論 文 の 内 容 の 要 旨

論文題目　Fundamental Studies toward Fall Risk Assessment of the Elderly in the Light of Relationship between Stumble and Depth Perception
(躓きと奥行知覚の関係に着目した高齢者の転倒リスク評価法に関する基礎的研究)

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The locomotive ability is an essential specificity for human beings to keep their physical/mental health and social connectivities. Falls and consequencing fractures can be a trigger of depriving this ability of the elderly and lead to be in the lower quality of life (QoL). In this dissertation, we aim at clarifying the factors of the falls and constructing the system that evaluates the elderly's frailty level to prevent falls. We focus on stumbles, which is one of fall pattern and is said to be seen popularly among relatively active and healthy community-dwelling elderly.
To achieve the purpose of this study, we set three research questions as follows:

(1) Can we clarify the dependency of the motion to the depth perception?
(2) Can we estimate the fall risk from the questionnaire response patterns?
(3) Can we place our measurement dataset that is in small-scale but has detailed data into the large-scale mother-set data and analyze them?

For the 1st research question, we approach in chapter 2 and 3. In chapter 2, we focused on the difference of the foot control for avoiding the stumbles to objects. The target motion for the analysis was an approaching and contact motion to the object that is placed in the going direction. We showed that the difference of the foot control for doing the target motion might be caused not only by aging but also by the difference of the localizing an object, in other words, the difference of the ability of the depth perception. In chapter 3, we proposed the depth perception estimation model using the difference of the strength of the manifestation of the visual illusion. In our proposed model, we set a hypothesis that the reason that a human perceives the virtual depth information during seeing the image that causes the visual illusion can be explained by the estimation of the position of the camera placed at a fixed point. We introduced the visual illusion k that indicates the scaler ratio of two objects illustrated in the image to express the level of manifestation of the visual illusion.

In this chapter, it was observed that the bigger the visual illusion ratio *k* value was identified for a participant, the closer he/she perceive an object. The relationship between the difference of the level of the manifestation of the visual illusion and the difference of the toe-off position just before contacting an object in the target motion in chapter 2 was also analyzed. The bigger *k* group, who showed the bigger visual illusion showed the larger distance between the object to contact and toe-off position compared with other elderly groups. Thus, the people who are considered to perceive objects closer than their ideal position in the virtual depth direction in the 2D image also perceive objects closer in the 3D space.

For the 2nd research question, we approach in chapter 4. We conducted interview research to 36 hospitalized patients who had experienced a fall-related hip fracture. The patients were also asked to answer the 25-question Geriatric Locomotive Function Scale (GLFS-25; The questionnaire for asking about their physical function). In this chapter, we proposed to use the log-likelihood for the questionnaire response pattern analysis and data imputation. The three categories of falls (Category (a): falls by unexpected external forces; Category (b): falls by losing balance or supporting forces; Category (c): others) are defined to categorize the patients' falls based on the interview. After the confirmation of the validity of our categorizing of falls using the clustering method and analysis of the frequency of the co-occurrence words, we trained the fall category classifier and the stumble risk estimator. The fall category classifier is modeled by the naive Bayes model, which utilizes the frequency of the words from the interview data in each fall category. Also, the log-likelihood of the GLFS-25 response patterns of the hospitalized patients and the participants in chapter 2 and 3 are used to train the fall category classifier and the stumble risk estimator. For the GLFS-25 response pattern classifier, we achieved 76.1% average classification rate (16 out of 21 cases) for category (a) and (b). Also, it is clarified that people who showed the abnormal (bigger/smaller) visual illusion ratio *k* in chapter 3 are at higher risk of falls compared with other elderly.

For the 3rd research question, we approach in chapter 5. We proposed the feature extraction method for the consecutive data such as motion capture data, EEG data, and for the discrete response pattern data of the questionnaires. The coordinate conversion method using matrix decomposition is also proposed. We used the large-scale data as the mother set and approximated it as the normal/exponential distribution so that we can calculate the probability of generation of the data. Using

this large-scale mother-set, we generalize the results of the small-scale dataset. The data is transformed into the coordinate system in which the physical characteristics and the cognitive characteristics are separately extracted.