TECHNICAL UNIVERSITY OF KOŠICE
Faculty of Mechanical Engineering

change your future

KALEM - a writing aid for patients with upper limb tremor

Branko ŠTEFANOVIČ, Monika MICHALÍKOVÁ, Lucia BEDNARČÍKOVÁ,

Teodor TÓTH, Radovan HUDÁK, Jozef ŽIVČÁK

Department of Biomedical Engineering and Measurement, Faculty of Mechanical Engineering, Technical University of Košice, Letná 9, SK-042 00 Košice, Slovakia

Contents

Introduction

Tremor, as the most common form of abnormal involuntary movements, is a rhythmic oscillation of certain areas of the body produced by alternating the contraction of mutually innervated muscles.

Successful treatment depends on the correct diagnosis, which the doctor must recognize according to the individual forms of the shivering and associated symptoms. Methods for tremor assessment are based on clinical observation, objective clinical evaluation, and computer analysis.

Basic types of tremor:

1. Passive - in the part of the body that is relaxed or supported against gravity and is not involved in conscious activities,
2. Active - during voluntary muscle contraction and can be divided into four basic groups, which are postural, kinetic, isometric, and specific.

Tremor frequency:

1. Slow (up to 4 Hz)
2. Medium (5 – 7 Hz)
3. Fast (above 7 Hz)

Tremor amplitude:

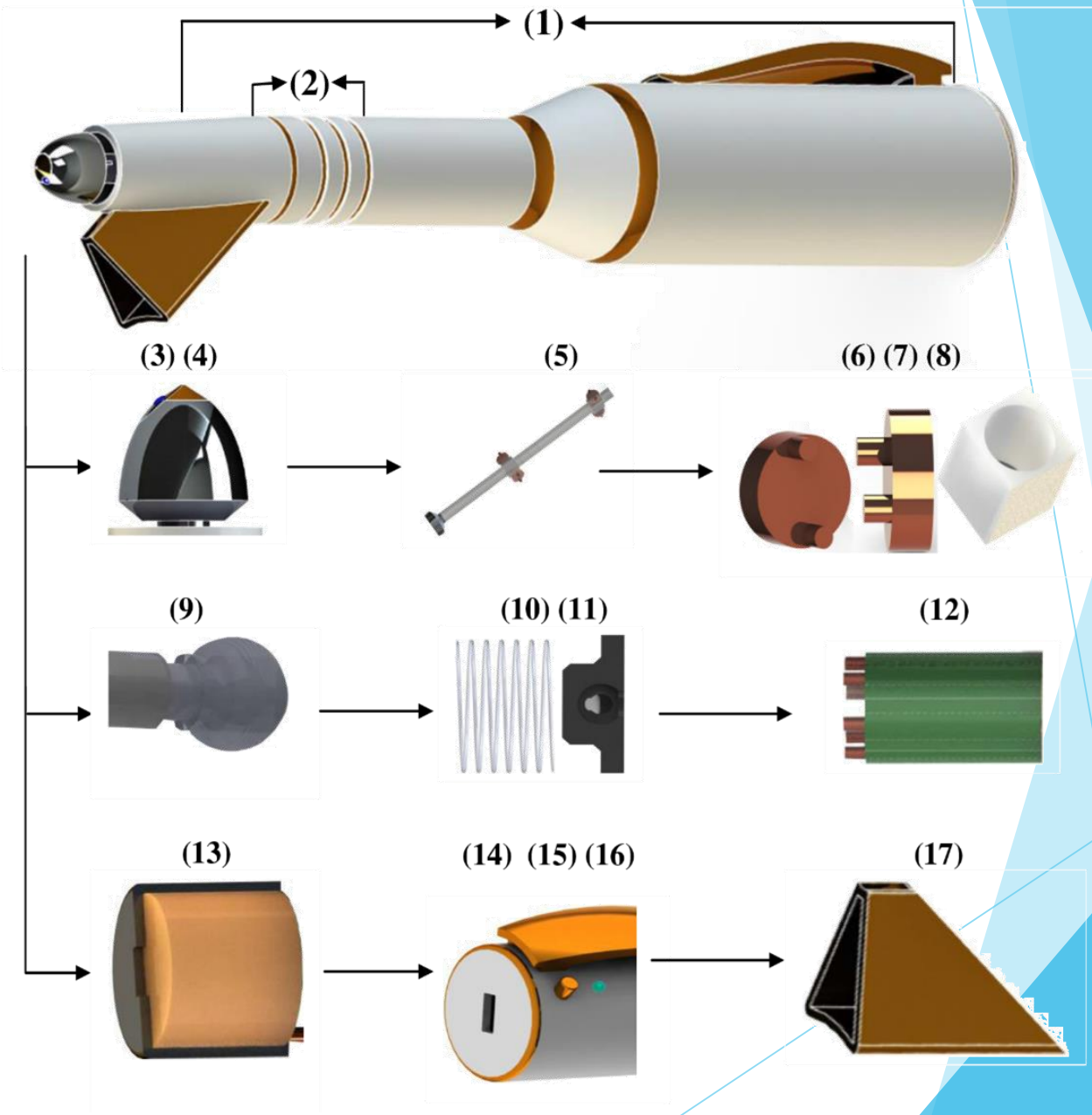
1.Fine (up to 1 cm usually fast frequency)
2.Medium (1 – 2 cm)
3.Coarse (above 2 cm usually slow frequency)

