SENSA: a System for Endoscopic Stenosis Assessment

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1. Introduction

Documenting the severity of a static or dynamic Central Airway Obstruction (CAO) is crucial to establish proper diagnosis and treatment, predict possible treatment effects and better follow-up the patients. The subjective visual evaluation of a stenosis during video-bronchoscopy still remains the most common way to assess a CAO in spite of a consensus among experts for a need to standardize all calculations [1].

The Computer Vision Center in cooperation with the «Hospital de Bellvitge», has developed a System for Endoscopic Stenosis Assessment (SENSA), which computes CAO directly by analyzing standard bronchoscopic data without the need of using other imaging tecnologies.

2. Methods

To fully support diagnosis during bronchoscopic explorations, SENSA functionalities include 3 main modules sketched in Fig.1: CAO computation, CAO visualization and CAO clinical validation.

In the computation module, CAO is obtained as the ratio between the areas delimited by a healthy reference ring and the obstructed lumen. Healthy and obstructed areas are computed taking into account geometric and appearance constrains [3]. This module supports connection to the PACs server and serial analysis of a set of DICOM cases internally identified with the tag SENSA. The visualization module shows SENSA contours on healthy and obstructed segments to allow a SENSA supported visual estimation of CAO. For the validation module we adopted a crowdsourcing approach in cooperation with the Pallas-Ludens company. A crowdsourcing pipeline separates extensive tasks into many micro-tasks adequate for online crowds [3]. We defined 2 micro-tasks: CAO visual assessment guided by SENSA contours and manual correction of SENSA contours to get the right CAO. The two CAO scores are compared to validate SENSA in terms of time spent to reach a diagnose and improvement in non-experts conclusions compared to experts.

3. Results

SENSA computational and visualization modules have been fully deployed at Hospital de Bellvitge for a pilot study. We analyzed 20 videos from patients with different degree of CAO severity. SENSA was compared to the validation to an average expert using a t-test for paired data. Clinically relevant area discrepancy was set to 15%, which is the minimum difference representing a change of 1 mm in the diameter. SENSA CAO presented a non-clinically relevant 9% of discrepancy and could run in the same bronchoscopy suit in less than 10 seconds.
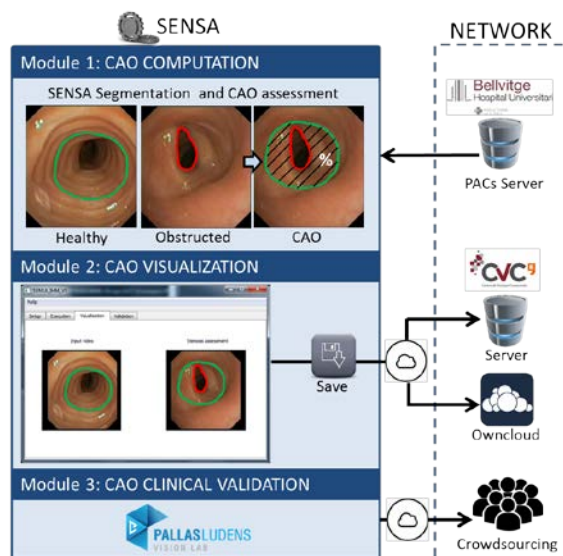

Fig.1: SENSA architecture

4. Discussion & Conclusion

Up to our knowledge, SENSA is the only available software able to analyze directly bronchoscopic images without using other imaging technologies or modifying current commercial devices. This pilot study indicates that SENSA is ready to be deployed in Bellvitge for its crowdtesting. The use of crowdsourcing ensures the large amount of data annotated by experts and non-experts together with clinical scores.

References

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