

A Preliminary Study on Estimation of Urination Desire Level from Vital Signs

Wen Dong, Harumi Inoue, Shaoying Huang, *Member, IEEE*, Wenwei Yu, *Member, IEEE*

Abstract— Urination prediction is critical for elderly care, and it has been shown that urinary volume influences significantly vital signs. However, no studies have reported the relationship between different urination desire levels and vital signs, nor the predictability of urination desire level by vital signs and HRV (Heart Rate Variability). This paper presents the preliminary results that fills up the gap above.

Clinical Relevance— The paper shows that the vital signs (ECGs, blood pressure, and heart rate) and HRV are highly correlated with urination desire levels. This shows the possibility to use vital signs to conduct urination prediction, which is contactless and suits the needs of dementia people.

I. INTRODUCTION

Urination prediction is critical for elderly care. Emura et. al. compared the autonomic nervous system during urinating on the bed and in the restroom [1]. Matsumoto et. al. showed the changes of blood pressure and heart rate before and after urination [2]. However, no studies have reported the relationship between different urination desire levels and vital signs, nor the predictability of urination desire level by vital signs and HRV (Heart Rate Variability).

In this study, we explored the possibility to predict the self-reported urination desire levels from vitals and HRV.

II. METHODS

In the experiment with 12 healthy subjects, electrocardiogram (ECG) and blood pressure were measured while the urination desire was reported and recorded. The urination desire level was set as Table I regarding the study by Kumori et al. [3]. From the ECG, RR interval was obtained by using time domain analysis. Blood pressure was recorded by using sphygmomanometer. Outlier detection method was used to exclude exceptional values. Support Vector Machine (SVM) was used to classify urination desire levels from heart rate, blood pressure and some indexes of HRV (HF (High Frequency), LF (Low Frequency), nHF(normalized HF)). Sensitivity, specificity, accuracy, F value were used to evaluate the classification results.

TABLE I. URINATION DESIRE LEVEL

Urination desire level	Definition
Level 1	No urination desire at all
Level 2	A little urination desire but do not mind
Level 3	Urinary motivation that can be tolerated
Level 4	Feeling urination desire and unable to concentrate
Level 5	Feeling strong urination desire and must go to the bathroom now

*This work was partially supported by JSPS (Japanese Society for Promotion of Science) Grant-in-Aid for Scientific Research, Embryo 19K22949.

Wen Dong is with the Department of Medical Engineering, Chiba University, Chiba, Japan (TEL: +81-43-290-3231; fax: +81-43-290-3231; e-mail: wdong@chiba-u.jp).

III. RESULTS

A significant difference was found in the comparison of urination desire Level 3 and Level 4 with nHF. Table II shows that there was a significant difference in the comparison of diastolic and systolic blood pressure in Level 4 and Level 5. There was no significant difference between Level 3 and Level 4, but systolic blood pressure was $p = 0.09$ and $p < 0.1$, which may play a significant role in estimating urination desire Level 3 and Level 4. There was no significant difference in heart rate.

Table III shows the estimation results of the urination desire levels. The “Time” in the feature is the elapsed time from the previous urination and the feature is only the elapsed time. When the outlier elimination is included in the pre-processing, the classification accuracy of the feature set elapsed time, blood pressure, and heart rate was 71.1%, which suggests the possibility of estimating the urination desire levels by vital signs and micturition cycle.

TABLE II. P-VALUE COMPARISON OF BLOOD PRESSURE AND HEARTRATE

	Tested urination desire level				
	Level3 After urination	Level4 Level5	Level3 Level4	Level4 Level5	Level5 After urination
Diastolic blood pressure	0.009		0.176	0.040	0.072
Systolic blood pressure	0.000		0.090	0.007	0.065
Heart rate	0.635		0.255	0.824	0.886

TABLE III. ACC OF EACH URINATION DESIRE LEVEL'S ESTIMATION

Feature	Elimination of outliers by the following variables			
	Without	With		
		nHF	Blood pressure	nHF Blood pressure
Time,nHF,Blood pressure,Heart rate	0.692	0.698	0.694	0.701
Time,nHF,Heart rate	0.689	0.686	—	—
Time,Blood pressure, Heart rate	0.692	—	0.711	—
Time	0.672	—	—	—

IV. DISCUSSION & CONCLUSION

The experiment results suggested that vital signs and HRV may contribute to the estimation of the urination desire levels. Data from more subjects should be collected.

In the future, unrestrained vital sign measurements for elderly people with dementia will be further explored.

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