Endometriosis Annotation in Endoscopic Videos

Andreas Leibetseder, Bernd Münzer, Klaus Schoeffmann, Jörg Keckstein
Institute of Information Technology
Alpen-Adria University, 9020 Klagenfurt Austria
Email: {aleibets|bernd|ks}@itec.aau.at, joerg@keckstein.at

Abstract—**When regarding physicians' tremendously packed timetables, it comes as no surprise that they start managing even critical situations hastily in order to cope with the high demands laid out for them. Apart from treating patients' conditions they as well are required to perform time-consuming administrative tasks, including post-surgery video analyses. Concerning documentation of minimally invasive surgeries (MIS), specifically *endoscopy*, such processes usually involve repeatedly perusing through lengthy, in the worst case uncut recordings – a redundant task that nowadays can be optimized by using readily available technology: we present a tool for annotating endoscopic video frames targeting a specific use case – *endometriosis*, i.e. the dislocation of uterine-like tissue.**
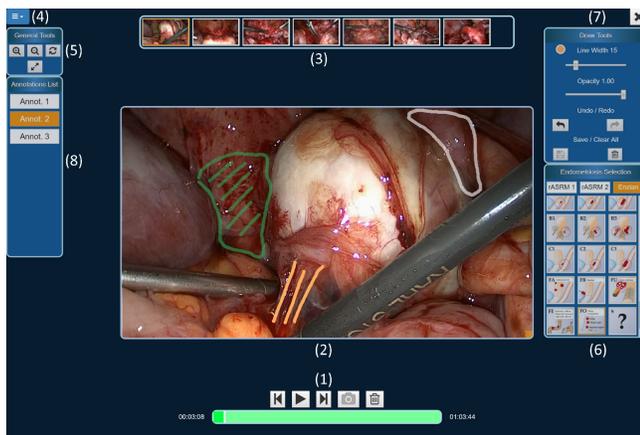
I. Introduction

Fig. 1: Endometriosis Annotation Tool, providing following features: frame selection/bookmarking, free-hand markings with assigned endometriosis classes (rASRM, Enzian) and textual notes.

Swift advancements in multimedia technologies enable effortless recording of surgical procedures – an opportunity that today already many medical institutions benefit from. Particularly *endoscopy* lends itself to such routines, since, being a type of minimally invasive surgery (MIS), it is performed by introducing a small camera, i.e. an endoscope, together with procedure specific instruments through natural or artificially created bodily orifices. Recordings from these custom-built devices, besides providing a legal safeguard for the medical staff, should facilitate post-surgery analyses, planning of therapeutic measures or future case revisitations. These are reasonable intentions that however, due to the lack of appropriate tools, in current practice require physicians to undertake time-consuming duties like manually scanning through hours-long video material or tediously sorting surgery snapshots. Considering automatic analysis of surgical media still is in its infancy [1], [2], [3], [4], [5], the need for manually searching relevant parts can not fully be rendered obsolete, yet, the task itself can be improved, while eliminating its unnecessary repetition for possible future case revisitations. Aiming at advancements in the latter area, we present a prototype for graphically and textually annotating endoscopic video frames (see Figure 1, Section II-B), specifically targeting the classification of *endometriosis* – a widespread gynecologic dysfunction, more thoroughly described in Section II-A.

Annotating surgical video frames or segments in general not only reduces the need for repeated video analysis, it also represents an opportunity for non-medical scientists to better understand physician's treatment procedures – knowledge that in turn can be used for further improving upon novel tools. Nevertheless, applications pursuing such goals comprise a relatively new scientific area [6], hence, research towards this direction currently rather turns out short: Hudelist et al. recently presented a tablet-based tool for patient debriefing as well as a solution for supporting surgical quality assessment [7], [8] and Guggenberger et al. aim at understanding endoscopic events [9].

In principal, our contribution offers functionalities similar to [7] and [9], yet, as mentioned, we target the utterly different use case of endometriosis classification, which can greatly improve post-surgical documentation of the anomaly's severity, facilitate planning further proceedings and even serve various educational purposes. Moreover, the tool differs in regard to semantics: rather than allowing the creation of arbitrary annotations, each of them must belong a specific category, i.e. endometriosis class (see Section II), which, albeit restrictive, results in a much more concise data collection for further scientific analyses. Hence, we explicitly want to emphasize the contribution's relevance for future research, as said data emerging from active usage will be invaluable for higher level goals like attempting automatic classification by using deep learning models, such as convolutional neural networks (CNNs) or finding salient similarities across patients' cases. The following section thoroughly introduces the tool's features and its use case.

