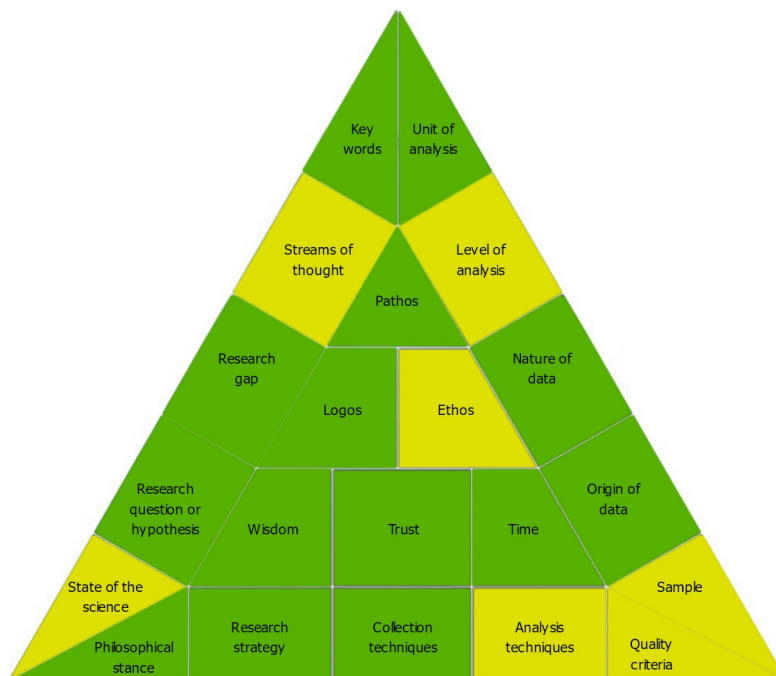


Non-Invasive Computer-Assisted Knee Arthroplasty Training Supported by Multimodal Image-Guided Navigation

Author: Catarina Lopes

Date: 2024-10-31 - 16:01:35 (WET)

Self-evaluation: 83%



Key words

1/21. Theoretical question: what are the two main keywords of your research?

The title of my research design is "Non-Invasive Computer-Assisted Knee Arthroplasty Training Supported by Multimodal Image-Guided Navigation".

Hence, my research focuses on two main keywords: "Computer-Assisted Orthopaedic Surgery", focusing specifically on "Computer-Assisted Knee Arthroplasty", and "Multimodal Image".

- Computer-Assisted Knee Arthroplasty: a type of knee arthroplasty surgery where computer technology, such as robotic or image-guided technologies, is applied pre-, intra- and/or post-operatively to improve the outcome of the surgical procedure [1].

- Multimodal Imaging: the incorporation of two or more imaging modalities during the same medical examination to produce a more complete patient examination by overcoming the limitations of single examinations [2].

[1] Leo Joskowicz and Eric J. Hazan. Computer aided orthopaedic surgery: Incremental shift or paradigm change? Medical Image

Analysis, 33:84790, 2016.

[2] Elda Chiara Colacchio, Mariagiovanna Berton, Francesco Squizzato, Mirko Menegolo, Michele Piazza, Franco Grego and Michele Antonello. The role of multimodal imaging in emergency vascular conditions: The journey from diagnosis to hybrid operating rooms. *Seminars in Vascular Surgery*, vol. 36, no. 2, pp. 355-362, Jun. 2023.

Self-evaluation: 100%

Streams of thought

2/21. Theoretical question: what are the two main streams of thought of your literature review?

Nowadays, computer-assisted knee arthroplasty is carried out with marker-based position tracking systems. To overcome the additional scarring and higher risk of infection provided by these invasive systems [1, 2], two main streams of thought can be found for my literature review:

Firstly, the registration process, which allows the surgeon to move the patient throughout the surgery whilst the surgical plan is being adjusted accordingly [3], has been explored with non-invasive alternatives, in particular with the use of ultrasound imaging registered with pre-operative computed tomography images of the knee [4-7].

Then, thanks to the rapid development of depth sensors, non-invasive spatial position tracking of the knee throughout the surgery has been introduced [8-10].

