

A Novel two-component method for augmenting gait cycles in biometric personal identification systems

1. Objective

Presented project concerns the issue of behavioural biometrics in the field of gait-based person identification systems. The planned research indirectly concerns the construction of a biometric system using motion sensor such as accelerometer and gyroscope. The main scientific objective is to develop a new two-component method for artificial increasing training set - data augmentation. This type of solution is used to improve recognition results when the training sets are relatively small and there is no possibility to collect new data.

The proposed algorithm of multiplying the training set will include an initial synthetic data generation module. With the use of mathematical modelling, it is supposed to enable simulation of accelerometer and gyroscope readings, e.g. assuming that the sensor would be tilted by 10° in relation to the actually captured data. The second component will use elements of artificial intelligence in the form of so-called generative models. These are specialized algorithms capable of acquiring knowledge in the form of historical gait samples and generating new time series considering the features of the signals.

The final results of the algorithm development aim to improve the accuracy of gait based person identification. ally, it should be emphasized that biometric systems based on motion sensors can be successfully implemented, for example, in smartphone devices.

2. Research description

The following scientific tasks will be carried out during implementation of the research project:

- **Synthetic generation of IMU signals (10 months)**

Development of a new method to multiply a human gait cycle training set based on analytical generation of new motion signals. Analytical determination of artificial accelerometer and gyroscope measurement values from orientation signals. Modelling the effect of sensor mounting/positioning on measurement values

- **Generative model-based gait cycle generation (12 months)**

Development of a new method for augmentation of human gait cycles based on artificial intelligence elements. The usage of machine learning models capable of learning the individual subjects' gait features, and the subsequent generation of similar time series.

- **Development of a two-component data augmentation algorithm (14 months)**

To develop a hybrid method comprising a synthetic motion signal generation and a generative component.

3. Reasons for approaching research subjects

In recent years, many areas of science have noted a rapid increase in the use of deep neural networks, the application of which gives very good classification results. However, , such solutions requires large numbers of training sets, which in some cases are too expensive to acquire, or impossible to collect for various reasons. Data augmentation is one of the methods that can improve the generalization properties of networks in such situations. To our knowledge at present:

- Unlike other fields (e.g., image processing), there is no generally accepted standard for motion signal augmentation;
- The augmentation techniques used for other data types cannot be transferred to the field of motion signal processing. Which indicates the need to develop new dedicated methods.⁴

4. Expected results

- Development of a stand-alone module enabling augmentation of gait cycles based on synthetic motion signals generation;
- Development of a stand-alone module capable of data augmentation based on historical gait cycles. Development of artificial intelligence models dedicated to motion signal generation;
- Development of a comprehensive two component data augmentation algorithm. Enabling synthetic sample generation as well as data multiplication based on historical gait cycles;
- Improving the accuracy of gait-based person identification.