OT-36

Engine generator for **synthetic signatures**

ULPGC Universidad de Las Palmas de Gran Canaria | Fundación Parque Científico Tecnológico

OTRI Oficina de Transferencia de Resultados de Investigación

TYPE OF R+D RESULT

New technology
New product
New service
New knowledge or skill

COMMERCIAL MATURITY LEVEL

Model or conceptual idea
Proof of concept (design)
Validated in a controlled environment
Validated in a real environment
Successfully implanted

PROTECTION LEVEL

Non- applicable
Patent
Software
Know - how
Utility model

Description of the solution. Problem solved

For centuries, handwritten signature has been accepted around the world to recognise the authorship of the persons signing. One of its most used applications has been legal validation of formal documents such as contracts, testaments, submission of tax returns or financial transferences, among many others. This has turned the signature into a biometric feature in the context of system and applications

From a technology perspective, there are two types of signatures:

- **Off-line or static signatures:** They are the most commonly used and traditional. These are the signatures that are kept in a paper after an individual signs using a writing tool, usually a pen. Information from this type of signature is usually kept in a scanned image.
- **On-line or dynamic signatures:** Their main feature is that they contain the time and dynamic order in which the individual signed (pen pressure, writing speed, acceleration and strokes). This type of signatures is registered using electronic devices such as tablets, where a digital pencil is used to write, or tactile devices such as smartphones, where you can write directly using your finger.

Technological advances have allowed the rise of robots that are able to act with the same features as human intelligence, by learning mathematical patterns based on known data, on order to generalise and foresee new situations. For this purpose, machine learning is used; it is based in introducing knowledge by continuous examples. The richer the sample of data, the more effective will be to train the machines.

However, collecting real data (signatures, in this case) is an expensive process that also finds some legal barriers or obstacles such as applicable laws for personal data protection.

A way to solve this problem is producing synthetic data, which are artificial data very similar to real signatures that are generated by computers. These data are anonymous and are created from a series of mathematical parameters that allow them to resemble to real data.

Generative models are able to learn from real data and create very similar data. Two possibilities can be distinguished:

- **Generation of duplicated samples:** To duplicate a signature means to artificially generate new signatures from one (or several) real genuine signatures. Among its advantages we find the following: training of automated verification systems; increase of the number of signatures in a database; or improvement of the initial performance of a verifier.
- **Complete generation of synthetic signatures:** During generation of a completely synthetic signature, the algorithms start working without knowing any real signature. In this modality, the algorithms define a new fictitious identity, design the signature and generate as many repetitions of such signature as requested. These generators create both static and dynamic signatures.

The proposed solution is an engine integrated by algorithms able to generate synthetic signatures, both duplicated (from a database made up of signatures of people who gave up them for the purpose of teaching and researching) and other ones generated completely synthetically, this is, without any real signature (this way any restriction related to the laws for personal data protection is deleted).

In fact, this engine is able of generate ad-hoc database for developing and training systems for commercial purposes. In this context, synthetic signatures have a wider range of uses, such as minimising the automated learning time or the cost and risk of the operations.

Fields of commercial application

Handwritten signature changes every time the individual signs. This is not only conditioned by the writing learning process of an individual, but also depends on the environmental circumstances, signatory's personality, education, cultural environment, as well as cognitive and motor skills.

In fact, the signature (as a behavioural biometric feature) is sensitive to long term variations that can be related to ageing or neuromotor degeneration, among others.

All these elements open a wide range of possibilities, that open doors to a large number of areas of commercial application. Among many others, the generation of synthetic signatures would contribute to multiple disciplines sensitive to handwritten signatures, such as the following:

- **Artificial intelligence:** As previously mentioned, computer scientists use database of synthetic signatures (especially useful when real data are very costly to obtain or hard to access) in order to optimise the training processes of artificial intelligence systems.
- **Forensic analysis:** Forensic documents examiners could use the duplicated generation of signatures as additional support for decision making. Evaluation of the handwritten signature's authenticity would allow to detect falsifications, frauds especially relevant in legal processes (contracts, testaments, letters of attorneys, etc.) or in economic transactions (bank transfers, tax returns, etc.).
- **Learning support:** Models used for synthetic generation of signatures could be applied in education area (for example for learning stroke by stroke) or for designing specific tests for rehabilitation or exercise people who suffer from visual diseases or some musculoskeletal disorders.
- **Helping to identify pathologies:** Since writing is directly correlated with the cognitive map and other biomedical signals associated to each individual, alternative applications of the signature verification are related to the early identification and assessment of learning difficulties in children or cognitive or motor degeneration problems in adults, such as Parkinson or Alzheimer.

Market opportunity

Currently, biometric recognitions is continuously growing. In our daily life, this technology is becoming more popular in access control, people identification, financial transactions or health and welfare, among many others.

Although the number of biometric features is limited, this technology is able to provide a better safety and comfort than traditional methods as those based on physical supports (for example, passports or identification cards) and those based on knowledge (for example, PIN numbers or passwords) in order to assure that the right person is in the right place and moment.

Some examples of biometric features are fingerprints, face, iris or voice, being signature one of the less used due to the lack of success in practical applications to date.

One of the crucial challenges of a biometric system based on signatures is the intra-personal variability, that is the similarity between signatures done by the same person, which is unpredictable. This temporary drift, that can even be degraded by ageing or other type of pathologies, poses a great challenge in automated recognition of the signature.

Another significant challenge to biometric systems based on signatures is inter-personal variability, which is unpredictable. This refers to the similarity between signatures done by different authors. In a system based on handwritten signature, inter-personal variability is mainly attributed to ways for identity falsification of the people signing.

In order to solve this situation, this generative engine is based in a combination of algorithms that are able to generate both completely synthetic signatures (interpersonal modelling) and duplicated signatures (intra personal modelling). This wide number of signatures allows to have a very complete training set, since it includes variabilities extra intra and inter-personal. This way, error rate is reduced while executing the automated signatures verification system based on artificial intelligence.

This is where the main market opportunity lies. As technology is contributing to solve all the aforementioned challenges, signature would become a solid biometric feature, with multiple commercial applications (see previous section) in a global market, and thus, of a larger size.

Competitive advantage

Handwritten signature is a biometric feature widely accepted by society. For example, signature is preferred than a fingertip, iris or any other biometric feature. Its use in automated recognition of people is, thus, a competitive opportunity.

In addition to this, creation of data artificially is, in general, most cost-effective than collecting data from real world. Among all the possible advantages of synthesizing handwritten signatures we can find the following:

- Producing signatures does not require any effort once the algorithms have been developed.
- There is no size limitation in terms of signatures of individuals since samples are generated by computer.
- Legal matters are not involved, so sharing third parties' data is not compromising.
- Human errors are deleted when labelling and organising database.
- It enables to carry out statistic evaluations that are significantly relevant for the systems performance.
- Ageing in signature or different maturity levels of handwriting can be simulated.
- Signatures affected by neurodegenerative diseases or other cognitive disorders can be simulated.
- As a consequence of this, a major opportunity to analyse the deterioration and loss of functions in organs responsible of writing.

Additionally, unlike other existing generative models, the engine for synthetic signatures developed allows to divide the complex writing process in different stages based on cognitive and neuromotor aspects.

Since proposed models intend to replicate the biological processes in a way close to reality, they not only allow to better understand the human writing functioning, but also, they offer more flexibility to adapt them to the different morphologies, lexicon and other peculiarities of real writing.

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