terrain. This distance is valid assuming sea level for your position. You have to correct this distance for the current altitude above sea level using formula in step 4. The current altitude you may read from the normal GPS position menu or from your map with adequate accuracy.

8. Watch the distance as indicated by GPS display. Move in terrain in order to arrive a good observation place which has the desired distance to the zero graze line. Do not forget the altitude correction.

   Note:
   The displayed value DST in Fig. 2, 4, 5 and 6 is the distance from the current position to the next waypoint(s) of active route, in Fig. 3 the distance between the waypoints. This is not the shortest distance from the current position to the zero graze line!

9. As usual, measure the final telescope position and altitude as good as possible (figure 7), make an exact description of the observation site and distances to near durable landmarks (e.g. big stone, tree, gully, edge of building) and document all details in your papers for final observation report (or - in case of terrain inspection in advance - for instruction of other observers).
   Do not forget to write down and to report also the used geodetic datum for your final position measurement reading.

Note:
The method is usable also for solar eclipse and similar expeditions. Then the route should defined by the predicted northern (southern) border line of totality.

Fig. 7 Position page with position and altitude above mean sea level

2. Adjustment of an equatorial telescope mount to the local meridian

Set-up of a temporary used observation place includes the alignment of equatorial mount to the meridian.
The astronomical methods using Pole Star or Scheiner's algorithm are not always practicable (southern hemisphere, waiting for a last minute cloude hole). Compass method is affected by declination and may be disturbed by unknown local anomaly.

A GPS receiver is then a good tool to solve this problem.
The method was shortly mentioned by Dr. Eberhard Bredner during ESOP 2000 in Poland. After that the author has used it and has found it worth to be described in detail. You need in addition a stick or bar, a white piece of cloth and - for

operation in darkness or twilight - a pocket lamp and a cat's eye reflector.

Follow the described steps for this method:

1. Switch on the GPS receiver. Set the heading in the setup page at TRUE north (see figure 1).
2. Put the GPS receiver at the point where you will set up your telescope. Measure the position of this point and save it as an waypoint, e.g. as "TEL"
3. Activate the GOTO - function and select the waypoint "TEL" crated in step 2 as the goal.
4. Take the GPS receiver and go away approximately in northern (southern) direction where you have direct sight to your telescope position. Go until you have reached a distance of at least 100 m; 200 m or more are better. Current distance DST and azimuth BRG to "TEL" then are indicated on the GPS map display or highway display (see also figure 5 or 6).
5. Go very slowly approximately from west to east (or in the opposite direction) and watch the azimuth indication. When the indicated azimuth is 180 degree or 0 degree then your current position and the position of your selected telescope point "TEL" are at the same meridian. Ensure that this point is visible from your telescope.
6. For better accuracy use a simple interpolation: When the azimuth changes from 179 to 180 (359 to 0) degree mark your position in terrain. Continue to go several steps in the same direction; mark the position again when the azimuth changes from 180 to 181 (0 to 1) degree. Repeat this for averaging several times. Estimate the middle of these marks and erect your stick with a white flag or so and / or the cat's eye there. Ensure again that this beacon is visible from your telescope.
   Measure and save this position as a waypoint e.g. "NORTH" ("SOUTH") for confirmation.
7. Return to your observation place, set up your telescope and use the white flag as a mark for the correct north (south) in order to adjust the mount azimuth. In the darkness use your pocket lamp to illuminate cat's eye. If necessary use the magnifying finder of your telescope as a collimator to boost the brightness of the pocket lamp. You may confirm the correct positioning of your installed beacon using the GOTO "NORTH" ("SOUTH") function at the telescope position. The indicated azimuth should be 0 (180) degree now.
8. Do not forget to pick up your north (south) beacon equipment.

Of course, the procedure described may be accelerated and simplified if an assistant is available.

Note:

The use of all real time GPS functions described above (also for exercises) is possible only under conditions where the GPS unit receives an adequate number of GPS satellites and has logged in. In all other cases the displayed pictures and values are wrong (frozen) or empty.

Modern Lunar Limb Profile Systems

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Sources

In 1963 C.B. Watts at U.S. Naval Observatory published his well known work 'The Marginal Zone of the Moon'. For many years it was the only and until today it has been the most comprehensive source for lunar limb data needed in occultation predictions and reductions. However, over the years it became evident that the so-called Watts' Charts contain several gaps and systematic errors resulting from the photographic method they are based on. The need for more accurate limb data can be met better and better as the number of available occultation observations is increasing. Today, there are two important systems of lunar limb profiles which are based on occultation observations:

ACLPPP and MOONLIMB. Both systems are well established now and are improved continuously. MOONLIMB and ACLPPP are not competitive, but they do complement one another. The authors cooperate in order to ensure the best quality of their projects. Careful comparisons made by D.Büttner and E.Riedel have revealed advantages and disadvantages of both systems. In many cases the data from both sources coincide well, but there are also cases with considerable differences. This results from the different methods in constructing both systems.

