MotionAnalysis.health

Technology Whitepaper

Discover what's under the hood

MotionAnalysis.health
a CURSOR INSIGHT spinoff

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About Us

MotionAnalysis.health is part of the Cursor Insight Group, an established, state-of-the-art company in the niche field of Human Movement Analysis. MA.h is focusing on healthcare applications. Cursor Insight Group is headquartered in the UK, its 27-strong team has been perfecting human motion analysis technology since 2000. Cursor Insight meets all relevant ISO, PSD2, SCA and GDPR requirements.

Our Technology

Types of Sensors

We have a strong passion for addressing various challenges in the digital health domain, and we aim to explore a wide range of sensor types and sets without imposing limitations. Our expertise spans the entirety of motion recording technology, encompassing both pre-built and personalized solutions. Among the numerous examples we've utilized are computer mice, tablet-and-pen configurations, heart rate sensors, eye trackers, wearable IMUs, and marker-based/markerless motion capture solutions for recording motion data.

We conduct thorough evaluations of each project's distinct requirements and choose the most appropriate sensor solution that balances ease of use with the utmost data quality.

Data Preprocessing

Regardless of the sensor type used to capture motion data, it's essential to recognize that any measurement is inherently inaccurate. The nature of the noise present in the data provided rarely aligns with the manufacturers' technical specification. This issue could stem from the device's inherent limitations or deliberate modifications in the firmware that either smooth or distort the actual motion.

For example, when recording data with a mouse, angle snapping or mouse acceleration is a standard noise added by the computer. Additionally, typical artistic users prefer seeing smooth lines on the tablet screen, thereby necessitating smoothing. Despite these challenges, most motion analysis experts rely on standard data cleaning and smoothing algorithms to manage inaccurate and noisy raw data, but we believe that these standard approaches fall short. Although standard filters might display a smoother line on the screen, they may further distort the acceleration data of the cursor.

As such, we employ a reverse engineering approach, thoroughly examining each device, understanding the background and figuring out how to carry out device-specific data preprocessing in order to recreate the original movement as accurately as possible.

Read our scientific paper, titled *"Anomalies in measuring speed and other dynamic properties with touchscreens and tablets"* published by the Institute of Electrical and Electronics Engineers to learn more about our data preprocessing.

Extracted Features

Our analytical stack employs a proprietary universal feature space to represent multidimensional time series datasets. This feature space was initially created using the technical meta-language of handwriting analysis, but has since been adapted over the past 15 years to suit other domains as well. It relies heavily on the dynamical properties of movements to provide a detailed representation of the motor program patterns that underlie the

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data. The extracted motion features have been effectively used in various fields, such as signature verification, continuous mouse movement authentication for cybersecurity purposes, personality trait prediction, and medical applications.

Leveraging this feature space provides us with a significant advantage over the prevalent use of standard physical features that lack deeper insight into the captured motion data.

Read our blog post, titled *"Discovering the periodic table of movement analysis"* published by the Institute of Electrical and Electronics Engineers to learn more about our feature extraction method.

Feature Screening

The selection of an optimal feature subset that effectively characterizes any movement data is pivotal for building efficient machine learning models. Given that our feature space consists of tens of thousands of features, it is critical to identify the most relevant ones for each specific task.

By working with a carefully selected, small subset of features, we can construct accurate prediction models even when only a limited amount of data is available. We have tried a wide range of well-known screening methods to accomplish this, but none of these methods yielded the desired results.

Consequently, we have developed our own feature screener method in collaboration with the **Wigner Research Centre** within the Hungarian Academy of Sciences, which we call the Random Forest-based Multi-Round Screening Method (RFMS). The Julia package that implements RFMS is publicly available on **GitHub**. To benchmark our algorithm, we used our own dataset generator called **BiometricBlender** which is also publicly available.

Read our scientific paper, titled *"BiometricBlender: Ultra-high dimensional, multi-class synthetic data generator to imitate biometric feature space"* published by Elsevier - SoftwareX to learn more about our feature screening method.

Prediction Models

Rather than relying on basic data analysis methods or feeding vast amounts of data blindly into deep learning models, our approach is to thoroughly comprehend the problem and the data at hand, and then select the appropriate solution. We are experts in various sophisticated decision making tools and always choose the most suitable one for a given project. Our proprietary AI toolchain enables us to extract task-specific, meaningful features that capture the essence of movement, resulting in more explainable models that in turn often lead to new discoveries.

Cross-domain Knowledge

Instead of focusing only on domain expert opinion on what modalities to extract and essentially automating an already established analysis method, we uncover new insights by building on our complex features that emulate human motor programs. We are always keen to gain a deeper understanding of human movement, and we have gathered experience in motion analysis across a wide range of domains, such as:

- **Signature verification,**
- **Cybersecurity,**
- **Bot detection,**
- **Continuous authentication,**
- **Gaming,**
- **Air traffic control,**
- **Athletics,**
- **Video-based walking recognition,**
- **Personality trait prediction,**
- **Neurological condition assessment,**
- **Emotional state and stress level evaluation,**
- **Biomedical signal analysis.**

This means that we are equipped with valuable and transferable skills that can be leveraged in any task involving complex time series analysis.

Scalable Solutions

In contrast to many research-focused teams, we have the experience of delivering commercial solutions that can scale to meet the highest business requirements. One such example is our biometric signature authentication solution, which has been relied upon by major banks for numerous years.

Our system is capable of analyzing millions of signatures per year and handling highly sensitive biometric data for millions of users, while adhering to strict security, GDPR and ISO standards. Our team is committed to comprehending each client's unique needs and providing solutions to challenges that may arise.

Clinical Partners

Collecting clinical motion data is a demanding task for any research institute, as it involves obtaining ethical approval, recruiting and motivating patients, and complying with regulations such as GDPR.

We are fortunate to have an ongoing partnership with the **Hungarian National Institute of Clinical Neurosciences**, where we provide the infrastructure for a well-equipped Motion Lab including the motion data analysis tasks. This lab includes a 12-camera optical motion capture system, a treadmill, a wearable eye tracker, and tablet + pen workstations that can assess both gross and fine motor skills during neurological assessments. The clinic by its nature has easy access to patients, and as a research institute, it has its own committee to decide on ethical approval, which results in a smooth workflow.

With these resources and support in place, we can efficiently collect and analyze clinical motion data to gain insights into various conditions.