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SUMMIT
SOFIA UNIVERSITY MARKING MOMENTUM FOR INNOVATION AND TECHNOLOGICAL TRANSFER

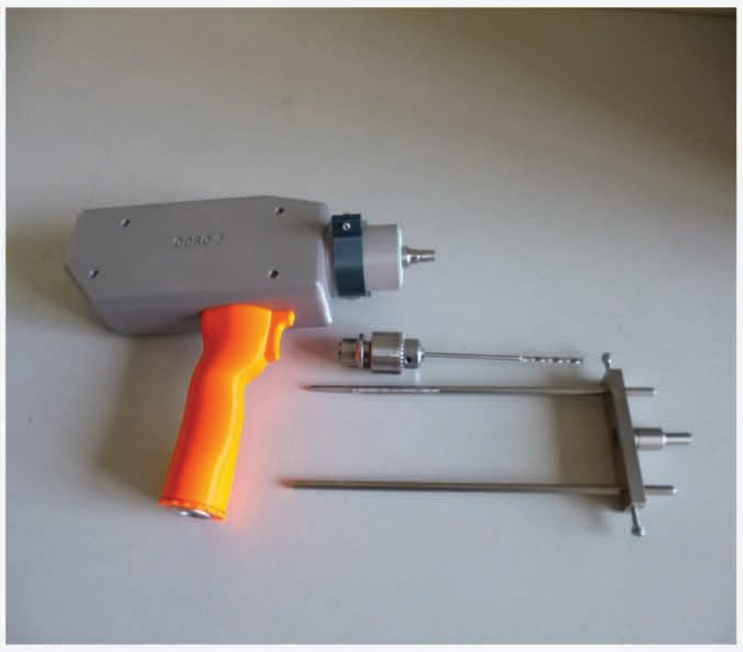
SOFIA UNIVERSITY -
MARKING MOMENTUM
FOR INNOVATION AND TECHNOLOGICAL TRANSFER

National Recovery and Resilience Plan
OF THE REPUBLIC OF BULGARIA

research group
Medical Robotics
research area: Orthopedic Surgery

Head of the research group
Prof. George Boiadjiev, FMI
Members of the group
Prof. Kamen Delchev, FMI
Prof. Ivan Chavdarov, FMI
Assoc. Prof. Tony Boiadjiev, IICT-BAS

Handheld robotized system for automatic bone drilling in the orthopedic surgery



INTRODUCTION

MEDICAL ROBOT - DEFINITION

- ❖ Computer technology and enhanced device
- ❖ At least two motors under control
- ❖ Key elements that improve surgeon's abilities
  - ➢ Vision
  - ➢ tissue manipulation or tissue sensing
  - ➢ alteration of the traditional direct local contact between surgeon and patient

Society of American Gastrointestinal and Endoscopic Surgeons and Minimally Invasive Robotic Association (SAGES–MIRA) Robotic Consensus Group

Problems in bone drilling operations

- Wrong determination of the hole depth
- Overheating and necrosis of the bone
- Trauma of the soft tissue near the bone
- Wider breakthrough diameter
- Unstable screw fixation and lack of effective stabilization
- The excessive temperature increasing over 50°C round the hole leads to necrosis
- The necrotic material existence lows the bone recovery and causes possible infections

PURPOSE: INTERNATIONAL PATENT OF INNOVATION OF MEDICAL ROBOT FOR BONE DRILLING IN THE ORTHOPEDIC SURGERY

MAIN COMPONENTS

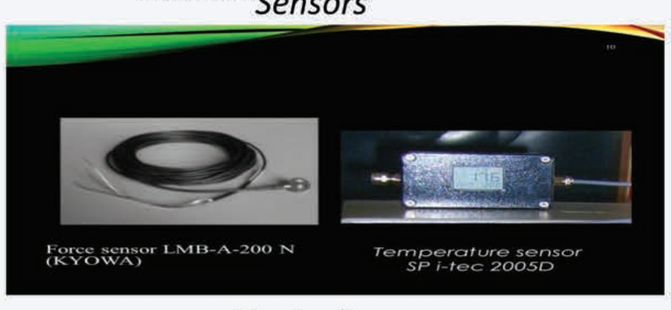
Motors

Linear actuator 43000–17

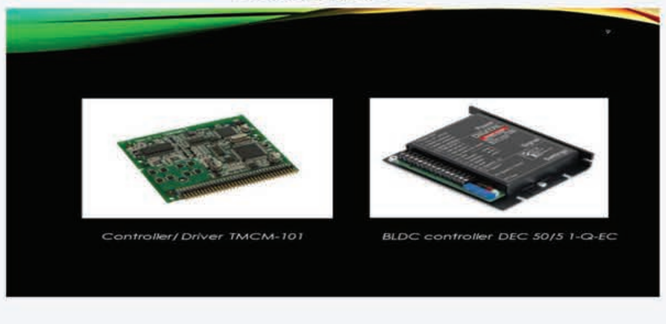
BLDC motor MAXON EC-4pole 30

(Haydon Kerc)

