Anexa. 10 lucrări relevante

1. Gruescu C., Nicoara I., Popov D., Bodea R., Hora H. 2008 Optical Glass Compatibility For the Design of Apochromatic Systems *Science of Sintering* **40** 131-140.

Science of Sintering, **40** (2008) 131-140

doi: 10.2298/SOS0802131G

UDK 666.3-128:621.315.612

Optical Glass Compatibility For the Design of Apochromatic Systems

C. Gruescu[1], I. Nicoara[1], D. Popov [2*)], R. Bodea[3], H. Hora[3]
[1] University "Politehnica" Timisoara, Mechatronics Department, RO-300002, Victoriei 2, Timisoara, Romania
[2] University "Politehnica" Timisoara, Department of Technical Physics, RO-300223, B-dul Vasile Parvan No. 2, Timisoara, Romania
[3] University of Oradea, Precision Mechanics Department, RO-410087, Universitatii 1, Oradea, Romania

Abstract:
The design of apochromatic systems is difficult because of two problems: the glass sorts compatibility and the c_1/c_a arbitrary input ratio. The optical glass manufacturers offer a wide range of sorts, so that the choice of triplet compatible glasses becomes itself an important separate problem. The paper provides a solution of mathematical modeling for the glass compatibility and, practically, analyses the sorts presented by Schott GmbH. The original software provided 22 compatible glass triplets. The authors explored the possibilities of enlarging the c_1/c_a ratio from the value 0.6 indicated in the literature to a range of [0.5...0.8]. Therefore, they designed and analyzed a set of 88 triplets. A correct glass choice can insure twice-larger apertures than the traditional ones for best quality apochromats (diffraction-limited).
Keywords: Optical glass compatibility, Triplet design, Image quality, Large aperture, Aspherical surface

1. Introduction

Apochromatic optical systems need a specific combination of optical glass sorts, whose dispersive properties insure correction of the longitudinal chromatic aberration and secondary spectrum. An apochromatic system accomplishes the superposition of image abscissas for three wavelengths, so that the secondary spectrum is much lower than for any other optical entity. The traditional optical system, which satisfies these conditions, is the cemented apochromatic triplet (fig.1). The design algorithm supposes that the operator has already chosen the glass sorts. Existing literature offers only general recommendations or a minimum number of compatible glasses [1, 2]. Efficient use of a large number of glass sorts needs a mathematical approach.

The database to investigate contains the glass sorts offered by the Schott Catalogue. The parameters taken into account are the refractive indexes of the spectral lines g, F', e, C', s, the Abbe number ν_e and the relative partial dispersion P_{ge}. The Schott Catalogue contains

*) Corresponding author: dusan_popov@yahoo.co.uk

2. Gruescu C., Lovasz E.-C., Ciupe V. 2014 Optics Optimization in Laser Spot Radius Minimization, *International Conference on Production Research – Regional Conference Africa, Europe and the Middle East, 3rd International Conference on Quality and Innovation in Engineering and Management* 231-234.

2014 International Conference on Production Research – Regional Conference Africa, Europe and the Middle East
3rd International Conference on Quality and Innovation in Engineering and Management

OPTICS OPTIMIZATION IN LASER SPOT RADIUS MINIMIZATION

C. M. Gruescu[1], E.-C. Lovasz[2], V. Ciupe[3]
[1, 2, 3] University Politehnica Timisoara, Mechatronics Department, Mihai Viteazu 1,
RO-300222, Timisoara, Romania

Abstract
The paper presents a short discussion on the spot size importance and the influence factors on it in laser machining applications. As optical system quality in terms of wavefront parameters is essential for the spot size and shape, the optical synthesis of lenses is considered fundamental. For a given application, which implies CO2 laser machining, the preliminary calculus of the expander and focusing objective is presented. The components are designed as best shape lenses. The system is analyzed on different focus shift collecting data on spot size and its relation to Airy disk radius from single spot diagrams. Two solutions are provided, one with spherical objective and one with aspheric objective. Spot sizes with a tolerance factor of 10 % establish large depth of focus. Both solutions are considered very well as the wavefront analysis shows parameters in the class of diffraction limited systems.

