

OPTICAL EVALUATION OF PNEUMATIC TYRES GROWTH

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ABSTRACT: The presented methodic is based on utilization of optical trace of illumious slot on tyre profile. This optical trace enables the measurement of tyres growth at free rotation during low and high revolution. It is one of tests in sense of regulation of U.N Committee for homologation of motorcycle tyres.

1 Introduction

For safety of road traffic the regulation for homologation of motorcycle tyres has been elaborated in European Economical Committee at United Nations [1].

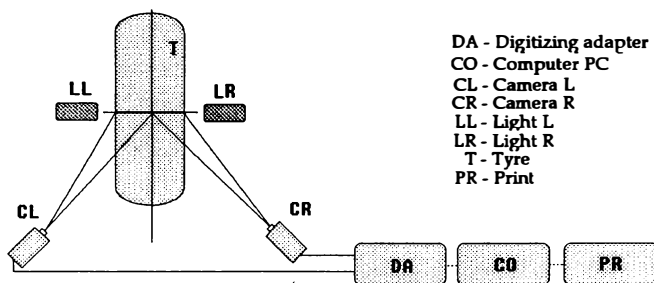


Fig.1. Block diagram of proposed measuring set-up.

One of conditions for the grant of homologation is the execution of a test of maximum growth of tyres dimensions at free rotation. A method of tyres growth investigation, being based on utilization of optical trace of illumious slot on tyre profile during low and high revolutions, was proposed at cooperation of IGTT and UP Olomouc (Fig.1). Two light sources (halogen lamps in glass parabola), fitted with slots, illuminate radially the tyre profile. The light traces (Fig.2) of slots on tyre are detected with two CCD cameras under equal angles according

to symmetry plane of wheel disk and perpendicularly to axis of tyre revolution. These light traces are tracked with cameras in real time during revolutions increasing and their images are recorded in required moment by means of video system, controlled with computer.



Fig.2 Image of light trace on tyre, one camera view.

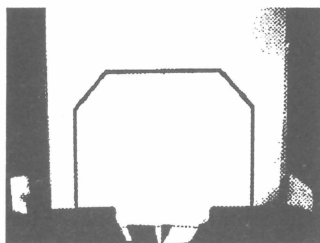


Fig.3 Image of check mask, one camera view.

Before starting of measurement a mask is placed on seated rim without tyre. The image mask corresponding to motorcycles body (Fig.3) is scanned with both cameras and is loaded in computer memory. This image is superposed on the images of optical traces of slots on rotating tyre, after finishing of experiment. Regarding to cameras positioning a spatial distortion occurs during scanning and montage of image (Fig.4). This distortion has to be corrected by suitable geometrical transformation.

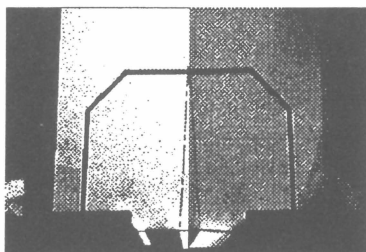


Fig.4 Image montage of check mask loaded with geometrical distortion

2 Study of geometrical transformation

In this part the study of one line in axis x is performed. The line has been scanned with a camera being displaced from point Z' into point Z on the circle

in distance of radius r from object plane. A derivation of relations for d_1 and d_2 , for geometrical transformation of camera image is the aim of it.

2.1 Real case of geometrical transformation 3D

In general case the camera is shifted into point $Z = [r, s, v]$ (Fig.5) that causes the change of the plane ξ in to plane α .

Plane α has the equation $rX + sY + vZ = 0$. The straight line p has the parametric expression $x = rt, y = st, z = a + (v - a)t$. We obtain the intersection point R of the line p and plane α by solution :

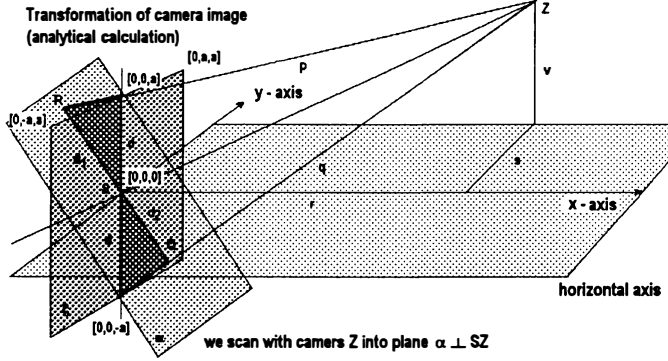


Fig.5 The analysis of image in plane ξ , being scanned from point $Z = [r, s, v]$

$$r^2t + s^2t + bat + v(v - a)t = 0 \quad (1)$$

$$t(r^2 + s^2 + v^2 - av) = -av \quad (2)$$

$$t = \frac{-av}{r^2 + s^2 + v^2 - av} \quad (3)$$

$$\mathcal{R} = \left[\frac{-arv}{r^2 + s^2 + v^2 - av}, \frac{-asv}{r^2 + s^2 + v^2 - av}, \frac{a(r^2 + s^2)}{r^2 + s^2 + v^2 - av} \right] \quad (4)$$

$$a(v - a)t = \frac{ar^2 + as^2 + av^2 - a^2v - av^2 + a^2v}{r^2 + s^2 + v^2 - av} \quad (5)$$

$$d_1 = \frac{\sqrt{a^2r^2v^2 + a^2s^2v^2 + a^2r^4 + 2a^2r^2s^2}}{r^2 + s^2 + v^2 - av} \quad (6)$$

$$d_1 = \frac{d\sqrt{r^2(v^2 + r^2) + s^2(v^2 + s^2) + 2r^2p^2}}{r^2 + s^2 + v^2 - dv} \quad (7)$$