II. Endometriosis Annotation Tool

The annotation tool is developed in close collaboration with leading endometriosis specialists [10], [11], [12], [13]. Regarding underlying technology, a web-based PHP/JavaScript design is chosen in order to ensure platform independent availability: any modern browser capable of handling HTML5 video can be utilized. The remainder of this section is broken up into two parts: Section II-A provides background information about the tool's target use case and Section II-B details its interface.

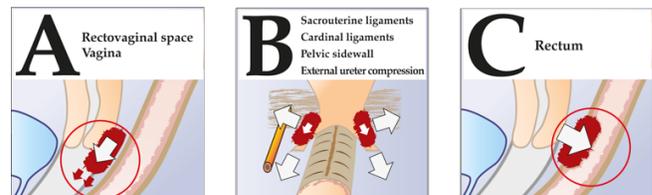### A. Use Case Background: Endometriosis

Fig. 2: Enzian Endometriosis Classification: example locations.

As one of the most common bodily disorders experienced by women of childbearing age, endometriosis is benign but can be

very painful and thus it should be removed in severe cases. Affected bodies abnormally produce cells with uterine properties outside of the uterus, which can occur on several locations, as has been identified by the medical community. Although some discrepancies exist among experts [14], most frequently the revised American Society for Reproductive Medicine (*rASRM*) score [15] and the European *Enzian* classification system [10] are used to determine the extent of endometriosis. As an example, Figure 2 shows three Enzian defined locations: vagina, ligaments and rectum, which further are classified by the magnitude of the affected tissue area. Since rASRM and Enzian complement each other, they both are integrated into our annotation tool, as part of the endometriosis selection functionality (6), shown in the right part of Figure 1.

B. Tool: Annotation Interface

The main interface of the annotation tool is demonstrated in Figure 1, portraying its most important aspect: selecting different endometriosis types and annotating corresponding areas in the currently selected frame. Video frame annotation in practice, however, involves several additional steps, which are detailed in the rest of this section.

Using the video controls (1), physicians can simply play or pause the patient's treatment video, select specific images by using frame-precise navigation and create as well as delete annotation snapshots. Whether exploring the video or editing an annotation, the main view (2) serves the purpose of displaying the current content, enabling dynamic frame resizing at any point in time, which includes scaling potentially existing sketches. Once a snapshot has been chosen for annotation via pressing the camera symbol, it is added to the list of annotateable frames (3), providing a quick point-of-interest overview as well as facilitating quick navigation between annotations. In order to accommodate individual editing preferences, general tools (4) and (5) enable basic functionalities like hiding toolboxes (5)-(8) or resetting the main view scale. The first step in annotating a selected frame is to choose an endometriosis class using the scrollable list (6) – quick links at the top of the list enable fast automatic scrolling to the individual categories belonging to the rASRM and Enzian systems. Graphical annotations are added to a frame via hand drawing, controllable by using the annotation specific tools (7), which offer a color preview, options for changing the line thickness as well as opacity, basic history functionality, save and clear buttons. All annotations for the current frame consist of an arbitrary amount of strokes and are listed in (8), providing the possibility of quickly modifying existing annotations or adding additional textual notes, as is depicted in Figure 3.

III. CONCLUSION

Planning therapeutic measures or revisiting patient cases can be cumbersome and time-consuming endeavors for physicians. In order to alleviate possibly entailed difficulties, while facilitating a more meaningful patient documentation, we present a tool enabling visual as well as textual annotation of endoscopic video frames, developed for assisting medical experts in analyzing endometriosis, a common female disorder, the severity of which can be determined using the rASRM score and Enzian classification system. Once annotated, selected frames can be revisited at any time providing a fast and easy overview of specific patients' conditions. To the best of our knowledge we are the first to propose a software tool with specific support for endometriosis annotation in video recordings from medical endoscopy.
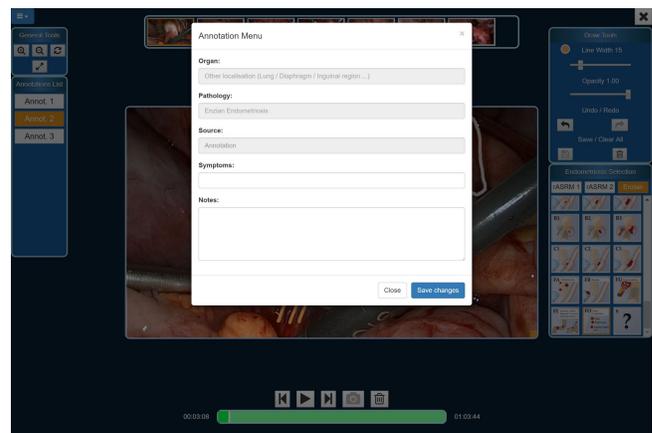

Fig. 3: Endometriosis Annotation Tool: adding textual notes.