Keywords:
optical design, laser machining, spot size minimization.

1 INTRODUCTION

Laser technology is not only a common one. It is a technology in fast progress, whose development aims to increase precision and efficiency, to reduce material and time waste. Non-conventional technologies replace conventional ones and, in addition, perform operation impossible to apply with older technologies.

Rapid spread and improvement of laser technologies implies better or new optical systems.

Laser optics comprise of two basic components, namely the expender and the focusing objective. The expander is a reversed Galileo telescope and the objective is a positive lens.

Usually, the expanders ensure a magnification within the range of [1.5…10] X, depending on the aperture of the laser beam source and the power density admitted by the lens material.

The objectives are designed for effective focal lengths within the range of [40…200] mm, depending on the working distance needed in an application. Objectives may consist of a singlet, a doublet or a system of more lenses, especially in the schemes of scanning laser systems.

Optical design is often referred to as general scheme in books [1] ... [4] or papers [5]. Optical parameters such as working distance and defocusing are called in relation with the spot size [6], [7]. The spot size and shape establish the actual energy distribution and finally, the precision and efficiency of the process.

The spot size depends on the quality of the optical system. Nowadays, the quality is expressed in wavefront parameters, sometimes related directly to Airy disk.

Most industrial power lasers work within the infrared range. The optical design is more difficult than for the visible range because of the small number of materials available for lens manufacturing.

The basic principles in laser optics design, recommended by manufacturers [9], [10] and discussed in [8] are as follows:

- The optical assemblies of the expander are singlet. This major simplifying is possible because of monochromatic radiation and theoretically zero slope of the beam. The residual spherical aberration remains the most important problem. As it influences directly the size of the spot, the design of lenses must apply algorithms based on spherical aberration minimization.
- The objective, large-sized in aperture, is also exposed mainly to spherical aberration.
- The most important parameters refer to focus abscissa, shape and size of the spot and depth of focus.
- Ideally, the spot should be circular for a uniform energy distribution. Its size can be optically controlled.

Practically, the spot size assumes two additive components, one due to diffraction and second due to residual spherical aberration:

$$d_{spot\ total} = d_{spot\ diffractional} + d_{spot\ aberrational} \tag{1}$$

where:

$$d_{spot\ diffractional} = \frac{4\lambda M^2 f}{\pi D}, \tag{2}$$

$$d_{spot\ aberrational} = \frac{kD^3}{f^2}. \tag{3}$$

In relations (2) and (3) λ represents the wavelength [μm], M – modal parameter of the beam [-], f – effective focal length of the objective [mm], D – aperture of the objective [mm], k – non-dimensional coefficient depending on the refractive index [-].

The spot size is strongly dependent on the f-number of the objective:

$$f/\# = \frac{f}{D}. \tag{4}$$

Practically, the design input data asks for the focal length as well as for the aperture. The literature recommends estimation relations for one of them in case the other one is given. If the focal length is fixed, the optimum aperture is:

$$D = \sqrt[4]{\frac{4\lambda M^2 f^3}{3\pi k}}. \tag{5}$$

If the aperture is imposed, the recommendation for the focal length is:

$$f = \sqrt[3]{\frac{\pi k D^4}{2\lambda M^2}}. \tag{6}$$

3. Gruescu C., Ionescu C., Nicoara I., Lovasz A. 2012 Experimental Optimization of Process Parameters in Laser Cutting of Polycarbonate Gears *Mechanika Journal* **18**(2) 233-238.

