# Development of a new device system for the determination of Leg-defective or/and Pelvis-defective position

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***Abstract:*** *The aim of this development was to produce an innovative examination and measuring device for the analysis and evaluation of the physical statics of patients. The new measuring system should be able to determine and evaluate any dysbalance of the leg length, pelvic obliquity and possible misalignment of the feet. In future, the system should be implemented as a semi-automatic measuring device within the scope of medical diagnosis.*

***Keywords:*** *Device system, Video-Footprint, Leg-Pelvis defective position, Measurement, Medical technology*

## I. INTRODUCTION

A wide variety of processes and measuring methods are currently used to determine leg or pelvic misalignment of patients. These include purely manual palpating or tapping the body, measurement with tape measures and angle measures or even image processing such as computer tomography and magnetic resonance tomography [1]. All these methods attempt to determine misalignment of the body by analyzing length or angular measurements. The newly developed semi-automatic measuring system (Fig. 1) could be used to compile the following parameters:

- Body size
- Shoulder height
- Leg length difference
- Pelvic obliquity
- Footprint analysis
- Gravimetric analysis.

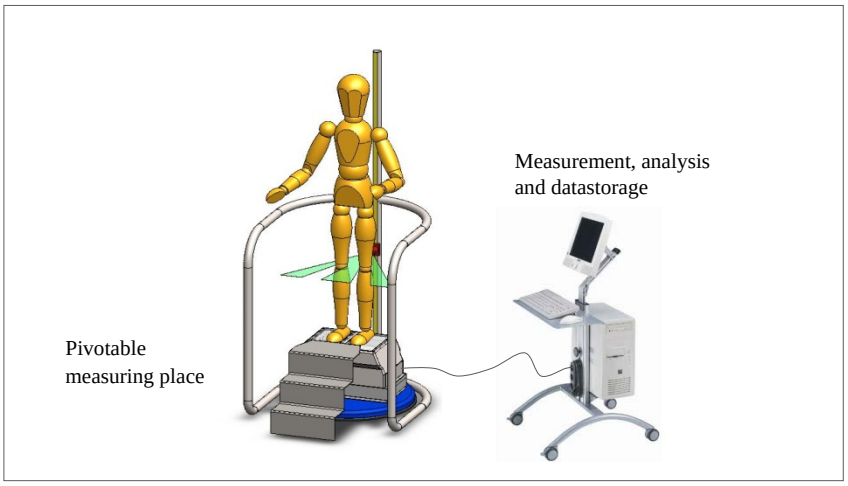


Fig. 1 Measuring system to determine leg and pelvic misalignment with measuring place and data storage

## II. PROCEDURAL METHOD

In order to compile the above mentioned parameters, a semi-automatic measuring system was developed which can produce and compensate for dysbalances using motorically adjustable footsteps, determine body sizes and differences using laser-assisted length and difference measurements and compile, archive and analyse all the data by implementing a specially develop software. The following sections describe the individual devices and/or measuring modules.

## III. MEASUREMENT OF LENGTHS

The length measuring device concerns a laser-assisted, magnetic absolute length measuring system. With this type of measurement, a sensor is guided over a magnetically coded metallic band. Due to the different lengths of three magnetic tracks, phase shifts are produced which, together with the signals from the sensor, produce absolute length values [2]. The measuring system used can realistically achieve accuracies up to 1 mm. The measured values established are transferred via an RS232 interface to a PC where they are processed or evaluated by project-specific software. Prior to each measurement, marker points are adhered to patients in relevant body areas. The laser beam is then focussed on these relevant measuring points and the distance between them measured. The laser used is assigned to Laser Class 2M [3] with a wavelength of 650 nm and output power of 5 mW. The length measurements can be taken with the patient standing and in three different positions (Fig. 2). Each measurement involves measuring the right and left halves of the patient as well as a rear view, following which the measurements are analysed.

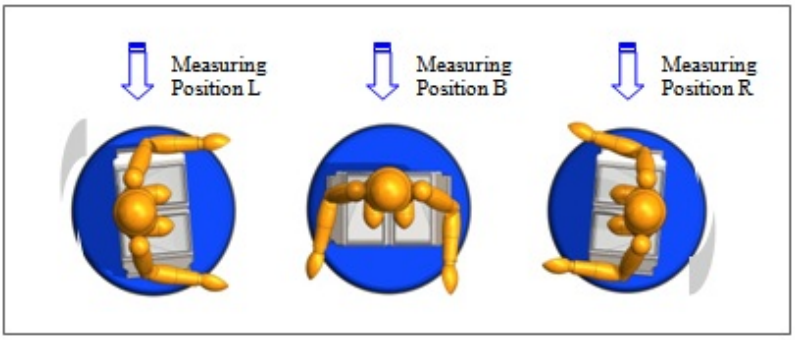


Fig. 2 Illustration of the various measuring positions (Positions L, B, R) as a plan view

## IV. FOOT POSITIONING KINEMATICS

In order to be able to compensate or simulate the differences in leg length or pelvic misalignment, foot positioning devices have been developed which enable each leg (foot) to be raised, lowered and/or tilted independent of the opposite side of the body. These devices (Fig. 3) can compensate for dysbalances in the human body. While the patient is standing on the two (right and left) motorically adjustable moving units, an external operating panel can be used to move the right and/or left leg (foot) up and down or tilt them to the side. Following compensation of any misalignment, the length measurement of the body size can be completed again.