Although writing is not a necessary activity for existence, handwriting is still a means of, for example, recording information, signing, or filling in a form. It is therefore possible to say that we encounter writing every day. For these reasons, pens and writing aids have been developed to compensate unwanted hand tremors.

In the reviewed literature that deals with abnormal involuntary movements of the upper limb, the focus is rather on the handwriting analysis than the tremor reduction using special aids. Therefore, it is appropriate to develop an individual writing aid for people with hand tremor disorder using CAD/CAM technologies.

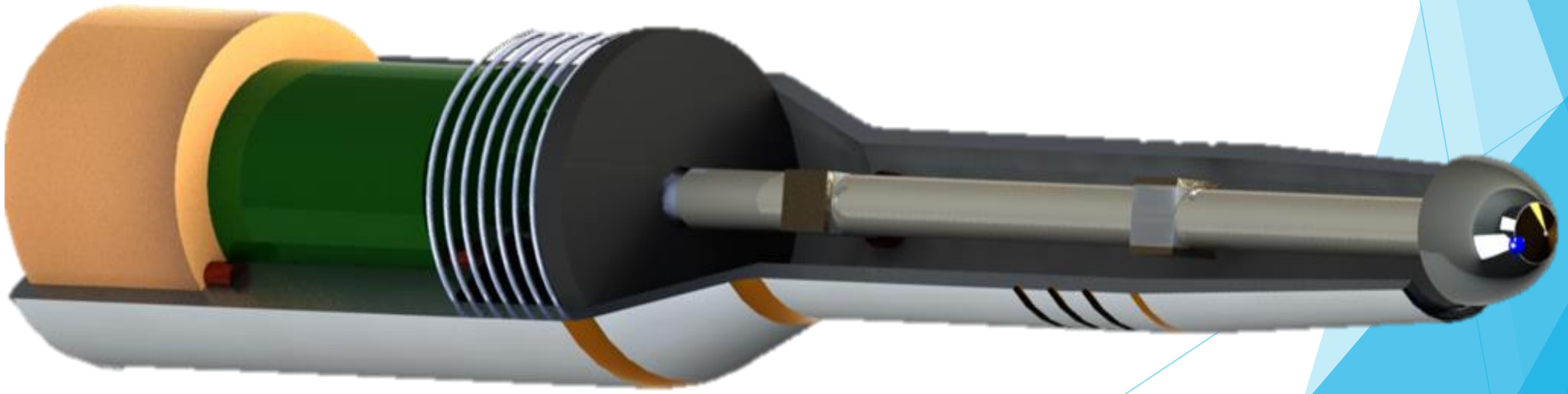
KALEM

1. Cover
2. Notches on the grip part
3. Tip
4. Ball in the tip
5. Lead
6. Coil
7. Single-winding coil
8. Ferromagnetic square
9. Joint
10. Spring
11. Hinge housing
12. Sensor and IMU module
13. Battery
14. Charging port
15. On/off button
16. LED light
17. Special pen tip