233

ISSN 1392 - 1207. MECHANIKA. 2012 Volume 18(2): 233-238

Experimental optimization of process parameters in laser cutting of polycarbonate gears

C.M. Gruescu*, C.L. Ionescu, I. Nicoara***, A. Lovasz******

**University Politehnica Timisoara, 2 Pta.Victoriei, 300222 Timisoara, Romania, E-mail:corina.gruescu@mec.upt.ro*
***University Politehnica Timisoara, 2 Pta.Victoriei, 300222 Timisoara, Romania, E-mail: cosminionescu@yahoo.com*
****University Politehnica Timisoara, 2 Pta.Victoriei, 300222 Timisoara, Romania, E-mail: ioan.nicoara@mec.upt.ro*
*****University Politehnica Timisoara, 2 Pta.Victoriei, 300222 Timisoara, Romania,*
E-mail: agneta.lovasz@library.upt.ro

crossref http://dx.doi.org/10.5755/j01.mech.18.2.1561

1. Introduction

Polycarbonate is widely used due to its mechanical, optical, thermal and chemical properties. Tensile strength (55 - 75 MPa), Young's modulus (2 - 2.4 GPa) and hardness (~70HRC) recommend the material also for manufacturing of gears, which work with low power or special conditions transmissions. Moulding and extrusion, commonly used to machine polycarbonate pieces, are not appropriate to obtain complex shape and preciseness as gears require. Also, the usual cutting technology of gears is long-lasting and inefficient if some faster machining process can be found. Generally speaking, specially designed technologies must be designed and implemented for machining particular materials or parts [1 - 2]. In the present case a nonconventional technology, for instance laser cutting suites much better.

Still, laser cutting is not very simple to apply. Targets regarding piece's characteristics (precision in shape and dimension, roughness, thermal side-effects etc.), time of machining and energetic supply needed, are hard to attain without a process optimization. The large number of parameters involved, exclude the choice by random of their values. There are optical, electrical and mechanical factors, which influence the laser cutting process. Different combinations of their possible values might satisfy requirements to attain different target criteria (diverse in nature and value). From optical standpoint, laser cutting is a nonimaging application. The quality of the optical system included in the structure of a laser cutting machine, influences directly the general traits of the process. Flexibility and preciseness are required in order to ensure easy transforming of radiant beam's properties (spot size, defocus facilities, and variable energetic density).

Control of electrical parameters, such as power supply, ensures appropriate energetic properties of the cutting beam (for pulse lasers, also pulse duration and pause duration are very important).

Mechanical design of the nozzle, precision and speed of cutting head's displacement are involved in accuracy and efficiency of machining. Establishing the most suited combination of values for all these parameters needs a mathematical approach. There are several optimization process methods, among which, the Taguchi method proved to be one of the best.

The subject of machining is a set of four gears making part of a two – step transmission. Geometrical complexity, precision of tooth pitch, roughness of flanks, variety of modulus and number of teeth recommend a flexible technology such as laser cutting.

2. Experimental equipment

Effective machining of sample pieces was achieved using an existing laser cutting machine, whose optical system was improved [3 - 6]. The computer aided equipment uses a CO_2 pulse laser source, 2 kW power. The machine belongs to C.A.L.F.A. laboratories at I.U.T. Bethune, Universite d'Artois, France. A general image and the scheme of the machine are presented in Fig. 1.

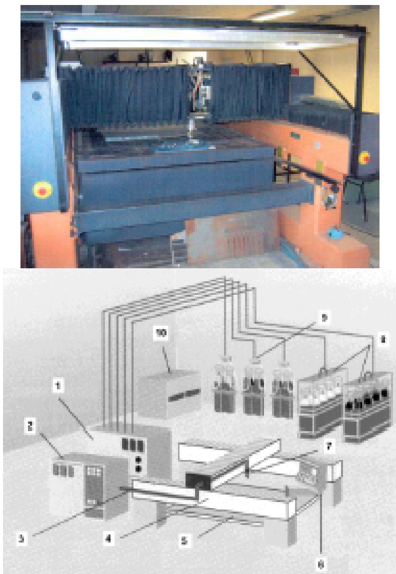

Fig. 1 Image and scheme of the laser cutting machine: *1* - power supply block, *2* - CO_2 laser source, *3* - optical beam path, *4* - mechanical structure, *5* - material to machine, *6* - numerical command block, *7* - cutting head, *8* - assemblies to provide and control auxiliary gas (He, Ar, N_2, O_2), *9* - assembly for CO_2 supply, *10* - cooling block