Sensors



Controllers



RESULTS

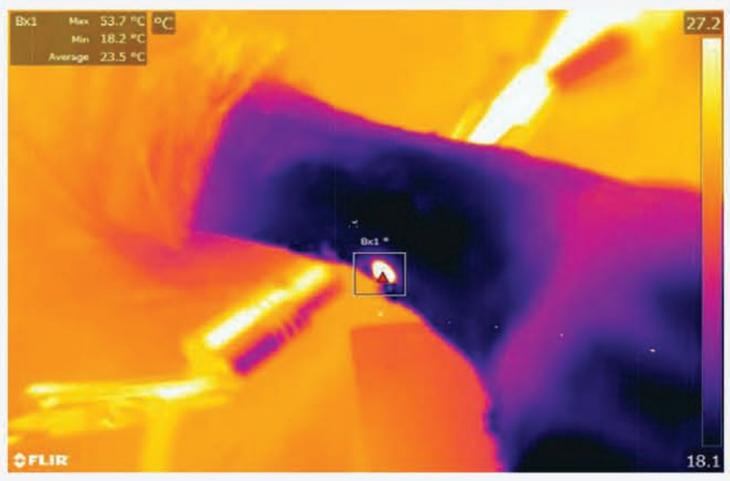
Basis of the method: Energy Conservation Law

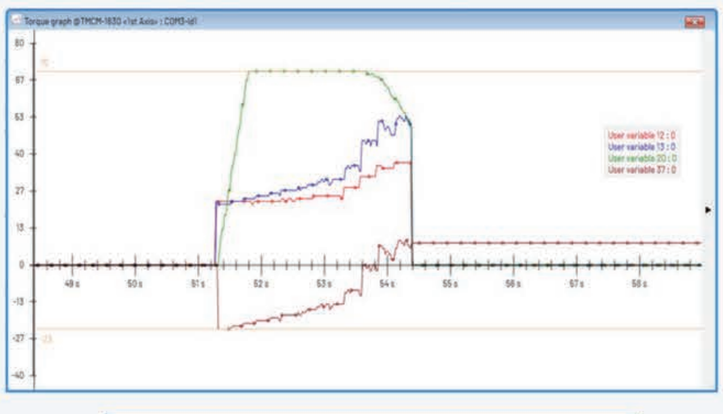
Energy spaces with their basic variables, notations, descriptions, units of measurement, and expressions in the basic units in the SI system

Energy Space	Notation		Description		Measure	Power	
Base Space	Across	Through	Terms	Unit	Dimension	P=XY	
Translation H_{TR}	v	F	Linear velocity / Force	Meter/ second / Newton	LT^{-1} / LMT^{-2}	v F	L^2M/T^3
Rotation H_R	ω	T	Angular velocity / Torque	Rad/ second / Newton. meter	T^{-1} / L^2MT^{-2}	ω T	L^2M/T^3
Thermal H_T	τ	$\dot{Q}$	Temperature / Thermal flow	Degree / Joule/ second	No Dimension / L^2MT^{-3}	$\tau \dot{Q}$	L^2M/T^3

Real time drill bit tip temperature calculation based of the data obtained by non-contact temperature sensor and the energy conservation law

Creation of the algorithm to calculate the target speed depending on the increase in the temperature of the drill bit tip. The control algorithm is a modified PI - control law to calculate the value of the correction Δs_k by which the drill speed should be changed in the next sampling cycle





Unicortical bone drilling with drill speed control

Blue line - drill bit tip temperature T_2 [°C]
Green line – drill speed [RPM]
Red line – temperature T_1[°C] measured by the temperature sensor

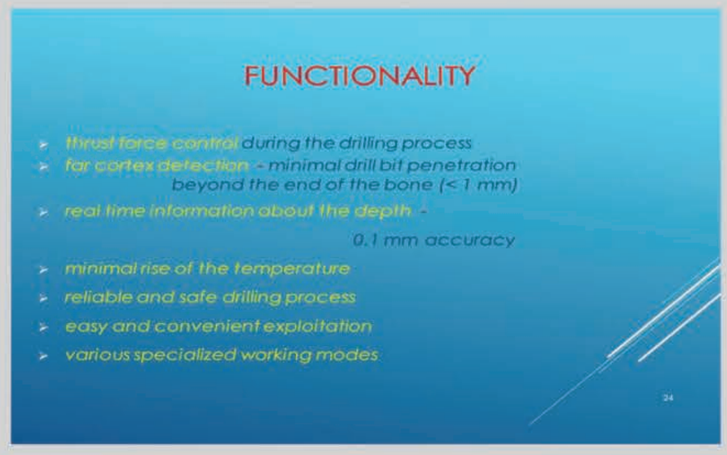
CONCLUSION

Technical specifications

- *Length: 310 mm*
- *Diameter: 60 mm*
- *Weight: 1.44 kg*
- *Rotation speed: 0 – 1000 rpm*
- *Linear speed: 0 – 9 mm/s*
- *Working zone: 0 – 87.5 mm*
- *Preset depth of drilling: up to 87 mm (in 0.1mm steps)*
- *Digital display*
- *Drilling precision: 0.1 mm*
- *Main working modes:*
  - *Manual*
  - *Automatic*

❖ *ELIMINATION OF GAUGE MEASUREMENT IN OPERATION*

- ✓ *Near cortex thickness determination*
- ✓ *Depth of marrow*
- ✓ *Far cortex thickness determination*



The handheld device for robotized bone drilling:

- ▸ *makes the process easier*
- ▸ *maximally eliminates the subjective factor*
- ▸ *guarantees precision, reliability and safety*

Contract **70-123-615**

International Report on Patentability (IPRP) WO2026/ 025167 / 05.02.2026

https://patentscope.wipo.int/search/en/detail.jsf?docId=WO2026025167&_cid=P21-MLAOH6-10940-1

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