New Scientific Results

I conclude the new scientific results obtained in the course of my research work as follows:

1. The concentrated dynamic stiffness and damping parameters required for the complex mechanical model of the human thigh – textile pocket system can be determined from the mechanical impedance, i.e. the quotient of the measured velocity response and transmitted force based on by help of a simplex algorithm which the undermentioned statements can be done with respect to:

> *Thesis I.: The dynamic stiffness and damping are required parameters for modelling of the human thigh. The dynamic stiffness is independent from the osculant surface while the damping depends on it as the following nonlinear (exponential) function in the characterized relevant 2100÷4600 mm^2 surface range [2], [10], [12], [13]:*
>
> $$k(A) = k\left[\frac{N}{m}\right]$$
>
> $$b(A) = b_0 e^{b_1 A}\left[\frac{Ns}{m}\right], \text{ where } b_0\left[\frac{Ns}{m}\right],\ b_1\left[\frac{1}{m^2}\right],\ A\left[m^2\right].$$
>
> *Thesis II.: Increasing the prestress of the textile pocket between 0,5÷8,5 N the damping grows on the characterized relevant 2100÷4600 mm^2 surface range while the dynamic stiffness remains constant [2], [10], [12], [13].*

2. The perception threshold of the human thigh that was not known till now was determined by the help of „two-alternative forced-choice procedure" which was applied beforehand to obtain the perception threshold of the human hand. With respect to this the undermentioned statements can be done:

Thesis III.: The minimum oscillation amplitude 0,3 μm perceptible by the human thigh is in the 140÷160 Hz frequency range. The measured perception threshold curve of the human thigh can be written in the 20÷250 Hz frequency range as the following nonlinear function [2], [10], [12], [13]:

$\lg X(w_f) = 1,5932 \cdot 10^{-9} w_f^4 - 1,2397 \cdot 10^{-6} w_f^3 + 0,0004 w_f^2 - 0,0545 w_f - 3,5966$, *where* $w_f\,[Hz]$ *is the exciting frequency,* $X\left(w_f\right)$ *[m] the oscillation amplitude.*

Thesis IV.: The sensitivity of the human thigh is independent from the osculant (cellular phone) surface in the relevant 2100÷4600 mm^2 *range [2], [10], [12], [13].*

3. The following statements can be made based on experimental and theoretical considerations for a DC micro-motor of small cylindrical diameter (4 mm) with two-pole radial magnetized permanent magnet and bell-shaped rotor:

Thesis V.: An active sensor can be prepared based on the induced voltage and the electrodynamic principle for the measurement of the perimetrical distribution of the air-gap induction of a DC micro-motor (small cylindrical diameter 4 mm two-pole radial magnetized permanent magnet and bell-shaped rotor) so that the thin wires of the measuring coil are parallel to the shaft of the DC motor [6], [8], [15], [16].

Thesis VI.: An arbitrary point of the 5÷15 μNm useful torque characteristic of a DC micro-motor (small cylindrical diameter 4 mm, two-pole radial magnetized permanent magnet and bell-shaped rotor) can be determined with a electromechanical, non-contact method by using an eddy current break. By help of this method the unknown parameters of the approximated useful torque – speed characteristic can be calculated from the measured values, beside constant voltage with a limited error [5], [9], [14], [19], [20].

4. The prototype of a radial flux linear-motor (actuator) with air-gap solenoid and based on *Lorentz*-force was manufactured which can be used for vibration function in cellular phones:

Thesis VII.: The application of identification methods yields that the springs applied in the radial flux linear-motor (actuator) with air-gap solenoid have a nonlinear characteristic where the cubic term plays a determining role on the linear term. It was shown that the mechatronical model of the actuator can be rewritten as a mechanical and electromagnetic system. Thus, the dynamic behaviour of the mechatronical model of the actuator is described by nonlinear, Duffing-type differential equation. The analytical formula giving the boundary of the bistable range of the actuator as the function of construction parameters is validated by experimental results [3], [4], [7], [17]:

$$\ddot{x} + 2D\alpha\,\dot{x} + \alpha^2(x + \mu x^3) = \frac{1}{m_m} N l_t B I,$$

$$L\dot{I} + N l_t B\,\dot{x} + RI = U_0 \cos(\omega t),$$

where $\alpha^2 = k/m_m$, $2D\alpha = b/m_m$.

Thesis VIII.: The self-inductivity of a coil usually can be neglected in case of air-gap solenoid DC micro-motors (small cylindrical diameter 4 mm, two poles and radial magnetized permanent magnet and bell formed rotor). Based on numerical simulation, neglecting the coil self-inductivity in the modelling of a radial flux linear-motor with 6 mm diameter air-gap solenoid causes only a 10^{-4} *relative error in the 0÷200 Hz frequency range [1], [11], [18]:*

$$\ddot{x} + \left(2D\alpha + \frac{(BNl_t)^2}{m_m R}\right)\dot{x} + \alpha^2\left(x + \mu x^3\right) = \frac{BNl_t}{m_m R} U_0 \cos(\omega t).$$