
UTILISATION OF PROGRAM SURFER IN THE MODELLING OF SURFACE AREAS OF TERRAIN SURFACE

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ABSTRACT

In this contribution we deal with the methodology of the terrain surface visualisation, on which experimental measurements of driving manoeuvres of agricultural technological vehicle MT8-222 were realised. Introduced methodology uses defined procedure when determining dynamic stability of vehicles following the standard STN 47 0170. There were obtained records of centre of the gravity accelerations at every instant of time. From these records of acceleration and by using Euler's parameters, there were evaluated contact points of the wheels with the terrain. Following the obtained contact points in the direction of down grade slope, contour line such as in the direction of tractive movement on the slope there were utilised program Surfer for visualisation of surface area of terrain surface. The results are utilizable in prediction of collision situation of attached aggregate, which is moving in the terrain.

Key words: surfer, terrain surface modelling, mathematical modelling

INTRODUCTION

In many technical applications, there are used algorithms of surface models and they are one of their essentials part in constructional application of CAD/CAM program. Basically, there are mostly used technologies as OpenGL or DirectX for visualisation of given curve surface area as introduced by Rédl (2006). The special case of application is the field of terramechanics and vehicle dynamics. From listed reasons, the models of the terrain surfaces are usable not only in geographical applications, but in vehicle dynamic as well, mainly in predicting of safety operation of agricultural mobile devices which is presented by Rédl et al. (2012). On the present, there exist many computer applications which enable us to model and visualise different types of the surfaces. Among these belongs for example program Surfer, which modules can be utilised when programming an own application in Visual Basic language as is published by Zheng et al. (2010). A solitary usage of mathematical parameters of spatial curve surface is however unavailable in these applications. Considering the listed fact is therefore appropriate to create own computer model and graphical 3D technologies use only for visualisation.

MATERIAL AND METHODS

Technologic vehicle

Technologic vehicle used for experimental measurement of drive manoeuvre was systemic tool carrier MT8-222 (fig. 1). This vehicle is designated for working on the sloping terrain. It is a mobile mechanism used for wide range of agricultural and communal adapters which executes works relative to maintenance of permanent grassy growth in mountain and foothill areas. The average value of gradient of the slope during manoeuvres was 30 – 33 degrees. The weight of the vehicle was 1356 kg. From experiment there were obtained records of the centre of the gravity accelerations. By subsequent processing and using Euler's parameters we evaluated coordinates of the contact points of the wheels with the terrain.

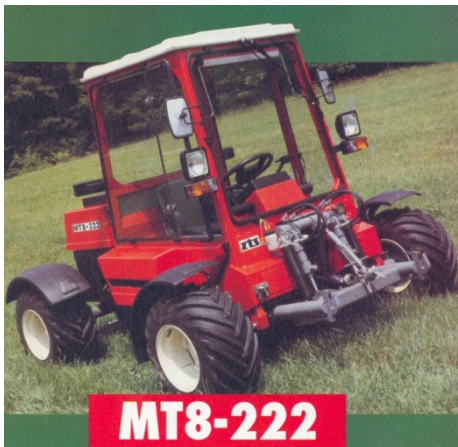


Fig. 1 Technologic vehicle MT8-222

Definition of surface area

Ivan (1989) stated that by continuous deformation of some coherent part of the plane is a surface area created. We can imagine this surface as some kind of bent sheet (of paper, metal plate...) or as a surface (boundary) of some body (in some case its part). Sometimes we can imagine the surface area as a set of positions of moving point, which - visually said - has two degrees of freedom.

By the term surface area we will denote hodograph S of vectorial function r of two variables u, v , which has these properties:

1. Its definition scope is a coherent set $G \subset E_2$
2. It is continuous on the set G

3. There exists such partition $\{G_k\}_{k \in I}$ of the set G that on the set $\bigcup_k G_k$ is one - to one.

Especially if the function r is a one - to - one on the whole set G , we discuss a *simple surface area*.

From the definition of the surface area and from the definition of vectorial function r of two variables follows that to every point $[u, v] \in G$ appertains exactly one point P from the surface S , namely the finishing point of the position vector $r(u, v)$ in respect of the pole of the hodograph (fig. 2). Thereby by the help of the vectorial function r there is defined a function from the set $G \subset E_2$ to E_3 . We say that this function, which is usually called the *dot function of two variables*, is *generated (induced) by vectorial function r* . We denote it with the letter \mathcal{R} . Therefore $P = \mathcal{R}(u, v)$ will stand for the point of the surface area S , which is image of the point $[u, v] \in G$ in the function \mathcal{R} (fig. 2). The solitary surface area is then the image of the set G in the function \mathcal{R} .

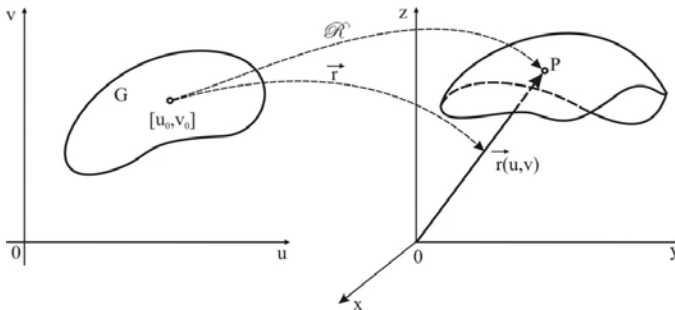


Fig. 2 The function from the set $G \subset E_2$ in E_3

Vectorial function r , which hodograph is the surface area S , is called (*admissible*) *parametric expression of surface area S* or shortly (*admissible*) *parameterisation of surface area S* .

