

UNIVERSITY OF PATRAS - SCHOOL OF ENGINEERING  
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING



ΠΑΝΕΠΙΣΤΗΜΙΟ  
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DIVISION: SYSTEMS AND AUTOMATIC CONTROL

## THESIS

of the student of the Department of Electrical and Computer Engineering of the School of Engineering of the  
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Subject

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**Robotic surgical tool manipulator - Recognition,  
control and manipulation of laparoscopic tools**

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Supervisor

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# ΠΙΣΤΟΠΟΙΗΣΗ

Πιστοποιείται ότι η διπλωματική εργασία με θέμα

**Robotic surgical tool manipulator - Recognition, control and manipulation of laparoscopic tools**

του φοιτητή του Τμήματος Ηλεκτρολόγων Μηχανικών και Τεχνολογίας Υπολογιστών

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παρουσιάστηκε δημόσια και εξετάστηκε στο τμήμα Ηλεκτρολόγων Μηχανικών και Τεχνολογίας Υπολογιστών στις

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Ο Επιβλέπων

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# 1 Kinematic Analysis

## 1.1 Forward Kinematics & DH parameters

## 1.2 Inverse Kinematics

### 1.2.1 Decoupling Technique

### 1.2.2 Workspace constraints & Singularity points

### 1.2.3 Numerical Solution

### 1.2.4 Quaternion Solution

### 1.2.5 Redundancy & Optimization Conditions

### 1.2.6 Comparison of Inverse Kinematics Techniques

# 2 Dynamic Analysis

# 3 Control

## 3.1 Robotic Arm Controller

## 3.2 Gripper Controller

# 4 Laparoscopic tool recognition with Computer Vision

# 5 Path Planning

# 6 Trajectory Planning

## 6.1 Trajectory planning in cartesian coordinates

## 6.2 Trajectory planning in joint angles space

# 7 Simulation with the ROS framework

## Nomenclature

${}^{i-1}\mathbf{p}_{iO}$  Position vector from the origin of the coordinate frame  $\{i\}$  to the origin of the coordinate frame  $\{i-1\}$

${}^{i-1}M_i$  Transformation matrix from coordinate frame  $\{i\}$  to coordinate frame  $\{i-1\}$

${}^{i-1}R_i$  Rotation matrix from coordinate frame  $\{i\}$  to coordinate frame  $\{i-1\}$

$c_i$  Shorthand notation for  $\cos\theta_i$

$s_i$  Shorthand notation for  $\sin\theta_i$

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## List of programs

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