ACLPPP was developed originally by B. Stevens in 1975 and is maintained by M. Sôma now. It uses exclusively grazing occultation observations. The profile data from each graze occasion (a particular star on a particular date) are stored separately in the database. Only observations belonging to the same occasion achieved at different places are combined with each other, but never observations of different stars at different dates. Thus, there exist many regions on the lunar limb (specified by the librations in longitude and latitude and by the Axis Angle) where ACLPPP contains more than one set of limb points. As a simplification the observations of the brightest stars are considered to be the most reliable ones.

ACLPPP is designed to improve the limb data from Watts' Charts where possible. All profile heights are related to the figure center of the Moon in order to be consistent with the Watts' Charts' reference system. The offset of the Moon's figure center from the mass center is about 0.5 arc

seconds in ecliptic longitude and 0.2 arc seconds in latitude. There are 11381 profile points in the most recent ACLPPP version (October 2002); 2371 of them are extrapolated.

MOONLIMB has been developed by D. Büttner since 1995. It combines data from both total and grazing occultations. All observations in the same region of the limb are used together in the process of deriving the profile points. Therefore, only one set of limb points does exist for a particular region, as far as observations are available for that region at all. MOONLIMB is a quite independent system and it doesn't belong to any other profile system. The profile heights are related to the Moon's mass center according to the lunar positions taken from the ephemeries LE 405. There is a total of 17347 profile points in the up-to-date version ML2001A (April 2002). More details can be found at: www.iota-es.de/moon.html.

Both ACLPPP and MOONLIMB cover only the polar regions of the Moon, namely the Axis Angles AA from 330 ... 30 and from 150 ... 210 degrees. In both systems the limb points are given at intervals of 0.2 degrees in AA as far as observations are available. The points are valid for libration ranges sized from about 4 to 6 degrees in longitude and 1 degree in latitude.

Usage

ACLPPP data are used by the profile prediction program named accordingly. Additionally, both ACLPPP and MOONLIMB are used in IOTA's grazing occultation prediction program GRAZEREG by E. Riedel and in the Lunar Occultation Workbench (LOW) by E. Limburg. The IOTA prediction program searches the ACLPPP- and MOONLIMB-database for limb heights in the closest libration longitude/latitude-square with a side length of 0.2 degrees for the specific Axis Angle. If a limb height is found it is plotted in the profile prediction with different characters allowing to distinguish the sources, giving advantage to MOONLIMB in overlapping cases.

On the reliability of the limb profile data

In either case the observers should be aware that the limb profiles are derived from real observations made by real observers under real conditions. This means, limb profile data are always a more or less good approximation of the actual limb topography, but can never be perfect or ideal. All programs for ACLPPP, MOONLIMB and GRAZEREG have been developed and checked carefully. They all use the most accurate lunar and stellar positions and are based on very precise calculation algorithms. The observations and the limb data derived from them were checked thoroughly for consistency and reliability.

However, all this high care cannot make up for every possible uncertainties inherent in the evaluated observations. For instance, MOONLIMB accepts only observations which are confirmed by other observations in the near neighborhood. If however these observations are all influenced by the same systematic error (e.g. wrong geodetic datum for all observer positions), then they all confirm each other, even if they all are wrong. On the other hand a tolerance must be defined which accepts observations in the neighborhood. This is a more empirical value. If it is too large, then too many observations are accepted and the profiles become rather uncertain, whereas a value too small leads to the rejection of too many observations and thus results in too few profile points.

Another possible limitation results from the distribution of the available observations. A set of the best graze observations doesn't necessarily cover the absolutely highest tops and deepest valleys of this particular lunar limb segment. Thus, a real profile may look somewhat different from an approximation based on even highly accurate and reliable observations.

Finally, the availability and the distribution of the observations has another influence. Today we are far away from describing all regions at the lunar limb with profiles derived from occultation observations. For instance, MOONLIMB covers about 34 % of the points theoretically possible based on the chosen grid in the librations and Axis Angle. This however means that profile points need considered to be valid over a certain range of librations. Thus, a profile point used in a prediction may be away a few degrees in longitude of libration from the actual value of the predicted graze event. This leads to a slight blurring of the predicted profiles.

Observers should realize that limb profiles theoretically may be accurate to 0.1 arc seconds or even better, but in case of uncertain observations errors of 0.5 arc seconds or more may occur. Thus, the authors should not be blamed too much for discrepancies between the predictions and the actual observations. To achieve successful observations the graze expedition leaders should rather spread out the stations widely enough to always cover any possible uncertainties in the profile predictions.

