Analysis of Moller - Summary

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Synthetic Vision For Enhancing Poor Visibility Flight Operations, H. Möller, Research Assistant and G. Sachs, Director, Institute of Flight Mechanics and Flight Control, Technische Universität München; IEEE AES Magazine, March 1994.

1. I have the evidence to swear behind Möller. See attached files *jm_pilotdocs1.pdf* and *jm_pilotdocs2.pdf* .

jm_pilotdocs1.pdf

It contains a description of the project (dated June 29, 1993) that became 5,566,073. It also contains an order for patents from the Patent Office (dated July 18, 1993) that includes U.S. Patent 5,185,610 **GPS System and method for deriving pointing or attitude from single GPS receiver** issued February 9, 1993 to Ward, et al.

jm_pilotdocs2.pdf

This is an order for patents from the Patent Office (dated September 6, 1993) that includes U.S. Patent 5,086,396 **Apparatus and method for an aircraft navigation system** issued February 4, 1992 to Waruszewski, Jr. This patent describes the Digital Elevation Database. Column 1, line 20 - Column 2 line 2:

> 2. Description of the Related Art
>
> In aircraft assigned missions over hostile terrain, the demands on the flight deck have become increasingly severe. The flight deck must monitor position and flight parameters while pursuing mission objectives. The mission objectives can include penetration of air space protected by hostile antiaircraft ordinance.
>
> The aircraft position is typically monitored by an inertial navigation system. After calibration, the objective is to have the inertial navigation system provide the global coordinates (i.e., latitude and longitude parameters) of the current aircraft position. In the inertial navigation system, small systematic errors are typically present that can cause the current designated position to deviate from the actual position by an amount that increases with time. To remedy these errors, coordinates of known locations over which the aircraft passes are used to provide a correction to the position designated by the inertial navigation system.
>
> More recently, maps of various portions of the globe have become available in which digitized terrain elevations are provided as a function of a grid of (latitude and longitude) locations. The availability of these digitized grid elevation maps has resulted, in; systems that can, based on measurement of the distance between the aircraft the terrain, correlate the position of the aircraft on the grid of the digitized map. These position locating systems generally rely on Kalman filters. For example, the SITAN (Sandia Inertial Terrain-Aided Navigation) system has been described in "Optimal Terrain-Aided Navigation Systems", by L. D. Hostetler, AIAA Guidance and Control Conference, Aug. 7-9, 1978 (SAND78-0874C); "Nonlinear Kalman Filtering Techniques for Terrain-Aided Navigation" by L. D. Hostetler and R. D. Andreas, IEEE Trans. on Automatic Control, Vol. AC-28, No. 3, March 1983, pages 315-323;

"SITAN Implementation in the Saint System" by J. R. Fellerhoff, IEEE, 1985, (CH2365-5/86/0000-0089); and "The AFTI/F16 Terrain-Aided Navigation System", by D. D. Boozer, M. K. Lau and J. R. Fellerhoff, Proc. of the IEEE National Aerospace and Electronics Conference, May 20-24, 1985 (0547-3578/85/0000-0351). Other systems have been described in "Performance Analysis of Elevation Map Referenced Navigation Systems" by C. A. Baird, IEEE, 1983, (CH1839-0/83/0000-0064); "A Digital Terrain Correlation System for Tactical Aircraft" by E. P. Bialecke and R. C. Lewis, IEEE, 1983, (CH1839-0/83/0000-0059); and U.S. Pat. No. 4,584,646, issued Apr. 22, 1986, entitled "System for Correlation and Recognition of Terrain Elevation" and invented by L. C. Chan and F. B. Snyder.

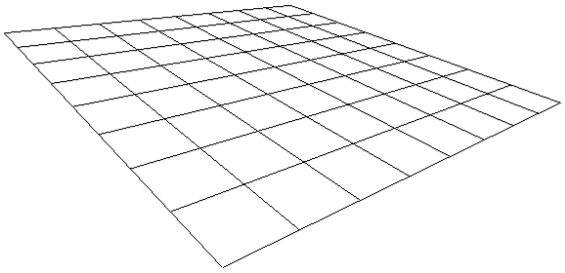
Waruszewski, Jr. uses the Digital Elevation Database for Terrain Referenced Navigation.

2. The Möller paper has some problems as prior art. The full discussion is in the attached file *jm_moller_analysis.pdf* . It refers to another file, *jm_rptmath.pdf* which is also attached.

