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

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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 (0.962) 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.

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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

<table>
<thead>
<tr>
<th>Data Type</th>
<th>mAP@.5</th>
<th>Precision</th>
<th>Recall</th>
</tr>
</thead>
<tbody>
<tr>
<td>RGB</td>
<td>0.995</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>NIR</td>
<td>0.339</td>
<td>0.361</td>
<td>0.7</td>
</tr>
<tr>
<td>RGBR</td>
<td>0.954</td>
<td>0.962</td>
<td>0.867</td>
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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.

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REFERENCES