

Contents

Colophon	4
Acknowledgements	iii
Abstract	v
Resumen	ix
Resum	xiii
Contents	xvii
1 Introduction	1
1.1 Cognitive and Behavioral Neuroscience	2
1.2 Animal Experimentation	4
1.3 Motivation	7
1.4 Objectives.....	9
1.5 Thesis Structure	9

2 RATT: RFID Assisted Tracking Tile.	13
2.1 Introduction	14
2.1.1 Behavior Experiments	15
2.1.2 Computer Vision Tracking Systems	16
2.1.3 Radio Frequency Tracking Systems	19
2.1.4 Mixed Tracking Systems	19
2.1.5 Radio Frequency Identification (RFID)	20
2.1.5.1 Inductive Coupling	20
2.1.5.2 Differentiation Features of RFID Systems	22
2.1.5.3 Tag Construction Formats	23
2.1.6 RATT Features	24
2.2 Materials and Methods	26
2.2.1 RATT System Concept	26
2.2.2 Software	27
2.2.3 System Core: LPC4088-ARM cortex	28
2.2.4 RFID Tags	30
2.2.5 ISO/IEC 15693	30
2.2.6 Smith Chart	30
2.2.7 Connectors	31
2.2.8 The TRF7960A	31
2.2.9 UDP Communication	32
2.3 Results	33
2.3.1 RATT Tile Virtual Concept	33
2.3.2 Control Board	34
2.3.3 RF Board	36
2.3.4 RFID Antenna Design	36
2.3.5 RFID Antenna Simulation	40
2.3.6 Structure	41
2.3.7 Triangulation Algorithm	44
2.3.8 Artificial Vision	45
2.3.9 Data Acquisition	47
2.3.10 Overall	48
2.3.11 MultiRATT Tile	51

2.4	Conclusions	52
3	HIVE Tracker	55
3.1	Introduction	56
3.1.1	Applications in Performing Arts and Athletics	56
3.1.2	Applications in Neuroscience and Medicine	57
3.1.3	Current State-of-the-art in Positional Tracking	57
3.1.4	Affordable, Smaller, and more Scalable	58
3.2	Materials and Methods	58
3.2.1	Valve Tracking System	59
3.2.2	Signal Processing	61
3.2.2.1	Photodiode circuit	61
3.2.2.2	Acquisition Hardware: Teensy	61
3.2.2.3	Acquisition Software: BONSAI	62
3.2.2.4	Triangulation Algorithm	63
3.3	Results and Discussion	63
3.3.1	Tracking: inside an ideal room	63
3.3.2	Tracking: in a non ideal room	64
3.3.3	Light Reflections	65
3.3.4	Tracking Refresh Rate	66
3.4	PCB Prototype	67
3.4.1	Hardware	67
3.4.2	Firmware	68
3.4.3	Size/Accuracy Trade-off	70
3.4.4	Cost	71
3.4.5	Autonomy	72
3.5	Conclusion	72
4	TherMouseDuino	73
4.1	Introduction	74
4.2	Materials and Methods	76
4.2.1	Overview	76
4.2.2	Heating System	77

4.2.3 Acquisition Device	78
4.2.4 Microcontroller	79
4.2.5 USB Host Module	80
4.2.6 RS-232 Communication Module	80
4.2.7 LCD User Interface	81
4.2.8 Model Identification	81
4.2.9 PID Control	82
4.2.10 Animals and MRI Acquisition Protocol	83
4.2.11 Surgery for fMRI experiments	83
4.2.12 fMRI data extraction	84
4.3 Results and Discussion	85
4.3.1 Experimental Identification Results	85
4.3.2 Control System Design Results	87
4.4 Conclusion	90
5 A Tangible Educative 3D Printed Atlas of the Rat Brain	93
5.1 Introduction	94
5.2 Materials and Methods	95
5.2.1 Data Selection: The 8 Most Relevant Macroscopic Areas in the Rat Brain	97
5.2.2 Three-Dimensional Reconstruction of the Desired Areas	99
5.2.3 Transforming the Facet Body into an Editable Solid Body	100
5.2.4 Rapid Prototyping	101
5.3 Results	103
5.4 Discussion	105
5.5 Conclusions	106
6 Automatic Device for Cutting 3D Tissue	107
6.1 Introduction	108
6.1.1 Histology	108
6.1.2 Microtome and Vibratome	108
6.2 Materials and Methods	110
6.2.1 System Concept	110

6.2.2 System Parts	112
6.2.3 Manufacturing materials	113
6.2.4 Acquisition System	114
6.3 Results and Discussion	114
6.3.1 Systems Specifications	114
6.3.2 Slicing test	116
6.3.3 Graphical User Interface	117
6.4 Conclusions	118
7 Lung Tumor Movement Simulator	119
7.1 Preface	120
7.2 Introduction	120
7.3 Materials and Methods	123
7.3.1 Linear Accelerator	123
7.3.2 Electromechanical Components	124
7.3.3 Microcontroller	124
7.3.4 Manufacture and Material	125
7.4 Results	125
7.4.1 Prototype Design	125
7.4.2 Movement and Path Simulation	127
7.4.3 Synchronizing the Movements	128
7.4.4 Path Verification	129
7.5 Discussion	131
7.6 Conclusions	133
8 Conclusions and Outlook	135
8.1 On the tracking devices	135
8.2 On the control temperature devices	136
8.3 On the 3D printed brain	137
8.4 On the histological cuts	137
8.5 On the tumor movement simulator	138
8.6 On the future work	138

9 Contributions	139
9.1 Research Internship	139
9.2 Publications in Journals	139
9.2.1 International Journals.....	139
9.2.2 National Journals	140
9.3 Patents	140
9.4 Publications in International Conference Proceedings	141
9.5 Awards and Honours	141
9.6 Others	142
9.7 Final Master Project Supervision	142
9.8 Final Degree Project Supervision	143
List of Figures	145
List of Tables	149
Abbreviations and Acronyms	151
Bibliography	155