My research aims to combine both methods to obtain a non-invasive computer-assisted knee arthroplasty training system that incorporates two or more imaging modalities and can be as precise as the currently marketed solutions without increasing the learning curve.

[1] Robert W. Wysocki, Mitchell B. Sheinkop, Walter W. Virkus, and Craig J. Della Valle. Femoral fracture through a previous pin site after computer-assisted total knee arthroplasty. *The Journal of Arthroplasty*, 23(3):462-465, April 2008.

[2] M. Nogler, H. Maurer, C. Wimmer, C. Gegenhuber, C. Bach, and M. Krismer. Knee pain caused by a fiducial marker in the medial femoral condyle: a clinical and anatomic study of 20 cases. *Acta Orthopaedica Scandinavica*, 72(5):477-480, 2001.

[3] Roberto M. Barbosa, Serrador Luis, Bruno Santos, M. V. Silva, Elena De Momi, and Cristina Santos. 3dslicer module to perform registration: An intraoperative situation. In *2017 IEEE International Conference on Autonomous Robot Systems and Competitions (ICARSC)*, pages 55-60, 2017.

[4] Guoyan Zheng and Lutz P. Nolte. Computer-assisted orthopedic surgery: Current state and future perspective. *Frontiers in Surgery*, 2:66, 2015.

[5] Wolfgang Wein, Athanasios Karamalis, Adrian Baumgartner, and Nassir Navab. Automatic bone detection and soft tissue aware ultrasound-CT registration for computer-aided orthopedic surgery. *International Journal of Computer Assisted Radiology and Surgery*, 10(6):971-979, June 2015.

[6] Jens Kowal, Christoph Amstutz, Frank Langlotz, Haydar Talib, and Miguel Gonzalez Ballester. Automated bone contour detection in ultrasound B-mode images for minimally invasive registration in computer-assisted surgery-an in vitro evaluation. *The international journal of medical robotics + computer assisted surgery: MRCAS*, 3(4):341-348, December 2007.

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[8] Xue Hu, Anh Nguyen, and Ferdinando Rodriguez Y Baena. Occlusion-Robust Visual Markerless Bone Tracking for Computer-Assisted Orthopedic Surgery. *IEEE Transactions on Instrumentation and Measurement*, 71:1-11, 2022.

[9] Xue Hu and Ferdinando Rodriguez y. Baena. Automatic Bone Surface Restoration for Markerless Computer-Assisted Orthopaedic Surgery. *Chinese Journal of Mechanical Engineering*, 35(1):18, March 2022.

[10] Salaheddine Sta, Jérôme Ogor, Hoel Letissier, Eric Stindel, Chafiaa Hamitouche, and Guillaume Dardenne. Towards markerless computer assisted surgery: Application to total kneearthroplasty. *The international journal of medical robotics + computer assisted surgery: MRCAS*, 17(5):e2296, October 2021.

Self-evaluation: 50%

Research gap

3/21. Theoretical question: what is the main gap that your research addresses?

With 19% of patients dissatisfied with their knee arthroplasty procedures, computer-assisted orthopaedic surgery has been introduced, appearing to have better outcomes than conventional techniques by reproducing a planned alignment with a similar learning curve [1]. However, orthopaedic interns are taught complex surgical techniques identically to conventional teaching, with theoretical teaching, virtual simulators, and hands-on experience with patients [2]. Moreover, marker-based position tracking systems are the most common but have the main limitation of being an invasive method, where a marker incision will cause additional scarring

and may increase the risk of infection, nerve injury, and bone fracture [3, 4].

To address these gaps, my research focuses on the development of a non-invasive computer-assisted training system supported by multimodal image-guided navigation.

[1] Muzaffar Ali, David Phillips, Anthony Kamson, Isaac Nivar, Raymond Dahl, and Richard Hallock. Learning curve of robotic-assisted total knee arthroplasty for non-fellowship-trained orthopedic surgeons. *Arthroplasty Today*, 13:194-198, 2022.

[2] Neil Vaughan, Venketesh N. Dubey, Thomas W. Wainwright, and Robert G. Middleton. A review of virtual reality based training simulators for orthopaedic surgery. *Medical Engineering & Physics*, 38(2):59-71, 2016.