Finally, it should be noted that video observations and GPS derived station positions don't necessarily guarantee the highest quality. There may be a variety of additional observer and/or operator depending error sources such as wrong double star component identification, wrong allocation of the measured station positions to the actual stations and ... and ... and ... ♦

First Experiences with a high sensitive Videocamera with internal Multiframe Exposure Time

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Abstract

This is a short report about the use of the high sensitive black-white video camera MTV-12V1-EX that allows to increase the sensitivity about 2 magnitudes in normal video mode and about 4 magnitudes by using the internal selectable multiframe exposure time with 0.3 sec time resolution (compared with sensitivity of simple black-white video cameras). A video record demonstrates some occultation events and starfields.

Introduction

The extension of observation limits of occultation events to weaker stars for visual observers is possible only by selection of a greater telescope. The video observer may keep the given telescope and use a more sensitive video camera to reach the same goal.
The author used a simple black&white video camera with internal automatic gain control in the direct 1000 mm focus of an AS-refractor with 100 mm aperture. Stars having a brightness of about 7 magnitudes gave good star images in each video frame, under good atmospheric conditions and without moon light influences. There are not a lot of minor planet occultations which could be observed using this equipment. Of course for lunar occultation has to be considered further degradation of detectable stars due to irradiation and depending of several other occultation parameters.
Therefore the author was interested in a video camera that can operate with exposure times over more than one single video frame (20 ms) in order to expand his observation possibilities. Such camera was described by H.H. Cuno during ESOP 2000 in Lodz / Poland. But it was not possible to buy it up to now.

Now the author has studied the internet link http://www.lechner-cctv.de/ in February 2002 (after a hint by Martin Dentel), were even such video camera with multiple frame exposure time (frame integration) is described and offered for sale. The practic demonstration of the model MTV-12V1 by an owner in Berlin was very instructive and convincingly. Furthermore the internet link also offers a new, more sensitive model of this camera ... and the author decided to buy it.

The main features of this black & white camera MTV-12V1-EX are:

minimal detectable illumination at CCD-Chip surface (normal video mode, 20 ms exposure) approximate 0,001 lx

single frame exposure time	0,08 ms ... 20 ms, manual and automatic
multiframe exposure time	20 ms ... 2,56 s (1 frame up to 128 frames)
selectable gain control	manual, automatic with preselected level
chip type	1/2" Sony EXVIEW HAD CCD (ICX249AL)
Chip size approximately:	horizontal 6,46 mm,
	vertical 4,83 mm)
effective pixels	number: 752(H) x 582(V)
	size: 8,6 µm (H) x 8,3 µm (V)
internal digital zoom	1 ... 2x (suitable for easy focus finding)
video output	normal analog VHS and SVHS video signal, 600 TV lines

The record of a fast moved little light source shows that the exposure time in multiframe mode is without interruption for frame transfers. So the time efficiency becomes maximal and readout noise stays at a low level.

The selection of maximum number of integrated frames can be made easily by on screen menu. This manual adjustment takes some seconds only. After that the camera requires several seconds again for gain and exposure time optimising. (This optimising time can be up to 120 sec if integration over 128 frame intervals were selected, of course suitable only for other than occultation work.)

Note:
The camera will not use the preselected maximum frame number for integration under all conditions. The really used exposure time may be shorter. It depends on the current chip illumination conditions and may vary when a significant bright object moves in or out the picture area.

Results below were reached in the focus of the 100/1000 refractor without moon light influence but under city illumination sky conditions:

- normal video mode; 0,02 s exposure time or time resolution:
  9 mag stars stable visible, 10 mag not stable to identify
- 16-times frame integration (ca. 0,3 s exposure time or time resolution, for occultation work mostly good suitable, shorter flashs and blinks are not to identify)
  11 mag stars stable visible, 12 mag not stable to identify

Occultations of stars by minor planets are possible now to mag 9 ... 11 with the 100/1000 refractor.

The observation limit of lunar occultation of weaker stars depends strongly on lunar phase, atmospheric light scattering and the distance of star to lunar details illuminated by sun. The author recorded occultations of 10 mag stars at the dark limb when the moon was illuminated about 75%. This is much better than the author could observe visually using the same refractor in times of his best eye fitness. Sometimes the occultation events at the video record seem to happen at the bright limb of the moon due to the earthshine and the camera sensitivity. ♦

Short report of the IOTA/ES Official Business Meeting 2002

<held on Saturday, October 5 at Hannover Observatory>

1. Report of the members of the board
Financial situation is satisfactory, but due to high postal expenses we have to keep the membership fee for 2003 by 20 EURO per annum. We need a new software for bookkeeping /administration because of the changement to EURO.

