

THE DEVELOPMENT OF ACTIVE MAGNETIC FIELD BASED TRACKING SYSTEM FOR EYE ANESTHESIA TRAINING SYSTEM

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INTRODUCTION

Ophthalmic anesthesia is a very important preparation process for ophthalmic surgery. Since 1990 the gold standard technique of local anesthesia for eye surgery is a retrobulbar block [1], but there still are problems with training of new physicians. Retrobulbar block requires a lot of experience during injection anesthesia to approach the target area behind the eye ball globe. Mistakes from retrobulbar block are able to cause many complications such as retrobulbar hemorrhage, and brain stem depression. Normally, the training program of ophthalmic anesthesia is based on cadavers, but it is a blind practicing procedure. The correct anesthetic procedure is dependent on only the expert physician's opinion, but without any evidences to guarantee correct placement. Therefore, many simulators have been developed to facilitate the training procedure [2]. Nevertheless, all systems have limitations in providing position, if the needle tip is blinded by eye-muscle which overlaps the area with the retrobulbar target because of the principle of the tracking method. Our previous system was developed to detect the needle tip in the workspace of the retrobulbar block even it locates behind eye muscle by a magnetized based system [3] as in Figure 1a. However, in our previous work we have errors from localization because of the mismatch between the workspace of the sensors and that of the retrobulbar operated space.

This work presents a simulation of Hall Effect sensors to cover the retrobulbar block pathway in a training system by considering the mechanics of eye anatomies.

METHODS

A manikin 3D model was developed using human CT scans. The workspace between the Hall Effect sensor and magnetized needle was measured by using a robot arm, which is at a 13 mm perpendicular distance to the sensor. However, the average globe radius of the human is 10.5-13 mm [4], so the distance of the orbit to the target area almost reaches the maximum workspace of the sensor. A system is also required that has no electronic cables in the retrobulbar operation space. Additionally, each sensor requires 3 electronic cables. Therefore, a model was developed by placing a sensor socket only in the orbit structure. We rendered a simulation model of the sensor workspace to estimate numbers of sensors and socket positions in orbit. In order to detect the full pathway of the retrobulbar space a system was required with 24 sensors. All electronic cables were mounted to a printed circuit board (PCB) behind the orbit structure. An experiment was carried out on a prototype developed to verify the workspace of the sensor arrays. A magnetized needle was pointed to the edge of the retrobulbar operation space and target area, which consisted of touching along one side of the optic nerve, touching the inferior rectus (IR), touching beside the lateral rectus (LR), and the approached target area. During this experiment, the sensing data were recorded and analyzed with threshold classification on MATLAB.

RESULTS AND DISCUSSION

The activated sensing data were plotted with sensor position. The different positions in the workspace produced different sensors patterns as in Figure 1c. The system is able to roughly calculate the area of the needle in the system from the pattern of activated sensors with accuracy more than 90 % (n=50).

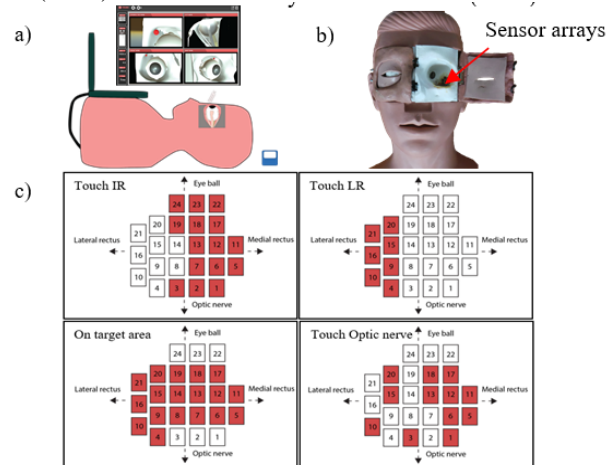


Figure 1: a) Conceptual designs of magnetic based retrobulbar block training system. b) The developed prototype of sensor position in manikin. c) Pattern of sensing data after passing threshold classification on MATLAB.

CONCLUSIONS

The developed magnetic based sensing system increased the sensitivity of sensor positions. The system is able to detect the needle in reference to the retrobulbar workspace as in the design step. However, the tracking system for needle position outside the retrobulbar workspace will be considered in the next iteration of the prototype.

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