The general features of the laser cutting machine are wavelength, μm; beam divergence, deg; emitted power, W; cutting speed, mm/s; vertical position of the spot, duration of pulse and pause, ms; chemical nature, pressure and

4. Lovasz E-Ch., Gruescu C.M., Ciupe V., Carabas I., Margineanu D., Maniu I. and Dehelean N. 2012 Advanced Digitization Techniques in Retrieval of Mechanism and Machine Science *Proc. of the XIth TMM Liberec 2012 Mechanisms and Machine Science* **8** 35-42.

Advanced Digitization Techniques in Retrieval of Mechanism and Machine Science Resources

E-Ch. Lovasz, C. M. Gruescu, V. Ciupe, I. Carabas, D. Margineanu, I. Maniu and N. Dehelean

Abstract The European project thinkMOTION works on the purpose of retrieving all-times content regarding mechanisms and machine science by means of creating a digital library, accessible to a broad public through the portal Europeana. DMG-Lib is intended to display the development in the field, from its very beginning up to now days. There is a large range of significant objects available, physically very heterogeneous and needing all to be digitized. The paper presents the workflow, the equipments and specific techniques used in digitization of documents featuring very different characteristics (size, texture, color, degree of preservation, resolution and so on). Once the workflow established on very detailed steps, the development of the workstation is treated. Special equipments designed and assembled at Universitatea "Politehnica" Timisoara are presented. A large series of software applications, including original programs, work for digitization itself, processing of images,

E-Ch.Lovasz (✉) · C. M. Gruescu · V. Ciupe · I. Carabas · D. Margineanu
I. Maniu · N. Dehelean
Universitatea "Politehnica" din Timisoara, Timisoara, Romania
e-mail: erwin.lovasz@mec.upt.ro

C. M. Gruescu
e-mail: corina.gruescu@mec.upt.ro

V. Ciupe
e-mail: valentin.ciupe@mec.upt.ro

I. Carabas
e-mail: ioșif.carabas@mec.upt.ro

D. Margineanu
e-mail: dan.margineanu@mec.upt.ro

I. Maniu
e-mail: inocentiu.maniu@mec.upt.ro

N. Dehelean
e-mail: nicolae.dehelean@mec.upt.ro

J. Beran et al. (eds.), *Advances in Mechanisms Design*, 35
Mechanisms and Machine Science 8, DOI: 10.1007/978-94-007-5125-5_5,
© Springer Science+Business Media Dordrecht 2012

5. Ciupe V., Lovasz E-C., Gruescu C.M. 2012 High Quality Document Digitization Equipment *Mechanisms, Mechanical Transmissions and Robotics, Applied Mechanics and Materials* 162 589-596.

Applied Mechanics and Materials Vol. 162 (2012) pp 589-596
© (2012) Trans Tech Publications, Switzerland
doi:10.4028/www.scientific.net/AMM.162.589

High Quality Document Digitization Equipment

Valentin Ciupe[1,a], Erwin-Christian Lovasz[1,b] and Corina-Mihaela Gruescu[1,c]

[1]Universitatea "Politehnica" din Timisoara, Mechatronics Department, 1 Mihai Viteazu, RO-300222, Romania

[a]valentin.ciupe@mec.upt.ro, [b]erwin.lovasz@mec.upt.ro, [c]corina.gruescu@mec.upt.ro (corresponding author)

Keywords: digital image, high speed digitization, optical and mechanical design, scanning software.

