Position statement
Physical activity monitoring of elderly patients: 3 tricks to advance the field?

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1 Introduction

Nowadays, many research groups are actively working on assistive technologies for the elderly. Technologies for capturing and understanding physical activity are an important aspect of this research field. Most often, they employ accelerometers or cameras. Applications include both diagnosis as well as long term monitoring, in the natural home environment of the elderly, in the nursing home and in the hospital. The position statement argues in favor of three possibble aproaches for improving the current state of the art: (1) look over the border of the domain, (2) sort out terminology issues and (3) use reference data sets. It might seem that this is nothing more than simply stating the obvious. On the other hand, none of the approaches is the current practice in the field.

2 Look over the border

In order to understand activity patterns of the elderly from sensory data captured by for instance accelerometers or cameras, often elaborated signal processing and pattern matching techniques are required. Additionaly, often sophisticated classifiers are used using state of the art AI and machine learning approaches. It is well known that the same techniques are employed in many other neighbouring fields, as for instance gesture recognition and event recognition (e.g. automatic traffic analysis).

Much less known is the link with the robot imitation domain. Robot imitation is guided by the dream of once being able to teach a new task to a robot, simply by demonstrating it. This has important applications both for industrial robots, but also in robot companions or house hold robots. Imagine how easy it would be to teach your house hold robot to dress the table simply by showing it how to do so. These types of applications might seem far future. However, the robot imitation community is progressing in an important manner and is based on strong theoretical work. The imitation task of a robot can be summarized as (1) understand the behavior which is shown by the teacher and (2) replicate it.

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Obviously, the common denominator between both fields is the understanding of human behaviour from video and other signals. At least equally important is however that robot imitation is currently starting to experience a transition from purely lab experiments towards applications in the natural environment. It is precisely this transition which is currently also observed in the monitoring of physical activity.

3 Sort out terminology issues

So far, this text did not specifiy the meaning of the term "activity monitoring". This is a common and major problem in many research published. In some publications, the term "activity monitoring" is used for pose detection (sitting, standing, ...) or for motion detection (i.e. deciding wether the elderly is moving or not). Yet other papers are looking into the recognition of specific activities (ranging from basic things like distinghuising between sleeping, sitting and walking, upto the recognition of specific behaviours as eating, dressing or bathing, making the link with activities of daily living.) The research field would benefit from a clear and widely accepted taxonomy expressing the differences in understanding of the concept of "activity". This does not entail that a full taxonomy of all possible human behaviour has to be established. Rather some high level–but widespread–definitions are required.

One approach to sort out the terminology issues is exactly to investigate fruitful examples of the other domains' emergence of shared terminology. The robot imitation community has been influenced significantly by some seminal papers (e.g. [1]) which characterized the most important research questions by summarizing them as "what, when and who to imitate?", "How to evaluate the success of the imitative attempt?" and "How to solve the correspondence problem?". They literarly translate into "what, when and who to monitor?" and "How to evaluate the monitoring attempt?". The fifth question deals with problems related to a different embodiment, which is not an issue in behaviour understanding, but in replication. A common practice has emerged in the robot imitation domain to simply identify which of the five questions is being investigated in each publication.

The imitation community gradually divided the "what" issue into "imitation of states" (static body configuration), "imitation of actions" (changes herein) and "imitation of effects" (changes to the external world) [2]. It is currently debated how goal-driven imitation can be included. Actions, states and effects correspond to the three example interpretations of activity monitoring given above.

4 Use reference datasets

The validation of the methods developed for monitoring the physical activity of the elderly is very time consuming as it requires an important amount of monitoring episodes to be gathered. In many cases, these monitoring episodes

can not be gathered in the lab by the researcher himself. Rather, the system needs to be deployed in the environment for which it is being developed (e.g. a nursing home) and needs to be evaluated by real patients. The process of establishing contacts with the nursing facility, sorting out all required paper work and actually installing and collecting the data can take several months to several years. Also, the effort to annotate the data with any kind of ground truth information for comparison is extremely time consuming. This has led to the unnatural situation that the major part of the available resources is invested in the validation effort rather than in the research effort. This entails that the research groups with good datasets currently have a strategic advantage over the others.

This strategic advantage currently stimulates research facility to cleverly hide their datasets. On the long term, the establishment of reference datasets will however prove to be more fruitful; it will improve the balance between research and validation efforts and will allow for a scientifically funded comparison of different algorithms.

It is essential for the community not only to understand the benefits of reference datasets, but also it's pure necessity. The wide support of the community is required to raise funding for such a project which will pay off on the long term, although it has drawbacks on the short term.

References

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