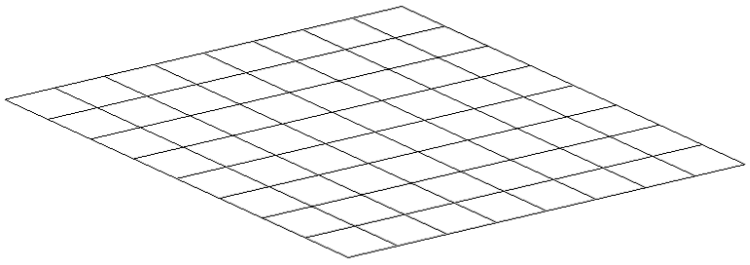
Here is an example where Möller falls short. The figures on the following page show a grid displayed using Orthographic Projection, Perspective Projection, and Möller Figure 3. The grids showing Orthographic Projection and Perspective Projection were produced by a computer program using the math presented in *jm_moller_analysis.pdf*. (They were not drafted.)

Möller's Figure 3 is an Orthographic Projection.

Perspective Projection



Orthographic Projection



Möller

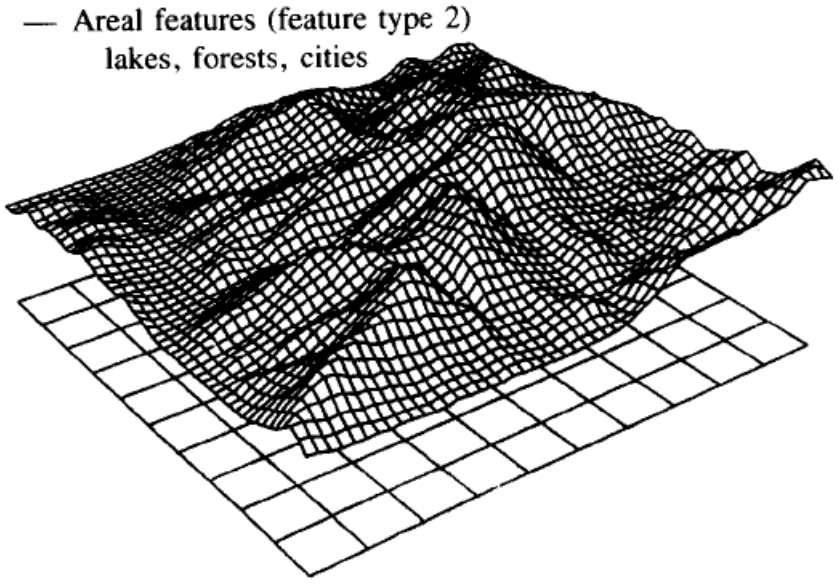


Fig. 3. DTED Grid

From Tadema, J. & Theunissen, E. (2003), **Feasibility of Using Synthetic Vision Technology for Uav Operator Support**. *Proceedings of the 22nd Digital Avionics Systems Conference*, pp. 8B1.1 - 8B1.13, Indianapolis, USA. {*ref3_tadema_DASC2003.pdf*}

Page 6:

> **Projection Type**
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> To present data of the environment of the vehicle on a display, some kind of projection has to be used. Perspective projections provide a realistic presentation of depth, appropriate for 3D data sources, but the resolution varies as a function of distance along the line of sight. *Orthographic projections* of 3D data have constant scaling but suffer strongly from ambiguity problems.

5,566,073 and 5,904,724 both teach the use of perspective projection.

Möller shows a Digital Elevation Database and displays it to the Viewer. But he displays it using orthographic projection and it is not clear whether this display is even responsive to the Viewer's Roll orientation.

This is not easy to determine because parts of the paper are demonstratively missing. The problem is not with {Company} even though the version {Company} supplied was poorly reproduced. The version that I got on my own was identical to {Company's}, only more legible.

1. Figures 3, 4, 6, 8, 9, and 11 are not referred to in the text. Either the paper was poorly written or the parts that referred to the figures were taken out.

2. The math is not properly explained. There are significant gaps. Filling in the gaps with the standard methods and techniques used today, but which were not standard when Möller did his work, is not permitted.

3. The evidence suggests that Möller's method is not responsive to Roll rotations.

4. Möller shows an Orthographic Projection, not a Perspective Projection.

A system that is not responsive to Roll orientation and/or which uses Orthographic Projection instead of Perspective Projection does not qualify as Synthetic Vision.

A list of desired results is not prior art.