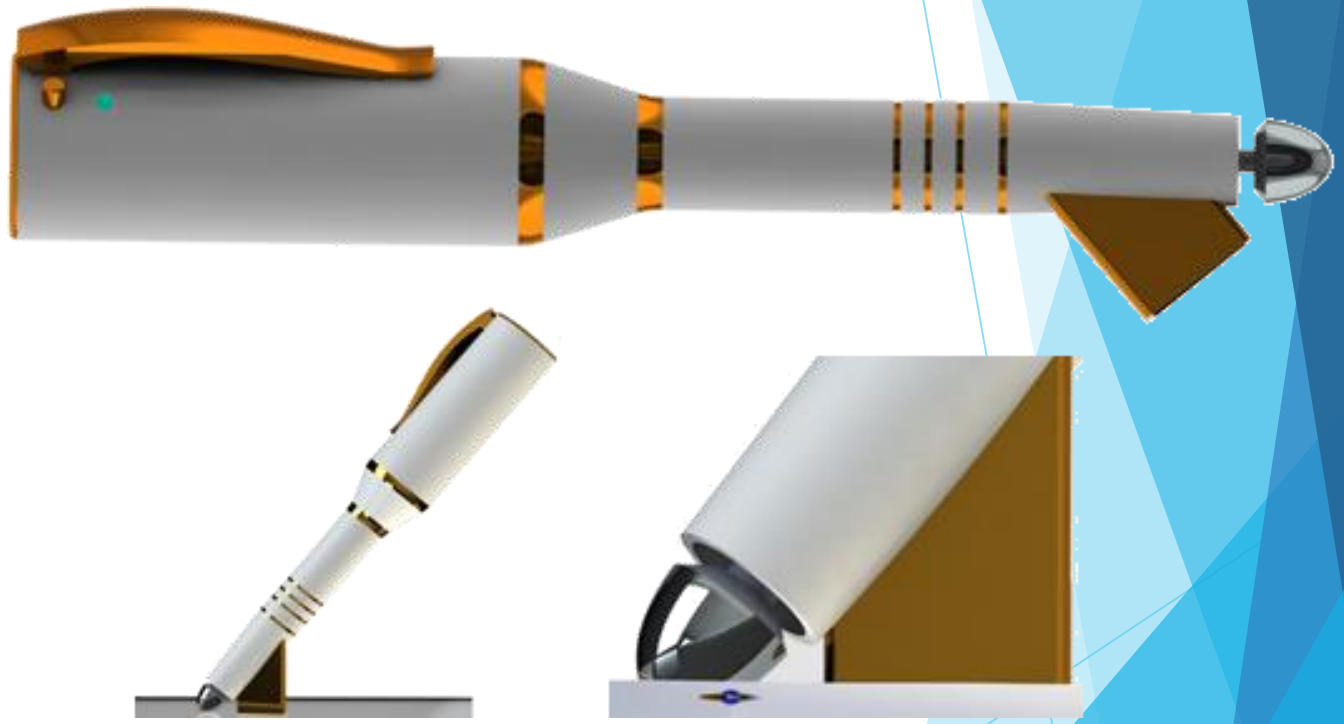
Construction of KALEM:

1. Cover (consisting of 2 parts)
2. Module 1 – Power supply
3. Module 2 – Sensor and microcomputer
4. Module 3 – Spring
5. Module 4 – Ball joint housing



Discussion

The emphasis in the construction of the designed device was placed not only on functionality, but also on the design itself. The shape of the device or its colour plays an important role in the design. Of course, in this case, the design should be combined with ergonomics, meaning that the user should not feel a significant difference in weight when writing with KALEM.



In terms of the material used, this is an inappropriately chosen variant if the user has an implemented pacemaker or uses a listening device. In order to prevent damage, it is possible to replace the polymer used with aluminium, the advantage of which, in addition to its low weight, is that it can absorb electromagnetic waves and thus prevent their penetration and consequent damage to said devices.

In case of insufficient notches in the gripping surface of KALEM created against the slipping of the fingers on the package, it can be supplemented with a specially shaped handpiece, which would also be placed in the gripping part and would fulfil the same function.

It is possible to add another LED to indicate the on/off of the entire device or would provide information about the error of, for example, a microcomputer.

The pen cover can be made by additive production and based on the requirements of the person, personalized if necessary. The main advantage is freedom in designing the device and the use of different types of plastic materials and colours, so that it is possible to easily change the type of material during the prototype testing.

Price of materials

Components number	Component	Component price (€)
1	Pen tip	1.20
2	Cover	7.00
3	Lead	0.76
4	Special pen tip	0.90
5	Coils	4.00
6	Ferromagnetic square	0.20
7	Neodymium magnet	0.06
8	Joint	3.00
9	Joint housing	3.50
10	Spring	0.90
11	Microcomputer (Atmel AVR Atmega8)	2.65
12	Sensor (Pololu 1264 – MinIMU – 9)	47.00
13	Battery (Li-Ion 3.6 V)	9.90
	Sum:	**81.07**

Conclusion

1. Test the suitability of the individual components of the device in terms of functionality and required performance, as well as the entire chain.
2. Find suitable settings and a compensation parameter for the controlling.
3. Practically test the functionality and controllability of the device on a patient with hand tremor disorder and compare results of writing with and without KALEM.

Thank you for your attention.