[3] Robert W. Wysocki, Mitchell B. Sheinkop, Walter W. Virkus, and Craig J. Della Valle. Femoral fracture through a previous pin site after computer-assisted total knee arthroplasty. *The Journal of Arthroplasty*, 23(3):462-465, April 2008.

[4] M. Nogler, H. Maurer, C. Wimmer, C. Gegenhuber, C. Bach, and M. Krismer. Knee pain caused by a fiducial marker in the medial femoral condyle: a clinical and anatomic study of 20 cases. *Acta Orthopaedica Scandinavica*, 72(5):477-480, 2001.

Self-evaluation: 100%

Research question or hypothesis

4/21. Theoretical question: what is the main question or hypothesis of your research?

This research addresses the following broad research question: "How can a non-invasive computer-assisted knee arthroplasty training system be as precise as the marketed solutions without increasing the learning curve?"

Self-evaluation: 100%

State of the science

5/21. Theoretical question: what is the current answer to your research question or hypothesis?

Marketed solutions for computer-assisted knee arthroplasty systems currently involve marker-based position tracking systems [1-3]. Since these systems are invasive to human skin, non-invasive methods for registration and spatial position tracking are being reported in the available literature.

The ultrasonography alternative for registration is based on a tracked ultrasound probe that is utilised as a non-invasive marker, acquiring the points and landmarks on the surface of subcutaneous bony structures [1, 4].

One of the most common and simplest tracked mode ultrasound probes is the A-mode, which scans a line through the body, measuring the depth along the acoustic axis of the probe [5, 6]. So, when this type of probe is placed on the patient's skin, it is capable of measuring the distance from the outside skin to the tissue border, resulting in input point coordinates for the registration algorithm. Despite being simple and non-invasive, this method has been proven to have limitations [1, 7], since its accuracy depends on the user's experience in placing the probe perpendicularly to the surfaces of the target bone structure. Some methods using autonomous systems for perpendicular placement of the probe have started being used in recent years to overcome this particular issue [8-10].

The B-mode is another commonly used tracked mode ultrasound probe, where a linear array of transducers simultaneously scans a plane through the body, scanning a fan-shaped area. That being the case, it not only detects surfaces from the perpendicular direction but also from the oblique perspective [5, 6].

In recent years, markerless tracking has been introduced thanks to the rapid development of depth sensors. Depth cameras automatically detect the target structure, and the pixels associated with the target are automatically segmented, usually through trained artificial neural networks, so that the camera is able to track intraoperatively the therapeutic object without the need for external markers, and is robust to occlusion [11-13].

[1] Guoyan Zheng and Lutz P. Nolte. Computer-assisted orthopedic surgery: Current state and future perspective. *Frontiers in Surgery*, 2:66, 2015.

[2] David Hernandez, Roja Garimella, Adam E M Eltorai, and Alan H Daniels. Computer-assisted orthopaedic surgery. *Orthopaedic Surgery*, 9(2):152-158, 2017.

[3] Liang Qiu, Changsheng Li, and Hongliang Ren. Real-time surgical instrument tracking in robot-assisted surgery using multi-domain convolutional neural network. *Healthcare Technology Letters*, 6(6):159-164, December 2019.

[4] Wolfgang Wein, Athanasios Karamalis, Adrian Baumgartner, and Nassir Navab. Automatic bone detection and soft tissue aware ultrasound-CT registration for computer-aided orthopedic surgery. *International Journal of Computer Assisted Radiology and Surgery*, 10(6):971-979, June 2015.

[5] Aladin Carovac, Fahrudin Smajlovic, and Dzelaludin Junuzovic. Application of Ultrasound in Medicine. *Acta Informatica Medica*,

19(3):168?171, September 2011.

[6] Carmel M. Moran and Adrian J. W. Thomson. Preclinical Ultrasound Imaging?A Review of Techniques and Imaging Applications. *Frontiers in Physics*, 8, 2020.

[7] M. Oszwald, M. Citak, D. Kendoff, J. Kowal, C. Amstutz, T. Kirchoff, L. P. Nolte, C. Krettek, and T. Hüfner. Accuracy of navigated surgery of the pelvis after surface matching with an a-mode ultrasound probe. *Journal of Orthopaedic Research: Official Publication of the Orthopaedic Research Society*, 26(6):860?864, June 2008.