Abstract. The paper describes an equipment specialized in digitization of single documents, journal-type documents and books. The equipment is designed and assembled at "Politehnica" University of Timisoara and works in a station developed within the European project thinkMOTION. The optical calculus aimed optimal illumination of two symmetrical areas and high quality of captured images. The object of scanning is printed matter, which exists exclusively in paper form and originates from different periods of scientific evolution. The mechanical design was based on criteria such as: flatness of active surfaces, quick placement and removal of the original document, mechanical raw focusing facilities, adjustment regarding the thickness of the original document and finding constructive solutions so that no damage is inflicted upon the original document, which may be one of a kind and, hence, historically very valuable. An original software was created in order to control the scanning process, to organize files and folders, which stock captured images in different stages of processing. The effective efficiency of the equipment is 10 – 12 pages/minute.

Introduction

Digital copies of analogue documents are very common in nowdays. Digitization is performed on purpose of creating multiple copies or original digital documents. The market offers a wide range of standard scanners, featuring very different technical parameters and designated to single document or thin printed matter processing [1], [2], [3], [4]. A particular class of scanners is specially designed for book scanning [5], [6], [7], [8], [9].

The requirements imposed by the activities of thinkMOTION project led to conceiving and building of an original scanning equipment.

These requirements refer to:

- possibility of scanning any type of document (single sheet, journal and book) without damaging in any way the original paper (bending, folding, scratching, tearing, heating etc.). This totally non-destructive feature is very important especially for old documents, with fragile pages, which exist in a small number of copies or even may be one of a kind
- maximum document size ~ 400 x 260 mm. Maximum page size taken into account was A4 (297x210 mm). A safety range of 50 mm was considered reasonable along three edges (top, bottom, left/right) for large non-standard old documents and also for efficiency of work on any size of page. The operator should not waste time because of a restricted positioning area
- high degree of resemblance of the copy in respect with the original. The problem of distortion toward outer sides and corners is present for most all-purpose scanners on the market, in case the original document is a thick book. Furthermore, the thicker the book is, the bending and folding are stronger
- high quality of the digitized copy. The optical resolution was imposed at 300 dpi, at least
- flexible color mode (color and grayscale)

6. Ciupe V., Lovasz E.C., Reessing M., Henkel V., Gruescu C.M., Zabava E.S. 2014 Interactive animation production by means of advanced image processing *SYROM 2013, Mechanisms and Machine Science* **17** 329-337.

Interactive Animation Production by Means of Advanced Image Processing

V. Ciupe, E.-Ch. Lovasz, M. Reessing, V. Henkel, C. M. Gruescu and E. S. Zabava

Abstract The paper describes an application developed within the European project thinkMOTION. The project aims to post online, within a digital library, heterogeneous content regarding mechanisms science and related fields. Special systems were developed in Ilmenau, Germany and in Timisoara, Romania, in order to actuate and take photographs of the physical models of the mechanisms to be digitized. The systems consist of a motor mechanically connected to the mechanism by means of a coupling device and electrically connected to a PC or a PLC. A digital still camera is connected to the same computer/controller. The logic of this system is to take a photograph after each rotational increment of 0.9°, thus obtaining a complete 400 images set that can be further processed via software in order to obtain an interactive animation which can be uploaded on the project's dedicated web portal and used in this way as an educational or informational content tool.

Keywords Interactive animation · Mechanisms · Physical models · Stepper motor · Servo motor · Java applet

V. Ciupe (✉) · E.-Ch. Lovasz · C. M. Gruescu · E. S. Zabava
Politehnica University of Timisoara, Timisoara, Romania
e-mail: valentin.ciupe@mec.upt.ro

E.-Ch. Lovasz
e-mail: erwin.lovasz@mec.upt.ro

C. M. Gruescu
e-mail: corina.gruescu@mec.upt.ro

E. S. Zabava
e-mail: eugen.zabava@mec.upt.ro

M. Reessing · V. Henkel
Technische Universität Ilmenau, Ilmenau, Germany
e-mail: michael.reessing@tu-ilmenau.de

V. Henkel
e-mail: veit.henkel@tu-ilmenau.de

I. Visa (ed.), *The 11th IFToMM International Symposium on Science of Mechanisms and Machines*, Mechanisms and Machine Science 18,
DOI: 10.1007/978-3-319-01845-4_33, © Springer International Publishing Switzerland 2014

7. Gruescu C.M., Garaiman A., Lovasz E.-C. 2015 Modeling of human spinal column and simulation of spinal deformities *Mechanika Journal* **3** 214-219.

