

CRITICAL REVIEW

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PROJECT

Develop a Novel Da Vinci interface, for robot-assisted ultrasound guided surgery.

PAPERS SELECTION

1) **DaVinci Canvas: A Telerobotic Surgical System with Integrated, Robot-Assisted, Laparoscopic Ultrasound Capability**

Joshua Leven, Darius Burschka, Rajesh Kumar, Gary Zhang, Steve Blumenkranz, (Donald) Dai, Mike Awad, Gregory D. Hager, Mike Marohn, Mike Choti, Chris Hasser, and Russell H. Taylor.

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J. Duncan and G. Gerig (Eds.): MICCAI 2005, LNCS 3749, pp. 811 – 818, 2005. © Springer-Verlag Berlin Heidelberg 2005

2) **Robot-Assisted Laparoscopic Ultrasound**

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N. Navab and P. Jannin (Eds.): IPCAI 2010, LNCS 6135, pp. 67–80, 2010. © Springer-Verlag Berlin Heidelberg 2010

Reasons for selecting the papers

- 1) Develop an in depth understanding of the existing robot-assisted laparoscopic ultrasound system.
- 2) Understand how our project goals will add to the capabilities of the existing system.
- 3) The second paper follows the results and feedback of the first paper. I wanted to understand how robot-assisted laparoscopic ultrasound surgical technique conceptualized and evolved.

Paper-I : Da Vinci Canvas

Summary

Minimally invasive surgical techniques address the issue of high morbidity associated with the Open surgery. The general goal addressed in this paper is to enable the surgeons to perform minimally invasive liver interventions with the efficacy of open surgery. The broader aim is to use the robotic-laparoscopic systems in many surgical fields. It describes and evaluates a system to integrate robot-assisted laparoscopic ultrasound (RLUS) into the DaVinci surgical robot system. The results of the user suggest that the real-time US integration is a useful tool and further research and development would bring advantages to the image guided surgical systems.

Comments

a) Abstract

of the paper is deficient. It only summarizes the goal of the paper but does not summarize how the system was evaluated and the results obtained.

b) Introduction and background

Introduction clearly describes the importance and goals of the research. The background research done in the field of robot-assisted ultrasonography is well discussed. It is suitably pointed out that none of the research systems integrate US into an interventional procedure.

c) System Overview

Overall the technical approach gives sufficient detail to understand the system.

- 1) **LapUs Tool:** Different images along with brief descriptions help in visualizing the developed tool and the system.
- 2) System block diagram gives a clear view of how information flows. Although the block diagram gives good overall view, depicting a connection between the endoscope, ultrasound probe and the slave console would have made the diagram clearer.
- 3) It is easy to follow the technical approach given the explanation of the video tool tracking and the detailed description of the calibration and registration procedures.
- 4) **Ultrasound Image Display** It is not very clear how the *picture in picture* insert mode looks like, a sample image to depict this mode would have given a clearer understanding.

d) Evaluation of the system

The general approach of recruiting surgeons with different levels of experience and defining the tasks (lesion finding/targeting) can be understood. However it is not very clear on how the surgeon feedback was recorded and quantized for example the text has sentences like "Almost all surgeons **felt**" "Surgeons felt" but how this was recorded and inferred is not mentioned. It is not described how the performance of different surgeons was measured and compared. Also, a tabular summary of the results would have eased the understanding of results.

e) Conclusions and Future Work

The goals described in the Introduction are correlated with the results obtained. It is concluded that a volume display was found to be less helpful and distracting but there is no such discussion or result in *Evaluation of the system*. The future work is not well elaborated for example there is a discussion about the need of a mapping tool but it is not mentioned in the future work.

Conclusion

Overall the paper successfully presents the goals of the research and its relevance. The abstract fails to summarize the paper well. The technical approach and the apparatus is well explained, small additions to the block diagram and ultra-sound image display would have been helpful. The general approach of evaluation of the system is clear but details of the how the results were recorded, quantized and inferred is missing. It helps to conclude that real-time display of ultrasound is a useful tool and more research on it can help in expanding the use of minimally invasive surgical techniques for complex procedures.

PAPER-II: Robot-Assisted Laparoscopic Ultrasound

Summary

This paper describes the development and evaluation of a new ultrasound system with the *da Vinci*® Surgical System (Intuitive Surgical Inc., Sunnyvale CA) for laparoscopic visualization. The advanced system overcomes the limitations discovered in the first paper like the non-articulated ultrasound probe and incorporates the feedback given by the surgeon to have mapping tool. User evaluation techniques involve recruitment of surgeons and comparing their performance on predefined tasks performed using the advanced system. It is concluded that the new system is highly desirable, and systems like these will allow the use of minimally invasive for complex surgical procedures.

Comments

a) Abstract

It aptly summarizes the goals, evaluation and the key results.

b) Introduction

The elaborated introduction helps to understand the background and relevance of the project. It puts across the broader goal of enabling the surgeons to perform minimally invasive liver interventions with efficacy of an open surgery and explore its other advantages like lower morbidity.

The limitation of the work done in previous paper i.e the absence of an **articulated** wrist is discussed and it is clear that the new system developed with a view to overcome this limitation and provide advanced capabilities.

c) Materials and Methods

Systems overview provides sufficient detail to understand the system. The new articulated laparoscopic tool is well-described using images.

Image Visualization and Interface.

While the previous paper lacked details about the visualization and images, this paper clearly explains the three modes of images viewing and suitable descriptions. It also effectively explains the other graphical information displayed along with the image overlay and its importance.

Two additional tools a) the measurement tool and b) mapping tool have been described. Although the functionality of the tools is clear the technical approach used behind these tools is *missing*.

d) User studies, results and discussion

The evaluation of specific features of the system like the user interface and the probe using pre-defined tasks is clearly depicted. It is clear what methods were used to measure the results and record surgeon feedback. Quantitative analysis of the results and their representation using charts and table add weight to the discussion and inferences.

It is distinctly discussed that how the advanced system overcomes the limitations the previous system. Based on the results obtained, the usefulness of user interface features like the image viewer ,measurement and mapping tool is discussed. Also, comparison of the system with traditional instruments helps in understanding the advantages of the system.

e) Conclusion

The conclusion is al; it describes how the results obtained align with the initial goal of developing an articulated LUS tool and determining its effectiveness. It also describes the advantages that the system offers in terms of probe positioning, finding the tumors, and surgeon fatigue.

Conclusion

Overall the paper successfully describes the development of a high dexterity robotic laparoscopic ultrasound tool for the da Vinci, its evaluation and relevance of the results obtained. The abstract summarizes the paper well. The technical details of the system are explained in sufficient detail, how it overcomes the limitations of the previous system; except for some details about the measurement and mapping tool. Additionally, the user study approach is clear and well defined; the results are quantized and well represented using the tables and charts.

RELEVANCE

The study of these papers has helped me develop a complete understanding of the existing system and the relevance of our project goals. Additionally, now I have a clear understanding of how the user studies are performed and their importance in evaluating a system. I can better appreciate the possibilities of improving the quality of human life through integration of technology and surgery.