The number of participants of our annual meeting is moderate, so we decided
- a: the next annual meeting will be October 11, 2003
- b: we will have then a short business meeting in the morning always followed by a workshop in the afternoon. (next year we will meet in Regensburg, up to now the topic of the workshop hasn't been decided).

We need the current e-mail-addresses of our members, so please write a short message before DECEMBER 2002(even if you believe we have your e-mail):
With address, phone number, fax number, e-mail and if possible number of the mobile phone you use during observations. If you want predictions you should give your coordinates (+ height) and a "travelling-circle" for grazing occultations

A statement of the project MOONLIMB by Dietmar Buettner was presented. At this moment all datas have been processed.

2. ESOP
2002 : Naples – Italy, your will find a report in O. N. 9/4
2003 : Trebur (30 km south of Frankfurt/Main) – Germany
-------August 29 / 31, scientific programme
-------September 1 -…..excursions (astronomical and others)
2004 : ??
2005 : ESOP XXV (!!)
-------will be organized by
DOA(Dutch Occultation Association) /
NVWS(Nederlands Vereniging van Waarnemers van Sterbedekkingen)

For 2004 we need still an invitation, please contact the secretary via secretary@iota-es.de.

3. Predictions
The situation was discussed, Wolfgang Zimmermann tries to include the Tycho II catalogue. The predictions will arrive in time this year.

4. Electronic projects
Hans Helmuth Cuno is working on a GPS-time inserter that will be available in 2003, the price must be higher due to expensive components.
There are a lot of new sensitive video cameras, the last ordered IOTA-cameras will be finished in the next time, there will be now new ones.

5. Scientific programme 2003
We have two (difficult) sun eclipses, two moon eclipses and the PHEMU03 observations.
During the moon eclipse NOV 9, 2003 there is a grazing occultation of a 7.8 star (northern graze line Germany – southern graze line Niger-Africa).
IOTA/ES will suggest observers to train themself with the MERCURY passage <May 7> in front of the sun, to be prepared to observe the VENUS passage in 2004.

6. Videocamera demonstration
We discussed the possibilities of a new Mintron camera (see www.lechner-cctv.de/astro.htm most in German)

7. Add-on's
From now on Wolfgang Rothe will collect your observation:

Total Ocultations and Grazing Occultations, there will be NO REDUCTION from him and he will not send datas to ILOC. We only want to have an overview about the activities of our members and a basis for the YICOM 2003.

Only IOTA/ES members who want to participate should send their datas by e-mail – not later than JANUARY 20, 2003 – to him:
----wrothe@t-online.de---

We will try to give our homepage www.iota-es.de a more informatic appearance, so we will place there a section:
------IOTA/ES this month / IOTA/ES next month-----
-if you want to place there (short)-information, please send them to the secretary, he will collect them and post them to the webmaster- (we start this year-begin now!!).

Ahlen-Dolberg, October 29, 2002

sgd:
Dr. Eberhard Bredner, secretary IOTA/ES

IOTA's Mission

The International Occultation Timing Association, Inc. was established to encourage and facilitate the observation of occultations and eclipses. It provides predictions for grazing occultations of stars by the Moon and predictions for occultations of stars by asteroids and planets, information on observing equipment and techniques, and reports to the members of observations made.

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IOTA European Section (IOTA/ES)

Observers from Europe and the British Isles should join IOTA/ES, sending a Eurocheck for EURO 20,00 to the account IOTA/ES; Bartoldknaust Strasse 8; D-30459 Hannover, Germany; Postgiro Hannover 555 829-303; bank code number (Bankleitzahl) 250 100 30. German members should give IOTA/ES an "authorization for collection" or "Einzugs-Ermaechtigung" to their bank account. Please contact the Secretary for a blank form. Full membership in IOTA/ES includes one supplement for European observers (total and grazing occultations) and minor planet occultation data, including last-minute predictions; when available. The addresses for IOTA/ES are:

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IOTA on the World Wide Web

(IOTA maintains the following web sites for your information and rapid notification of events.)

IOTA Member Site
http://www.occultations.org

This site contains information about the organization known as IOTA and provides information about joining IOTA and IOTA/ES, topics related to the *Occultation Newsletter*, and information about the membership--including the membership directory.

IOTA Lunar Occultations, Eclipses, and Asteroidal and Planetary Occultations Site
http://www.lunar-occultations.com

This site contains information on lunar occultations, eclipses, and asteroidal and planetary occultations and the latest information on upcoming events. It also includes information explaining what occultations are and how to report them.

IOTA's Telephone Network

The Occultation Information Line at 301-474-4945 is maintained by David and Joan Dunham. Messages may also be left at that number. When updates become available for asteroidal occultations in the central USA, the information can also be obtained from 708-259-2376 (Chicago, IL).