214

ISSN 1392–1207. MECHANIKA. 2015 Volume 21(3): 214–219

Modeling of human spinal column and simulation of spinal deformities

C. M. Gruescu*, A. Garaiman, E. C. Lovasz*****
**University Politehnica Timisoara, Mihai Viteazu 1, 300222, Timisoara, Romania, E-mail: corina.gruescu@upt.ro*
***University Politehnica Timisoara, Mihai Viteazu 1, 300222, Timisoara, Romania, E-mail: alice_garaiman@yahoo.com*
****University Politehnica Timisoara, Mihai Viteazu 1, 300222, Timisoara, Romania, E-mail: erwin.lovasz@upt.ro*

crossref http://dx.doi.org/10.5755/j01.mech.21.3.8505

1. Introduction

Modeling and simulation is widely used in all domains as resourceful tools in design, enhancement, improving or forecasting behavior of different systems. A wide range of software is available to aid solving engineering problems. However, there are systems, such as the biological ones, to which modeling and simulation is a very difficult task. The difficulty originates in two essential features:

- human body parts are very irregularly shaped;
- anthropometrical normal data is very scattered, regarding age, sex, race, profession, local environment traits and so on.

Therefore, biological models are not yet developed on large scale even though they would be very useful in investigating and monitoring patients suffering of widespread diseases. However, there is an encouraging start in modeling different parts of human body, such as feet [1], arms [2], mobile bones of the head [3] etc. The purpose of modeling is either depicting abnormal anatomical shapes or designing of devices such as prosthesis.

The present work focuses on the class of spinal deformities, which are very common in now-days. Most individuals suffer of mild or severe spinal column deformities, such as scoliosis, lordosis, kyphosis or combinations of these. Deformities cause diminution of personal comfort and of physical or intellectual capacity of effort. When severe, deformities bring on large distortions of thorax shape and alteration of respiratory process. Such spinal diseases occur frequently at school-age population, due to incorrect posture and/or to improper desk design and less frequently to adult population, due to sedentary activities (teachers, librarians, IT specialists etc.). The elder population also suffers because of irreversible bone alteration. Plenty of statistics describe the prelevance of such diseases in different places of the world, taking into account a lot of aspects such as: age, sex, profession, life standard etc. [4-6].The studies emphasize very detailed the importance of identifying early stages of spinal deformities because of cautious prognostic and very high costs of treatment [7].

Engineering sciences offer a large series of equipments to investigate the human bone system. Among the methods of investigation in use, the most common are X-ray, CT or MR imaging, Moire topography, digital ultrasonic mapping and optical scanning [8-17]. The stating order of these methods is chronological regarding the implementation and inversely from invasive character standpoint.

Countries which develop long term healthcare programs always include spinal deformities among the main issues to investigate and monitor, especially to school children and persons involved in specific professional activities. The main problems in tracing and monitoring spinal deformities consist of:

- finding a quick and less invasive method of investigation;
- establishing a set of numerical parameters to describe completely the column's shape;
- storing of a large amount of data considering the big number of subjects in the database;
- accessing data and evaluating the evolution of patients.

In order to model the spinal column and simulate its behavior, considering a long-term monitoring of an extended sample of population, the following workflow was conceived (Fig. 1).

