

Development of Wearable system for Diagnosis and Treatment of Benign Paroxysmal Positional Vertigo

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Abstract— a system has been proposed for diagnosis and treatment of Benign Paroxysmal Positional Vertigo (BPPV). The system for BPPV diagnosis could measure and analyze electro-nystagmus signals. The system for BPPV treatment has showed to perform better than the existing handout system.

I. INTRODUCTION

Benign Paroxysmal Positional Vertigo (BPPV) is a common disease that accounts for 17% — 42% of patients with dizziness [1]. BPPV occurs when the otolith falls into the semicircular canal which causes nystagmus according to head position. To diagnose BPPV, the degree of nystagmus depending on the head position is tested, and for treatment, otolith repositioning exercise, like the Epley Maneuver [2], has been developed.

BPPV triggers severe dizziness, headache, and vomiting, and these symptoms make it difficult for a patient to see a doctor. Moreover, because the relapse rate of BPPV is high, it is important for the patient to manage the disease at home. So, the current study has proposed a wearable system which can diagnose and treat BPPV at home.

II. MATERIALS AND METHODS

The suggested system consists of two parts, the ‘nystagmus measurement system’ and the ‘Epley maneuver guiding system’.

– Nystagmus measurement system : a suitable analog front end was developed to measure nystagmus. An algorithm was developed to determine the direction of nystagmus from the acquired data. To verify the algorithm, sensitivity and specificity was calculated using nystagmus signals, artificially produced by 10 healthy subjects.

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– Epley Maneuver guiding system : To guide the Epley maneuver, a commercial Attitude and Heading Reference System (AHRS) sensor (EBIMU24GV2, E2box, Korea) was used to measure the subject’s head orientation in real time. The guidance system gave the direction of the Epley Maneuver and was developed using LABVIEW 2009 (National Instrument, USA). 9 additional healthy subjects were included to verify the effectiveness of system, and they were asked to perform the Epley Maneuver with and without the developed system. Each result was analyzed statistically using the Wilcoxon signed-rank test to determine whether the treatment with the system performed better than the treatment without the system.

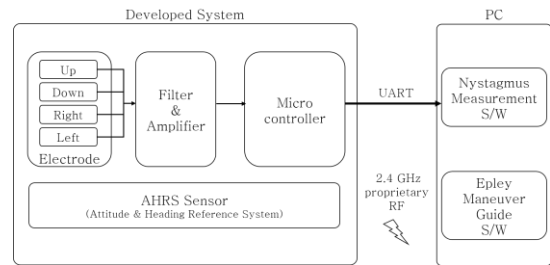


Figure 1 Hardware Architecture

	Step 1	Step 2	Step 3	Step 4
T(+)	40	28	44	42
T(-)	5	17	1	3
Valid(O/X)	O	X	O	O

Figure 2 Result of Wilcoxon Signed Rank Test

III. RESULT AND DISCUSSION

The algorithm showed 1.00 sensitivity and 0.85 specificity when verified with the nystagmus measurements. The signed rank test showed that the proposed guiding system can increase the accuracy of the Epley Maneuver.

The limitation of the current study is the absence of real patients. Hence the integrated test in which patients are supposed to utilize the proposed system for its own purpose was not performed. In the future, this system will be tested on patients and will be modified to be more convenient.

REFERENCES

- [1] N. Bhattacharyya, R. F. Baugh, L. Orvidas, et al, “Clinical practice guideline: Benign paroxysmal positional vertigo,” *Otolaryngol Head Neck Surg.*, vol. 139, pp. S47–S81, November 2008.
- [2] T. D. Fife, D. J. Iverson, T. Lempert, et al, “Practice Parameter: Therapies for benign paroxysmal positional vertigo (an evidence-based review) Report of the Quality Standards Subcommittee of the American Academy of Neurology,” *Neurology*, vol. 70, pp. 2067–74, May 2008