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The distance of camera from an object plane $r > 0$ and the magnitude s can be as positive as negative in view of the position of right or the left scanning camera. If $v > 0$ we assume the displacement of camera above horizontal plane, if $v < 0$ so we assume that the camera goes below horizontal plane. If we consider $(d = a) > 0$ then $d_1 > d$ and $d_2 < d$, on the assumption that $v > 0$.

3 Scanning device

In our case the camera of type OS458 has been used. Its CCD element has organization of 795 x 596 pixels and its size is 7.95 x 6.95 mm. The sensitivity of these cameras is 0.01 Lux and they are supplied with 12 V DC which can be obtained with suitable adapter, either directly or from power source of used computer.

4 Digitizing adapter

The video signal is leads to grabber-digitizing board, which is placed in ISO expansion slot of used computer bus and is connected with video board of computer by feature connector. In our case it has been used the adapter VideoPlus for IBM PC, being able to sample input video signal as much as 1024 spots in one line and 2^8 , i.z 256 levels of brightness with ratio of GRB colours according to used palette. This adjustment was determined in our case by above mentioned type of cameras and with regard to organization of adapter memory, it means that the resolution of individual images is 800 x 600 spots with exploitation of 680 x 512 spots for image information at utilization of palette with 256 shades of gray.

5 Actual measurement

As it being presented in introduction, two cameras have been used for tracking of light traces of the slots. They were by programm switched with input multiplex of the digitizing adapter. The first object is both cameras scanning check mask of frame created on suitable substrate and attached in rim without tyre. The adjustment is performed so, that we use the function of program *Calibration*. This function enables to compare the freezed image of tube by first camera with the real time image of tube scanning by the second camera. The performing of cameras adjustment was the task of this part.

With graphic files, obtained in this way, the image R-montage is by programm performed so, that the left half of resulting image corresponds with left half of left input image, and the right one is the right half of right input image. The R-montage (Fig.6) is stored into computer memory and it can be also used to

further measurement. Now a tyre is located on the rim and the image L-montage (Fig.7) is created at low revolutions, in the same way, as above described. It follows the start of tyre rotation to high revolutions corresponding to velocity of 160 km per hour and scanning of the image H-montage (Fig.8). The resulting image is sum of the R,L,H montage, that is the image in low revolution, in high revolution and the frame on rim, is performed by computer automatically. The resulting image is displayed on screen of monitor picture tube (Fig.9). The resulting montages can be arbitrarily stored,inspected, printed, or exponent into other programs.

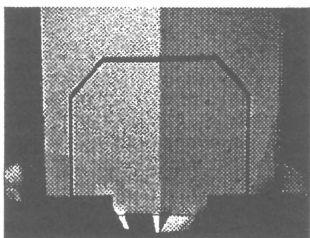


Fig.6 The image of frame mask on free rim

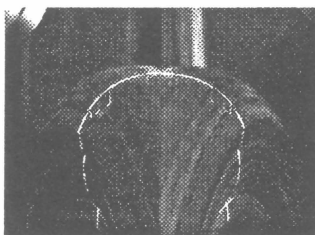


Fig.7 The image of light slots traces at low revolutions.

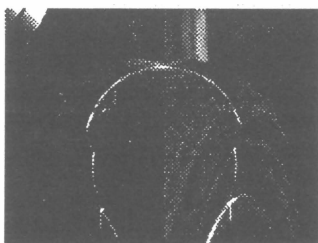


Fig.8 The image of light slots traces on tyre profile at high revolutions

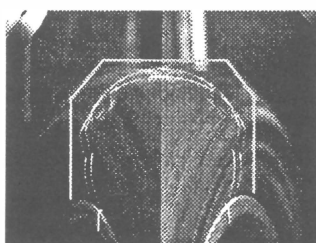


Fig.9 The montage of image of frame mask and of traces of slots images on tyre profile

6 Programme function

The proposed program for control of digitizing board is written in language of machine instructions of utilized processor whereby enables to control directly

the functions. For main program to safeguarding of communication between digitizing board and personal computer, performing of introduced geometrical transformations, image montage and operations with the high-level language is used. After realising by user, the whole system reports with basic menu. The selection is performed with cursor keys and acknowledgement with key *Enter*.

7 Conclusion

The presented method of measurement of tyre growth at free rotation, which is based on utilization of optic trace of luminous slot on tyre profile during low and high revolutions, was proposed as one of tests in sense of regulation of U.N Committee for homologation of motorcycle tyres. This optical method is very simple and enables to watch growing of the tube in real time.

References

- [1] Regulation of European Economical Committee for homologation of motorcycle tyres.
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- [3] Druckmüller, M., Heriban, P.: *Scientific Image Analyzer DIPS, Version 4.0*. SOFO, Brno 1992.

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