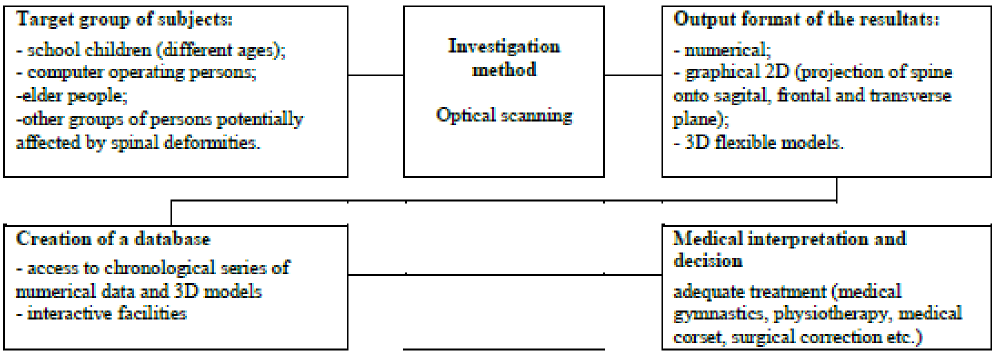

Fig. 1 Workflow of the biometric investigation and monitoring

8. Lovasz E-C., Gruescu C. M., Garaiman A., Carabas I., Bodea R. 2013 Scanning System Integrated within Biometric Measurements *New Trends in Medical and Service Robots. Theory and Integrated Applications. MeSRob 2013 Mechanisms and Machine Science* **16** 131-144.

Scanning System Integrated Within Biometric Measurements

E.-C. Lovasz, C. M. Gruescu, A. Garaiman, I. Carabas and R. Bodea

Abstract The chapter presents the implementation of a non-invasive method of investigation for the spinal column. The scanning equipment, in a proper configuration, provides 3D images of human torso. Specific software developed writes information into an interactive database and computes 16 numerical parameters, describing the column's shape, respectively the human posture. A sequence of the program computes the relative angle of rotation between successive vertebrae or segments of the column. The database also allows modelling of different types of vertebrae and, finally of personalized spinal columns.

Keywords Scanning · Spinal column · Modelling · Simulating · Spinal deformities

1 Introduction

During the last two decades, imaging became an every-day method of investigation all over the medical field. However, objective medical imaging,

---

E.-C. Lovasz (✉) · C. M. Gruescu · A. Garaiman · I. Carabas
University "Politehnica" of Timişoara, Timişoara, Romania
e-mail: erwin.lovasz@mec.upt.ro

C. M. Gruescu
e-mail: corina.gruescu@mec.upt.ro

A. Garaiman
e-mail: alice_garaiman@yahoo.com

I. Carabas
e-mail: iosif.carabas@mec.upt.ro

R. Bodea
University of Oradea, Oradea, Romania
e-mail: rbodea@uoradea.ro

D. Pisla et al. (eds.), *New Trends in Medical and Service Robots*, 131
Mechanisms and Machine Science 16, DOI: 10.1007/978-3-319-01592-7_10,
© Springer International Publishing Switzerland 2014

9. Vutan A.M., Ciupe V., Gruescu C.M., Lovasz E.-C. 2018 Experimental Method for Dynamic Evaluation of Spinal Column Deformation Exercises *Proc. of The 12th IFToMM International Symposium on Science of Mechanisms and Machines (SYROM 2017) MMS* **47** 137-146.

Experimental Method for Dynamic Evaluation of Spinal Column Deformation Exercises

A.-M. Vutan, V. Ciupe, C. M. Gruescu and E.-C. Lovasz

Abstract Spinal deformities appear very frequently in child or adult population. Researches in this field are widely spread and continuously developing now-days, as the current schemes of treatment are long-lasting, costly and not very effective. The authors propose an investigation method based on a set of sensors, which are accelerometers and provide data in order to generate a mathematical model of the spine, namely a high degree polynomial. Basic parameters, such as the Cobb angle are computed within the mathematical algorithm. The angles acquired by the sensors are recorded as functions of time, so that the change in shape of the spine during the exercises prescribed by the kinetotherapist is subject of study and a criterion for optimizing the nature and intensity of the exercises.