[8] Felix von Haxthausen, Sven Böttger, Daniel Wulff, Jannis Hagenah, Verónica García-Vázquez, and Svenja Ipsen. Medical Robotics for Ultrasound Imaging: Current Systems and Future Trends. *Current Robotics Reports*, 2(1):55?71, March 2021.

[9] Lailu Li, Lei Zhao, Rayan Hassan, and Hongliang Ren. Review on Wearable System for Positioning Ultrasound Scanner. *Machines*, 11(3):325, March 2023. Number: 3 Publisher: Multidisciplinary Digital Publishing Institute.

[10] Kuan-Ju Wang, Chieh-Hsiao Chen, Jia-Jin (Jason) Chen, Wei-Siang Ciou, Cheng-Bin Xu, and Yi-Chun Du. An Improved Sensing Method of a Robotic Ultrasound System for Real-Time Force and Angle Calibration. *Sensors*, 21(9):2927, January 2021. Number: 9 Publisher: Multidisciplinary Digital Publishing Institute.

[11] Xue Hu, Anh Nguyen, and Ferdinando Rodriguez Y Baena. Occlusion-Robust Visual Markerless Bone Tracking for Computer-Assisted Orthopedic Surgery. *IEEE Transactions on Instrumentation and Measurement*, 71:1?11, 2022.

[12] Xue Hu and Ferdinando Rodriguez y. Baena. Automatic Bone Surface Restoration for Markerless Computer-Assisted Orthopaedic Surgery. *Chinese Journal of Mechanical Engineering*, 35(1):18, March 2022.

[13] Salaheddine Sta, Jérôme Ogor, Hoel Letissier, Eric Stindel, Chafiaa Hamitouche, and Guillaume Dardenne. Towards markerless computer assisted surgery: Application to total knee arthroplasty. *The international journal of medical robotics + computer assisted surgery: MRCAS*, 17(5):e2296, October 2021.

Self-evaluation: 50%

Philosophical stance

6/21. Methodological question: what is the philosophical stance of your research?

The philosophical stance of this research is quantitative objectivism, as it deals with measuring the precision and the time for the learning curve of the developed non-invasive computer-assisted knee arthroplasty training system in comparison to other available systems. So, there will be measurement of an objective reality.

Self-evaluation: 100%

Research strategy

7/21. Methodological question: what is the qualitative, quantitative, or mixed-method of your research?

My research strategy can be considered quantitative, as it focuses on developing a training system for knee arthroplasty, based on the processing of imaging data, paired-point matching complemented with surface matching for registration and exploration of depth sensors for spatial position tracking.

The system will be assessed first through laboratory experiments and objective indicators, such as precision of image feature location and dynamic parameter estimation, and absolute and relative trajectory evaluation metrics. Moreover, real-life training sessions will be carried out where the time spent on each simulated surgery will be measured as well.

Self-evaluation: 100%

Collection techniques

8/21. Methodological question: what are the data collection techniques of your research?

Since this project is in collaboration with the Unidade Local de Saúde de Santo António, during laboratory experiments, computed tomography and ultrasonography data will be collected from knee phantoms with the help of imaging technologists. The objective indicators will then be retrieved from these experiments.

Regarding real-life training sessions, the previously used knee phantoms will be reutilised, with computed tomography data already collected. However, ultrasonography data will have to be collected by interns who are using the system, to obtain registration in real time. Since acquiring ultrasonography images during surgery is not a standard procedure, interns will be taught how to collect them. Not only will the previous objective indicators be retrieved from these sessions, but also the time spent on each simulated surgery.

Self-evaluation: 100%

Analysis techniques

9/21. Methodological question: what are the data analysis techniques of your research?

The data analysis techniques are of quantitative nature. Due to the research strategy producing numerical objective results, multivariate statistical analysis methods will be carried out with the IBM SPSS Statistics software.

Self-evaluation: 50%

Quality criteria

10/21. Methodological question: what are the tactics of your research to ensure scientific quality criteria?