REFERENCES

[1] B. Münzer, K. Schoeffmann, and L. Böszörmenyi, "Content-based processing and analysis of endoscopic images and videos: A survey," *Multimedia Tools and Applications*, pp. 1–40, 2017.

[2] M. J. Primus, K. Schoeffmann, and L. Böszörmenyi, "Temporal segmentation of laparoscopic videos into surgical phases," in *Content-Based Multimedia Indexing (CBMI), 2016 14th International Workshop on*. IEEE, 2016, pp. 1–6.

[3] ——, "Instrument classification in laparoscopic videos," in *Content-Based Multimedia Indexing (CBMI), 2015 13th International Workshop on*. IEEE, 2015, pp. 1–6.

[4] B. Münzer, K. Schoeffmann, and L. Böszörmenyi, "Relevance segmentation of laparoscopic videos," in *Multimedia (ISM), 2013 IEEE International Symposium on*. IEEE, 2013, pp. 84–91.

[5] M. J. Primus, K. Schoeffmann, and L. Böszörmenyi, "Segmentation of recorded endoscopic videos by detecting significant motion changes," in *Content-Based Multimedia Indexing (CBMI), 2013 11th International Workshop on*. IEEE, 2013, pp. 223–228.

[6] K. Schoeffmann, M. A. Hudelist, and J. Huber, "Video interaction tools: a survey of recent work," *ACM Computing Surveys (CSUR)*, vol. 48, no. 1, p. 14, 2015.

[7] M. A. Hudelist, S. Kletz, and K. Schoeffmann, "A tablet annotation tool for endoscopic videos," in *Proceedings of the 2016 ACM on Multimedia Conference*. ACM, 2016, pp. 725–727.

[8] M. A. Hudelist, B. Münzer, S. Kletz, K. Schoeffmann, and H. Husslein, "A tool to support surgical quality assessment," in *IEEE Proceedings of the Third International Conference on Multimedia Big Data (BigMM)*, 2017.

[9] M. Guggenberger, M. Riegler, M. Lux, and P. Halvorsen, "Event understanding in endoscopic surgery videos," in *Proceedings of the 1st ACM International Workshop on Human Centered Event Understanding from Multimedia*. ACM, 2014, pp. 17–22.

[10] J. Keckstein, "Endometriosis in the Intestinal Tract – Important Facts for Diagnosis and Therapy," *coloproctology*, vol. 39, no. 2, pp. 121–133, mar 2017. [Online]. Available: http://link.springer.com/10.1007/s00053-017-0144-5

[11] L. Mettler, I. Alkatout, J. Keckstein, and I. Meinhold-Herrlein, "Endometriosis – a concise practical guide to current diagnosis and treatment," pp. 99–120, 2017.

[12] N. P. Johnson, L. Hummelshoj, G. D. Adamson, J. Keckstein, H. S. Taylor, M. S. Abrao, D. Bush, L. Kiesel, R. Tamimi, K. L. Sharpe-Timms *et al.*, "World endometriosis society consensus on the classification of endometriosis," *Human Reproduction*, 2016.

[13] M. S. Abrão, F. Petraglia, T. Falcone, J. Keckstein, Y. Osuga, and C. Chapron, "Deep endometriosis infiltrating the recto-sigmoid: critical factors to consider before management," *Human reproduction update*, vol. 21, no. 3, pp. 329–339, 2015.

[14] D. Haas, O. Shebl, A. Shamiyeh, and P. Oppelt, "The rasrm score and the enzian classification for endometriosis: their strengths and weaknesses," *Acta obstetricia et gynecologica Scandinavica*, vol. 92, no. 1, pp. 3–7, 2013.

[15] M. Canis, J. Donnez, D. Guzick, J. Halme, J. Rock, R. Schenken, and M. Vernon, "Revised american society for reproductive medicine classification of endometriosis: 1996," *Fertility and Sterility*, vol. 67, no. 5, pp. 817–821, 1997.