2021 43rd Annual International Conference of the
IEEE Engineering in Medicine & Biology Society (EMBC)
Oct 31 - Nov 4, 2021. Virtual Conference

Efficacy of Computer-Aided Parathyroid Detection from Excised Thyroid Specimen using Both RGB/NIR images and YOLOv5

Jongchan Kim, Jennifer Yoo, Jonathon O. Russell and Jaepyeong Cha, *Member, IEEE*

***Abstract*— Accidental removal of the parathyroid glands during thyroid surgery can occur, potentially leading to postoperative hypocalcemia. We tested a computer-aided detection (CADe) using the co-registered RGB/NIR camera and ex-vivo thyroid tissue specimen. The average precision was significantly higher in the paired RGB/NIR data (0.995) than NIR (0.339) and RGB (0.954) data alone. The proposed CADe may increase the parathyroid detection rates clinically.**

***Clinical Relevance*—Parathyroid glands control calcium levels in the body and are crucial to maintaining homeostasis. Accidental excision of the gland can bring about negative consequences, thus precise and fast detection of normal glands can improve the surgical outcome during thyroid surgery.**

I. Introduction

Parathyroid glands (PGs) are small endocrine glands in the neck that play a key role in maintaining normal extracellular calcium concentration. Serious complications can occur when one or more of the PG is unintentionally injured or removed during thyroidectomies. The PGs can be difficult to distinguish surgically due to their small size and the appearance that is often similar to lymph nodes, fat, and occasionally thyroid tissue [1].

Near-infrared autofluorescence detection from PG has gained much attention since its original discovery in 2011 [2]. Many studies have shown the effectiveness of the technology [3]. However, false-positives and false-negatives have been reported due to the low specificity [4]. In this study, we introduce a dual-RGB/NIR imaging based deep learning system (YOLOv5) for CADe of PG with high accuracy.

II. Methods

A FDA registered dual-RGB/NIR camera system (ITSEL1711, InTheSmart Co. Ltd., Seoul, South Korea) was used under approval by the JHU institutional review board (IRB00224302-CIR00059986). Three images of RGB (320×320×3), NIR (320×320×3), RGBR (320×320×4) from the same specimen were used to train the model. We collected 100 images, 70 of which were randomly sampled and used to train the model. The remaining images and labels were used to test the model performance.

J. Kim, J. Yoo, J. Cha are with the Sheikh Zayed Institute for Pediatric Surgical Innovation, Children's National Hospital, Washington DC, 20010 USA (corresponding author: +1-202-476-6426; fax: +1-202-476-1280; e-mail: jcha2@childrensnational.org).

J. O. Russell is with the Department of Otolaryngology – Head and Neck Surgery, Johns Hopkins School of Medicine, Baltimore, MD 21287 USA.

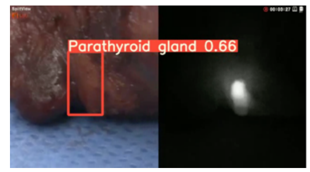

Figure 1. A picture of real-time parathyroid detection using YOLOv5.

YOLO, well known for real-time object detection, was used as a baseline model that can aid surgeons in localizing PGs intraoperatively. The models were finely tuned with training dataset during 30 epochs. The codes, written in Pytorch, ran on the Tesla P100-PCIE GPU.

III. Results

Three models were compared with metric in [Table1].

TABLE I. Comparison Results of Average Precision

Data Type	Metrics		
	mAP@.5	*Precision*	*Recall*
RGBR	**0.995**	1	1
NIR	0.339	0.361	0.7
RGB	0.954	0.962	0.867

IV. Discussion & Conclusion

Proposed CADe with RGBR shows higher accuracy than NIR images alone and holds a potential to improve intraoperative decision makings and surgical outcomes.

Acknowledgment

The authors thank the nursing staff for their help and Eugene Oh and Yoseph Kim for data collections.

References

[1] G. Thomas *et al.*, "Comparing intraoperative parathyroid identification based on surgeon experience versus near infrared autofluorescence detection - A surgeon-blinded multi-centric study," *Am J Surg,* May 13 2021, doi: 10.1016/j.amjsurg.2021.05.001.

[2] C. Paras, M. Keller, L. White, J. Phay, and A. Mahadevan-Jansen, "Near-infrared autofluorescence for the detection of parathyroid glands," *J Biomed Opt,* vol. 16, no. 6, p. 067012, Jun 2011, doi: 10.1117/1.3583571.

[3] C. C. Solorzano *et al.*, "Current state of intraoperative use of near infrared fluorescence for parathyroid identification and preservation," *Surgery,* vol. 169, no. 4, pp. 868-878, Apr 2021, doi: 10.1016/j.surg.2020.09.014.

[4] D. O. Hartl, Raïs; Guerlain, Joanne ; Breuskin, Ingrid ; Abbaci, Muriel ; Laplace-Builhé, Corinne, "Intraoperative Parathyroid Gland Identification Using Autofluorescence: Pearls and Pitfalls," *World Journal of Surgery and Surgical Research,* vol. 2, no. 1, 2019.