



ABCDE



Scientific Report

First name / Family name

Ting Wang

Nationality

Chinese

Name of the *Host Organisation*

INRIA Sophia Antipolis

First Name / family name
of the *Scientific Coordinator*

Jean-Pierre Merlet

Period of the fellowship

01/10/2013 to 31/01/2015



I – SCIENTIFIC ACTIVITY DURING YOUR FELLOWSHIP

From 01/10/2013, I began my research about assistance robotics for elderly people at the Hephaistos project-team, INRIA Sophia Antipolis. Hephaistos has developed a smart walker ANG-2, which was instrumented with encoders, 3D accelerometer and GPS. This allows one to determine the walker trajectory and acceleration information during a walk. It was assumed that this information will allow to determine and analyze walking patterns. To confirm this assumption an experiment involving 54 subjects (with 30 elderly people) was performed at INRIA and at Nice hospital. My work is to perform a full analysis of these data in order to determine medically pertinent indicators for the walking and to compare them with indicators that are currently being used by the medical community.

Many studies have examined the effect of age on walking by comparing younger with older adults. These studies analyzed some usual gait parameters, such as step length, gait cycle, step width, cadence and gait speed. Especially gait speed is regarded as a very important indicator of health. Therefore, the first step of my work is to determine the steps of the subjects by using the sensor infos. As soon as the steps are determined, those usual gait parameters of the young and elderly subjects can be obtained. We compared the results of the two groups and we found that there is no significant difference between the two groups, which is consistent with some previous studies. Hence the usual gait parameters are not sufficient and sensitive enough to evaluate the health state of elderly people. Since the walking trajectory, which is missing in other gait analysis methods, can be calculated based on the encoder data. We compared the walking trajectory of the two groups and some new walking quality indices were found, such as lateral motions and maneuver area.

Moreover, we also compared the acceleration and velocity infos of the two groups. It is found that the elderly subjects exhibited larger mean forward acceleration and lower RMS (root mean square) of yaw angular velocity compared to the young subjects. Furthermore,



we found that after the walking test there are 4 elderly subjects who experienced a fall during the last two years. Hence the gait parameters of these 4 subjects are compared with that of the other elderly subjects. The results reveal that the usual gait indicators mentioned above are neither sufficient nor sensitive enough to evaluate the fall risk of the elderly. On the contrary, the indicators obtained, based on the info of inertial sensors, are more sensitive to the walking quality of the elderly subjects. Therefore, using the intelligent walker instrumented with inertial sensors to do gait analysis is an effective method for the elderly adults.

In summary, we proposed a new gait analysis method by using an instrumented Rollator walker. The work has been written as two papers. One is accepted by the journal *Robotics and Autonomous Systems* with minor revision, and another is accepted for oral presentation by the *Second Workshop on Assistive Computer Vision and Robotics (ACVR'14)*.

From October 2014, I worked on a project of technology transfer of INRIA with Bernard Senach, a CR at Hephaistos, INRIA Sophia Antipolis. We plan to build a start-up to develop the smart walker of Hephaistos to be a product. With the help of Patrice Prez, the head of technology transfer office, we have created the collaboration with Living Lab, CIR and CHU de Nice for the development of our start-up.

II – PUBLICATION(S) DURING YOUR FELLOWSHIP

[1] Ting Wang, Jean-Pierre Merlet. Walking analysis of young-elderly people by using an intelligent walker ANG. *Robotics and Autonomous Systems (Elsevier)*, accepted with minor revision, May. 2014.

[2] Ting Wang, Claire Dune, Jean-Pierre Merlet et al. A new application of smart walker for quantitative analysis of human walking. The Second Workshop on Assistive Computer Vision and



Robotics (ACVR'14), Zurich, Switzerland, September 2014, accepted for oral presentation.

III – ATTENDED SEMINARS, WORKHOPS, CONFERENCES

- Seminar of ERCIM, Athens, October, 2013.
- Seminar of the Project PAL (Personal Assisted Living), INRIA Sophia Antipolis, February, 2014.
- The Second Workshop on Assistive Computer Vision and Robotics (ACVR'14), Zurich, Switzerland, September 2014.

IV – RESEARCH EXCHANGE PROGRAMME (REP)

During the April and September in 2014, I have visited the Automatic Control and Computer Engineering Department at Technical University of Catalonia (UPC) during two weeks.

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