Equation

$$r = r(u, v), [u, v] \in G, \tag{1}$$

by which is the function r stated, is called *vectorial or parametric equation of the surface area S* . If it holds that in the coordinate system (O, i, j, k) is $r = xi + yj + zk$, $r(u, v) = x(u, v)i + y(u, v)j + z(u, v)k$, then the vectorial equation (1) is equivalent with this system of equations:

$$x = x(u, v),$$

$$y=y(u,v), \quad [u, v] \in G \quad (2)$$

$$z=z(u,v).$$

Equations (2) are called *parametric equations of the surface area S* in respect of the given coordinate system. The numbers (variables) are called *parameters of the surface area S*. The set G is called *domain of surface area parameters S*.

Description of program Surfer

To create a model of the terrain surface, where the vehicle was moving during the experiment we used program Surfer. Surfer is a full – function 3D visualization, contouring and surface modelling package from company Golden Software, Inc. (2002) that runs under Microsoft Windows. It is a grid-based graphic program which interpolates irregularly spaced XYZ data into regularly spaced grid. Grids may also be imported from other sources, then the grid is used to produce different type of maps including contour, vector, wireframe, image shaded relief and surface maps. Examples of maps that can be created in program Surfer are depicted in fig. 3.

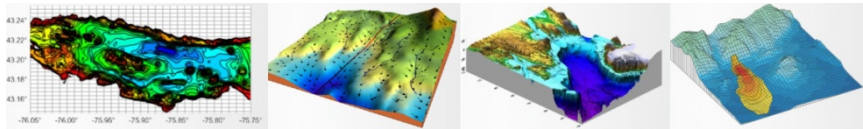


Fig. 3 Examples of maps from Surfer (from the left: contour map, vector map, 3D surface map, 3D wireframe map)

RESULT AND DISCUSSION

During the experiment there were executed a manoeuvre with the technologic vehicle MT8-222. The manoeuvre was performed while moving along the down grade slope. During execution of the manoeuvre there were no overturns of the vehicle. From experimental measurements, we obtained records of acceleration of the centre of the gravity at every instance of time. From these records of accelerations and by using Euler parameters we evaluated the coordinates of the contact points of the wheels with the terrain in the direction of down grade slope, contour line such as in the direction of tractive movement on the slope. Subsequently we utilised the program Surfer to create a visualisation of surface area of the terrain surface, on which the vehicle performed the manoeuvre. We apply this software to transform XYZ coordinates of contact points into publication – quality map. The result of the modelled surface is depicted in fig. 4. The results are utilisable when predicting collision situation of the vehicle and attached aggregate, which is moving in the terrain.

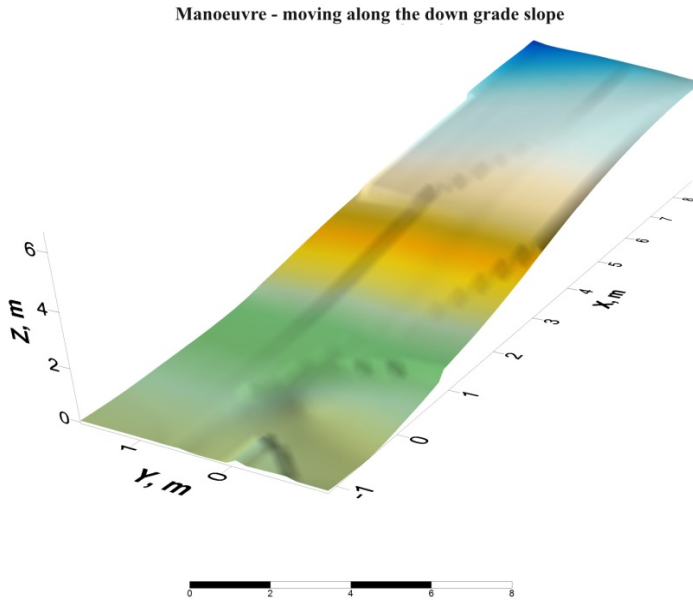


Fig. 4 Manoeuvre – ride in the direction of down grade slope

CONCLUSIONS

Models of the terrain surfaces are useful not only in geographical applications, but also in vehicle dynamic. By knowing the terrain surface we can predict the safety operation of agricultural mechanism and devices. In this contribution we dealt with the modelling of surface areas of terrain surface by utilisation of program Surfer which is designated for 3D visualisation where transformation of XYZ data into publication – quality maps is used. In experimental measurements there were obtained acceleration of the centre of the gravity. By subsequent processing we obtained coordinates of contact points of the wheels with the ground. Using the program Surfer we created a model of the surface of agricultural terrain which is shown in fig. 4. Unlike general mathematical programs such as MathCad, Matlab or Mathematica, program Surfer is specifically oriented on the imaging of similar models and has different functions that improves optical models, for example Anti-aliasing.

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