PROJECT PROPOSAL

PREDICTING THE ACTIVITY OF THE PERSON BASED ON THE POSITION OF BOTH ANKLES, BELT AND CHEST

1. INTRODUCTION

Classification of the body posture based on the location of body sensors was important part of the Project CONFIDENCE - Ubiquitous Care System to Support Independent Living [1]. The main goal of this European project was to ensure the that the elderly people can live independently with the minimal support from the working age population [2]. The primary concern for the independent living of elderly people is to provide the immediate medical support in case of emergency like falling or fainting. In this context Kaluža et al. [3] developed a multi-agent system for the care of elderly people living at home on their own. The architecture is based on 7 groups of agents communicating among themselves for detection and raising alarms for emergency situation. Out of these 7 agents, Interpretation group of agents is responsible for figuring out if a situation is emergency or not. In this group machine learning agents detect emergency situations based on models induced with machine learning.

These machine learning models uses several algorithms for the detection of emergency situation primarily fall detection. Fall detection techniques can be developed using the data from accelerometers, gyroscopes and location sensors (body sensors or tags). Various papers have been published on fall detection techniques [2, 4, 5, 6, 7, 8].

2. PROPOSED METHODOLOGY

This project will be mainly focussing on the approach describe in Luštrek & Kaluža (2009) [2]. In the mentioned literature 12 body tags were attached to the shoulders, elbows, wrists, hips, knees and ankles. In the data set available with us [9] only 4 body tags were attached on chest, belt and ankles. The next section discussed in detail about the methodology for the formation attributes by Luštrek & Kaluža (2009) [2] and how can it be modified for our current dataset [9].

2.1. Attributes

Luštrek & Kaluža (2009) [2] designed three sets of attributes for describing the user's behaviour. Reference attributes, Body attributes and Angle attributes.

2.1.1. Reference Attributes

These attributes are based on the reference coordinate system i.e. the global coordinate system describing the location of the user but Luštrek & Kaluža (2009) [2] used only z coordinate since activity can take place at any location. Hence, following attributes have been used in Luštrek & Kaluža (2009) [2].

(i) z coordinate of tag at time t (z^t_{iR})

(ii) absolute velocity of the tag (v^t_{iR})

(iii) velocity of tag in z direction (v^t_{ziR})

(iv) absolute distance between the tags i and j (d^t_{ijR})

(v) distance between tag I and j in z direction (d^t_{zijR})

In the present project we are going to use the same attributes but instead of 12 tags it will be 4 tags

2.1.2. Body Attributes

The body attributes are expressed in coordinate system with reference to the user's body. Luštrek & Kaluža (2009) [2] uses the centre of left and right hip as the origin and the vector from this origin to the centre of left and right shoulder as z axis of the body. Since we have tags at belt and chest, we will use the coordinate of belt as origin (***o***) and vector from belt to chest as the body z axis.

For y axis Luštrek & Kaluža (2009) [2] uses the vector from body origin to the left hip, however we do not have the knowledge of the body direction, hence in this study we will use an arbitrary y axis which will be perpendicular to body z axis. So, the following equations will be referred for body coordinate system

$\boldsymbol{o} = \frac{\boldsymbol{b}}{|\boldsymbol{b}|}$ where ***b*** is vector of belt tag

$\boldsymbol{k} = \frac{\boldsymbol{c}-\boldsymbol{o}}{|\boldsymbol{c}-\boldsymbol{o}|}$ where ***c*** is vector of chest tag

j will be chosen such that ***j.k*** = 0

i = ***j*** x ***k***

Then the coordinates of tag will be transformed in body coordinate system by defining a proper transformation matrix. The following attributes will be used in body coordinate system

(i) coordinates of the tag I at time t (x^t_{iB}, y^t_{iB}, z^t_{iB})

(ii) absolute velocity of the tag (v^t_{iB})

(iii) angles of movement of the tag with respect to the z axis and xz plane (ϕ^t_{iB}, θ^t_{iB})

(iv) z coordinate of the origin of the body (z^t_{oR})

(v) direction of x axis of the body coordinate system with respect to z axis and xz plane (Φ^t_{oR}, Θ^t_{oR})

(vi) absolute velocity of the origin of the coordinate system (v^t_{oR}) – This attribute will be same as (ii) and hence can be omitted in this project

(vii) angles of movement of the origin of the body coordinate system with respect to z axis and xz plane (ϕ^t_{oR}, θ^t_{oR})

In Luštrek & Kaluža (2009) [2] another body coordinate system with reference z was used in which reference z axis was used as body z axis and x axis was determined such that it is perpendicular to body z axis and vector of body origin an left hip. Since in this case we are using arbitrary x or y axis it is as good as using reference coordinate and hence it is not considered in this study.

Moreover, the attributes with first snapshot coordinate system was also used in Luštrek & Kaluža (2009) [2] but later proved to be less significant and therefore is not included in this study also.

2.1.3. Angle Attributes

Luštrek & Kaluža (2009) [2] uses angle attributes as the angles between body parts that rotates like shoulder angles and hip angles w.r.t upper torso, angle between upper and lower torso and elbow and knee angles. However, in this project we will use only the angle between lower and upper torso (q^t_T) as angle attribute.

2.2. Filtering of Noisy Data

The noisy data was smoothened with Kalman filter [2] and the same will be used here.

2.3. Machine Learning Algorithms

The algorithms mentioned below was used by Luštrek & Kaluža (2009) [2] and the accuracies are calculated using 10-fold cross validation.

1. C4.5 decision trees
2. RIPPER decision rules
3. Naïve Bayes
4. 3-Nearest Neighbour
5. SVM
6. Random Forest
7. Bagging
8. Adaboost M1 boosting

The study at hand is a multiclass classification problem and the final algorithms to be used for this project will be decided at later stage. The main focus of this study will be predicting the best algorithm with the available data [9] and tuning the machine learning algorithm to improve the accuracy (if possible).

3. ACTIVITY CLASSIFICATION

The activity to be predicted is classified into six classes:

1. walking
2. falling
3. lying down
4. lying
5. sitting down
6. sitting
7. standing up from lying
8. on all fours
9. sitting on the ground
10. standing up from sitting
11. standing up from sitting on the ground

4. REPORTED ACCURACIES

The accuracies reported in Luštrek & Kaluža (2009) [2] is around 80% to 905 but they have used 12 tags and we are using only 4 tags. Mirčevska et. al. (2009) [4] used the tags at neck and ankles only and combined it with expert knowledge to classify the human posture. The reported the accuracy between 75% to 95%. This study also aims to achieve the accuracy in the same range.

5. REFERENCES

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