To ensure the scientific quality criteria of my research, different types of validation tactics will be used:

- External validity based on statistical generalisation.
- Internal validity based on the use and evaluation of the system by orthopaedic interns.
- Statistical measurements for validity and reliability based on performing multiple experiments and analysing parameters of precision of image feature location and dynamic parameter estimation, and absolute and relative trajectory evaluation metrics.

Self-evaluation: 50%

Unit of analysis

11/21. Empirical question: what is the unit of analysis of your research?

The unit of analysis of this research is the knee, in particular the knee phantoms to be used in training sessions. The change in the size, shape, limit of movement and severity of pathology of this joint will vary the relationship between the computer-assisted knee arthroplasty system and the acquired multimodal images. The interns that will use the system are also units of analysis since they will be varying the relationship due to differences in handling the system.

Self-evaluation: 100%

Level of analysis

12/21. Empirical question: what is the level of analysis of your research?

This research will be focused on a micro level of analysis, due to the scale of the units of analysis being a small group of knee phantoms and interns in a very particular situation of knee arthroplasty simulation.

Self-evaluation: 50%

Nature of data

13/21. Empirical question: what is the nature of the data of your research?

The nature of the data is quantitative, as the research question pertains to a measurement of the precision and learning curve of the training system. This will be answered by the obtained numerical values that result from the conducted experiments - precision of image feature location and dynamic parameter estimation, absolute and relative trajectory evaluation metrics, and time spent on surgery simulation.

Self-evaluation: 100%

Origin of data

14/21. Empirical question: what is the origin of the data of your research?

The data of my research is primary data, as the knee phantoms will be created and printed throughout the research and the multimodal imaging data will be collected during experiments. The training system will be developed by this research so any data obtained from its evaluation will also be first-hand data.

Self-evaluation: 100%

Sample

15/21. Empirical question: what is the sample of your research?

For this research, there will be a descriptive sample, as its analysis will state facts and proven outcomes from the studied population. The study will involve 15 orthopaedic surgery interns, so at least 15 knee phantoms will be created to have each orthopaedic trainee working with a new case study. The interns will be from the Unidade Local de Saúde de Santo António and their data will be retrieved during the experimental phase of the research.

Self-evaluation: 50%

Pathos

16/21. Rhetorical question: what are the positive and negative emotions of your research?

Osteoarthritis is one of the most common knee pathologies, having affected around 87 million patients worldwide in 2020 [1]. This number is expected to increase since there has been a slow rise in the incidence of knee osteoarthritis due to the ageing of the population [2, 3]. The treatments for this degenerative joint disease could go as far as total knee arthroplasty. In fact, the number of total knee arthroplasties performed each year is expected to increase from 118,666 to 1,219,362 by 2035 in the UK [4]. Since up to 19% of patients are dissatisfied with their outcomes [5, 6], there is a demand for efficiency in this type of procedure, whilst maintaining accuracy and precision [5, 7]. Furthermore, surgical techniques have been improved and developed for optimal implant alignment, which is essential for implant longevity and reduced risk of revision [5, 8]. For that reason, computer-assisted orthopaedic surgery has been introduced, providing better surgical and clinical outcomes by reproducing a planned alignment in knee arthroplasty with a similar learning curve [5-11]. However, orthopaedic interns are taught complex surgical techniques identically to conventional teaching, with theoretical teaching, virtual simulators, and hands-on experience with patients [12]. Moreover, marker-based position tracking systems are the most common but have the main limitation of being an invasive method, where a marker incision will cause additional scarring and may increase the risk of infection, nerve injury, and bone fracture [13, 14]. For this reason, this work's main positive emotion is of public interest.

With a gap in the market and the literature, the development of a non-invasive training system with the same precision and learning curve as other systems could go as far as replacing the most common solutions in the operating room and changing the current literature trend. Hence, this work has commercial and scientific value.

Despite that, negative emotions include ethical concerns when experimenting with orthopaedic interns and the use of patients' personal data to create real-life-like knee phantoms.

Even though this research does not involve physical interventions on the participants, orthopaedic surgery interns will only participate after giving informed consent, containing a detailed description of the study in lay terms, as well as study duration, risks, confidentiality, and rights of the participant.