Keywords Spinal deformation · Accelerometer · Mathematical model of the spine

1 Introduction

Vertebral disorders are very common in recent years among children and adults, due to lack of physical activity [1] and long-term prolonged sitting position [2]. Spinal deviations, such as scoliosis, may occur from younger ages continuing to

A.-M. Vutan · V. Ciupe · C. M. Gruescu (✉) · E.-C. Lovasz
Politehnica University of Timisoara, Timişoara, Romania
e-mail: corina.gruescu@upt.ro

A.-M. Vutan
e-mail: anamariavutan@yahoo.com

V. Ciupe
e-mail: valentin.ciupe@upt.ro

E.-C. Lovasz
e-mail: erwin.lovasz@upt.ro

© Springer International Publishing AG, part of Springer Nature 2018
I. Doroftei et al. (eds.), *New Advances in Mechanism and Machine Science*, Mechanisms and Machine Science 57,
https://doi.org/10.1007/978-3-319-79111-1_13

10. Vutan A.-M., Gruescu C.M., Ciupe V., Margineanu D.and Lovasz E.-C.2018 Effectiveness of Physical Exercises in the Treatment of Scoliosis - Mathematical Approach *MESROB 2018 MMS* **65** 25-34.

Effectiveness of Physical Exercises in the Treatment of Scoliosis - Mathematical Approach

A.-M. Vutan, C. M. Gruescu(✉), V. Ciupe, D. Margineanu, and E.-C. Lovasz

Politehnica University of Timisoara, Timişoara, Romania
anamariavutan@yahoo.com, {corina.gruescu, valentin.ciupe, dan.margineanu, erwin.lovasz}@upt.ro

Abstract. The treatment of scoliosis is based on physical exercises with light and medium severity of deformation. The effectiveness of the exercises is assessed by means of Cobb angle variation. In order to compute the values of the Cobb angle, a mathematical model of the spine is generated. A set of eight sensors, type accelerometer, is attached to the vertebrae in significant points of the column. Its shape is approximated with a high degree polynomial, which allows the determination of the inflection points and Cobb angles. The study consists in assessment of three exercises frequently used in treatment protocols.

Keywords: Spinal deformation · Mathematical model of the spine Cobb angle · Physical exercises

1 Introduction

Idiopathic scoliosis is a deviation in frontal plane with unknown cause. It mainly affects children over eight years old until bone maturation is achieved. The lateral inclination of the column is accompanied by the vertebral rotation vertebrae to the convexity of the curve [1]. Generally, there is a primary curve showing the highest rotation and one or more secondary (compensatory) curves [2]. When vertebral rotation is located at the thoracic region, the rotation of the vertebral body determines the movement and deformation of the entire rib cage, causing the rib hump [1]. The child with idiopathic scoliosis is evaluated periodically by the orthopedic doctor. The protocol requires clinical and radiologic evaluation every 6 months, from the moment of diagnosis until the end of bone maturation. Thus, the Cobb angle is calculated on the X-ray, representing the intersection of the perpendiculars to the tangent line of the upper plateau of the superior vertebra of the curvature and the tangent line to the inferior plateau of the lower vertebra of the curve [2]. Depending on the degree of inclination and rotation of the spine, the orthopedist determines the treatment to follow. The protocol for a scoliosis (Stagnara protocol) requires: scoliosis specific exercises (if the Cobb angle is below 25°) or specific exercises and orthopedic treatment wearing a brace (if Cobb angle is between 25° and 50°) or surgery (if Cobb angle is above 50°) [1]. Specific exercises programs for scoliosis will be part of the patient's life immediately after

© Springer Nature Switzerland AG 2019
G. Carbone et al. (Eds.): *New Trends in Medical and Service Robotics*, MMS 65, pp. 25–34, 2019.
https://doi.org/10.1007/978-3-030-00329-6_4