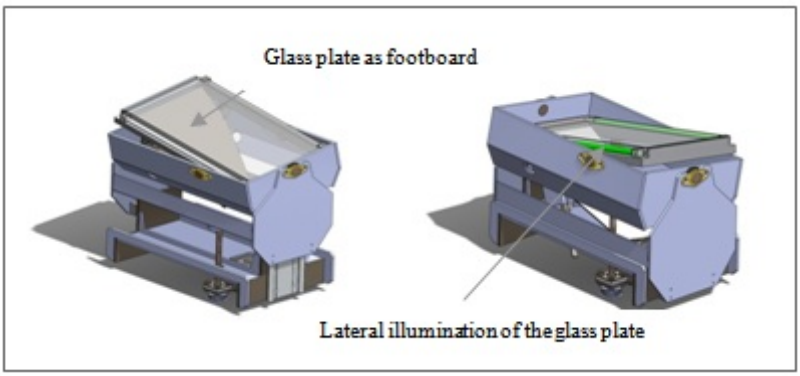


Fig. 3 Foot positioning devices, right and left, with illustration of the extreme positions in lateral, dorsal and up/down

## V. FOOTPRINT ANALYTICS

A further special feature of our newly developed system is the capability to take photographs of the soles of the feed when a load is applied and when the load applied is changed. To do this, green light is derived laterally from the cold light cathodesin two glass plates (left and right foot positions). The light is reflected to the top surfaces of the glass through total reflection and, therefore, cannot escape from the glass plates. However, as a result of the pressure applied by a foot, the light can escape from the glass plates at the pressure points exerted by the feet [4], and these point are particularly well highlighted visually (Fig. 4). A visual foot sole analysis or pressure diagnosis can be completed. The pressure images of the feet are recorded in real time by a video camera and stored as individual frames. The images of the feet can be produced before and after compensation of a dysbalance. A comparison of the footprint images can also be used as evidence of successful compensation of a dysbalance.

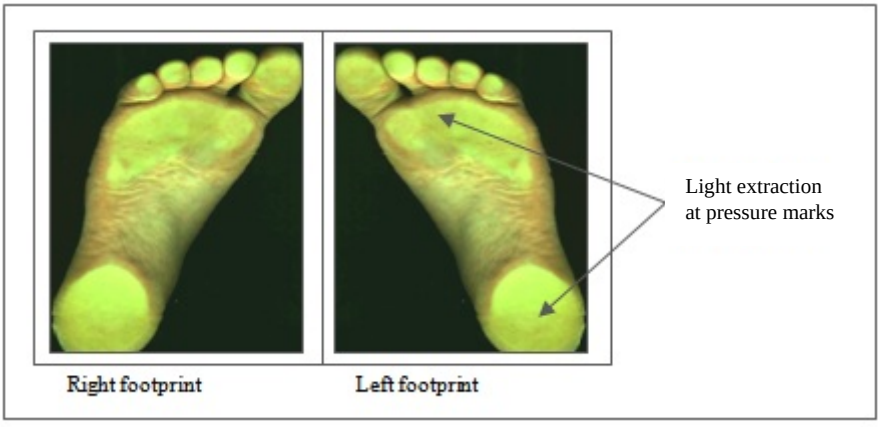


Fig. 4 Illustration of two video-footprints with highlighted pressure points through decoupling light

## VI. CONCLUSION

During the development of this innovative system of devices for measuring leg and pelvic misalignment, a prototype was produced which is currently in the practical trial phase. The prototype is being tested with regard to its everyday practicality in a large, North German orthopaedic practice by medical students. The results of the practical tests should serve as a basis for optimising the system. An application for a patent has been registered at the Deutschen Patent- und Markenamt (German Patent and Trademark Office) for the above measuring system. The patent is registered under Patent Number: DE 10 2010 047 460 A1 [5]. Following the practical tests and optimisation phase in 2013 and 2014, it is planned to put the new measuring system into series production.

## VII. ACKNOWLEDGEMENTS

For the support by realization of this project, we would like to thank the Faculty of Engineering Science and the Institute of Innovations-Transfer, both at the Jade University in Wilhelmshaven, Germany. We would also like to thank Brigitte Bohlen from ESBO Schuhtechnik, domiciled in Oldenburg, Germany. Some further thanks go at the Lower Saxony Country, Germany, and onto the European Union, for the partial financing of the development.

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