Since this project involves the collection and processing of personal health data, in particular of knee computed tomography imaging, the data will be collected, stored, and processed under guidelines defined by institutional management authorities and monitored by the internal ethical committee. All patients will confirm their consent by signing a free and fully informed consent form containing a detailed description in lay terms of the study and how data will be stored. They will be informed of their right to access their personal data, rectify incorrect data, request data erasure when no longer needed, request opposition or limitation to its processing, or request its portability.

[1] A. Cui, H. Li, D. Wang, J. Zhong, Y. Chen, and H. Lu. Global, regional prevalence, incidence and risk factors of knee osteoarthritis in population-based studies. *eClinicalMedicine*, vol. 29?30, Nov. 2020.

[2] I. J. Wallace et al. Knee osteoarthritis has doubled in prevalence since the mid-20th century. *PNAS*, vol. 114, no. 35, Aug. 2017.

[3] Y. Ren et al. Incidence and risk factors of symptomatic knee osteoarthritis among the Chinese population: analysis from a nationwide longitudinal study. *BMC Public Health*, vol. 20, no. 1, p. 1491, Oct. 2020.

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[7] D. G. Deckey et al. Robotic-Assisted Total Knee Arthroplasty Allows for Trainee Involvement and Teaching Without Lengthening Operative Time. *J Arthroplasty*, vol. 37, no. 6S, pp. S201?S206, Jun. 2022.

[8] G. W. Doan, R. P. Curtis, J. G. Wyss, E. W. Green, and C. W. Clary. Image-Free Robotic-Assisted Total Knee Arthroplasty Improves Implant Alignment Accuracy: A Cadaveric Study. *The Journal of Arthroplasty*, vol. 37, no. 4, pp. 795?801, Apr. 2022.

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[12] Neil Vaughan, Venketesh N. Dubey, Thomas W. Wainwright, and Robert G. Middleton. A review of virtual reality based training simulators for orthopaedic surgery. *Medical Engineering & Physics*, 38(2):59?71, 2016.

[13] Robert W. Wysocki, Mitchell B. Sheinkop, Walter W. Virkus, and Craig J. Della Valle. Femoral fracture through a previous pin site

after computer-assisted total knee arthroplasty. The Journal of Arthroplasty, 23(3):462-465, April 2008.

[14] M. Nogler, H. Maurer, C. Wimmer, C. Gegenhuber, C. Bach, and M. Krismer. Knee pain caused by a fiducial marker in the medial femoral condyle: a clinical and anatomic study of 20 cases. Acta Orthopaedica Scandinavica, 72(5):477-480, 2001.

Self-evaluation: 100%

Logos

17/21. Rhetorical question: what is the scientific logic of your research?

The scientific logic of my study is abductive since the main goal is to develop a new system and not describe or measure an already existing technology. By the end of this work, there will be a new and innovative technology to aid with the training of orthopaedic surgery interns for knee arthroplasty.

Self-evaluation: 100%

Ethos

18/21. Rhetorical question: what are the limitations of your research?

Possible hurdles are mainly related to imaging data availability. Although datasets for knee computed tomography images exist (e.g. [1]), paired knee computed tomography/ultrasonography data is limited. Since this project is in collaboration with the Unidade Local de Saúde de Santo António, computed tomography/ultrasonography data will be collected directly from the hospital archives.

Additionally, when applying ultrasonography as a registration method to a pre-operative virtual object, the resulting ultrasound images are usually noisy and need to be processed before registration [2]. So, a possible limitation of the research could be a lack of quality when acquiring ultrasound imaging, which could eventually lead to less precision when utilising this non-invasive method. For this reason, there needs to be an experimental stage with the parameters of ultrasound machines as well as the processing of the data.

[1] M. Zhang et al. Feasibility study of three-dimensional printing knee model using the ultra-low-dose CT scan for preoperative planning and simulated surgery. Insights into Imaging, vol. 13, no. 1, p. 151, Sep. 2022.

[2] Jens Kowal, Christoph Amstutz, Frank Langlotz, Haydar Talib, and Miguel Gonzalez Ballester. Automated bone contour detection in ultrasound B-mode images for minimally invasive registration in computer-assisted surgery-an in vitro evaluation. The international journal of medical robotics + computer assisted surgery: MRCAS, 3(4):341-348, December 2007.

