

Foot Clearance Prediction using Wrist Position: A Pilot Study via Public Dataset

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Abstract— Elderly people experience fall accidents due to tripping by lack of foot clearance (FC). Thus, FC should be continually monitored in daily life for preventing fall accidents. Smartwatch is considered as suitable wearable device for FC measurement since users preferred to wear sensors on the wrist in daily life. However, smartwatch cannot directly measure FC because smartwatch is mounted on wrist. Therefore, FC prediction from wrist position is necessary. The objective of this study is to propose the prediction method for FC using wrist position. The proposed method predicts FC by machine learning-based regression model and 3D positions of wrist. The proposed method was tested by public gait dataset. The results showed that the proposed method could accurately predict FC. These results indicate that the proposed method can be used for fall prevention system using smartwatch.

Clinical Relevance—This study can contribute to realize fall prevention system using only smartwatch.

I. INTRODUCTION

Some elderly people experience fall accidents due to tripping by lack of foot clearance (FC) [1]. Thus, FC should be continually monitored in daily life for preventing fall accidents. Commonly, FC is measured by vision-based system such as camera [1]. However, the vision-based system is difficult to use in daily life because these systems have limitations for measurement area due to range of camera. Therefore, new measurement method for FC using wearable sensor is necessary. Smartwatch is considered as suitable wearable device since users preferred to wear sensors on the wrist rather in daily life [2]. However, smartwatch cannot directly measure FC because smartwatch is mounted on wrist. Therefore, FC prediction from wrist position is necessary. The objective of this study is to propose the prediction method for FC using wrist position.

II. METHODS

The proposed method predicts FC by machine learning-based regression model and 3D positions of wrist (Figure 1). The MSP algorithm was used for machine learning-based regression model. The proposed method was evaluated by the public gait dataset provided by Schreiber and Moissenet [3]. Gait data for straight walking with self-chosen speed performed by 10 participants were extracted (males, 6; females, 4; Age, 36.8 ± 13.2 years; Height, 1.73 ± 0.0938 m; weight, 67.3 ± 9.36 kg). Vertical position of foot (left head of

2nd metatarsus) and 3D position of wrist (left radial styloid process) were used for evaluation. These positions were measured with 100 Hz sampling rate by optical motion capture system [3]. The proposed method was tested via 10-folds cross validation. Correlation and root mean square error (RMSE) between actual and predicted FC were evaluated.

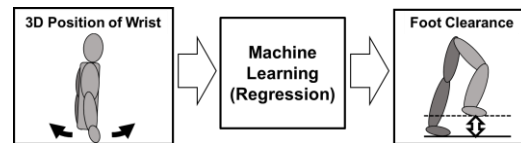


Figure 1. Prediction method for foot clearance.

III. RESULTS & DISCUSSION

The results (Figure 2) showed that the proposed method could accurately predict FC (correlation, 0.87; RMSE, 0.012 m). These results indicated that fall prevention system was able to be realized by using the proposed method. Future works should develop tracking method for wrist position.

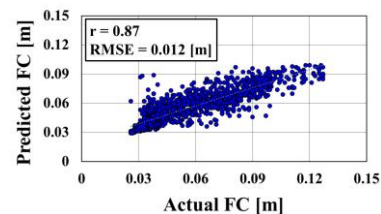


Figure 2. Scatter plot between actual and predicted foot clearance.

IV. CONCLUSION

This paper proposed the prediction method for FC using machine learning algorithm and wrist position. The proposed will be applied for fall prevention system using smartwatch.

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