Self-evaluation: 50%

Wisdom

19/21. Authorial question: what is your education and experience related to your research?

I received my B.S. and M.S. degrees in Bioengineering in the field of Biomedical Engineering from the Faculty of Engineering of the University of Porto in 2020 and 2022, respectively.

Throughout my academic path, I had the chance to explore different areas of Biomedical Engineering, outside the academic course that I have an interest in. During my third year of my Bachelor's, I worked at INESC TEC Porto with the Face Analytics Group, where I dealt with the eye and mouth detection of the human face via images and videos. I was also a part of the ERASMUS+ Internship programme during my Master's, where I went to the University of Twente in the Netherlands. During my internship at the Biomedical Systems and Signals Group, I was part of the research team on the influence of cueing on dual-task performance and cortical activity using a combined EEG/fNIRS cap.

However, it was during my Master's dissertation that I finally discovered what I enjoy most in the field of Biomedical Engineering: medical devices that assist physicians during their clinical practice through automation, instrumentation, and control. So, I did my dissertation in the Department of Mechanical Engineering at the Faculty of Engineering of the University of Porto, which involved the development of a radiolucent system for positioning automatically the lower limb during knee stress radiography. This system had promising results and has motivated Dr Adélio Vilaça, responsible for the project at the Unidade Local de Saúde de Santo António, to implement it in the hospital soon. In December 2022, we were given a grant until June 2023 provided by the BIP PROOF framework, and, in January 2023, we published the article titled "Knee Positioning Systems for X-ray Environment: A Literature Review" in the Physical and Engineering Sciences in Medicine journal. So, I have academic research experience related to medical imaging, computer vision, automation, instrumentation and control.

Self-evaluation: 100%

Trust

20/21. Authorial question: who are the partners of your research?

Institutional partners of this research include the Automation, Instrumentation and Control section at the Faculty of Engineering of the University of Porto, the BiRD Lab at the University of Minho, and the Unidade Local de Saúde de Santo António.

The main support is being provided by the supervisors of this project:

- Joaquim Mendes, main supervisor, is a Full Professor, head of the Automation, Instrumentation and Control group at the Faculty of Engineering of the University of Porto and responsible for the courses of Mechatronics, Instrumentation and Automation. He is also a researcher at INEGI - LAETA and a member of the LABIOMEPE UPorto Biomechanics Lab.
- Cristina Santos, co-supervisor, is an Assistant Professor at the Department of Industrial Electronics of the University of Minho, and a researcher at the Centre for Microelectromechanical Systems, where she is responsible for courses in Robotics, Computer Vision, Machine Learning and Control, and the Principal Investigator of the research team on Medical Robotics and Locomotion (BiRD Lab).
- Adélio Vilaça, co-supervisor, is an orthopaedic surgeon at the Orthopaedic Department of the Unidade Local de Saúde de Santo António, specialised in the knee joint. He is also an Invited Assistant Professor at the Abel Salazar Biomedical Sciences Institute of the University of Porto and a member of the LABIOMEPE UPorto Biomechanics Lab.

Self-evaluation: 100%

Time

21/21. Authorial question: what is your availability of time and resources for your research?

Currently, I have full availability to work on this PhD research, as I was granted a scholarship by the Foundation for Science and Technology for a period of 4 years. Even though it has been already one year, I believe I have the capacity to develop the planned project on schedule.

Regarding resources for this study, the Automation, Instrumentation and Control section at the Faculty of Engineering of the University of Porto is supplying licenses for most software, manufacturing services, and depth cameras; the BiRD Lab at the University of Minho is also providing depth sensors; the Unidade Local de Saúde de Santo António will guarantee human resources and data collection for the evaluation of the obtained system, and the deployment of the prototype with the collaboration of orthopaedic surgery interns. Additionally, the LABIOMEPE UPorto Biomechanics Lab is providing ultrasound machines. A short period of mobility of 4 months at the NEARLab at Politecnico di Milano is being done to explore other types of ultrasound machines and depth sensors.

Self-evaluation: 100%