

AN ARCHITECTURE OF COGNITIVE HEALTH EVALUATION AND MONITORING SYSTEM

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ABSTRACT

Together with physical health condition monitoring, professional athletes focus on how cognitive-mental abilities like reaction times, anticipation, risk taking, etc. influence their performance in competitions. Cognitive health differences are visible when comparing high-performance athletes to novices – certain mental abilities like decision making or anticipation are much more developed in elite athletes. Registration of physiological parameters together with decision making and cognitive tests is an important part in self-regulation programs of athletes. The main purpose of this work is to create a system prototype that uses virtual reality devices that support WebVR. The implementation of AI techniques gives feedback and identifies factors that are bottlenecking cognitive health performance. The improvements in smart coaching of professional athletes may improve their mental abilities. This work presents a recent Kaunas University of Technology research in the ITEA-2019-19008 Inno4Health project “Stimulate Continuous Monitoring in Personal and Physical health”.

1. PROJECT DESCRIPTION



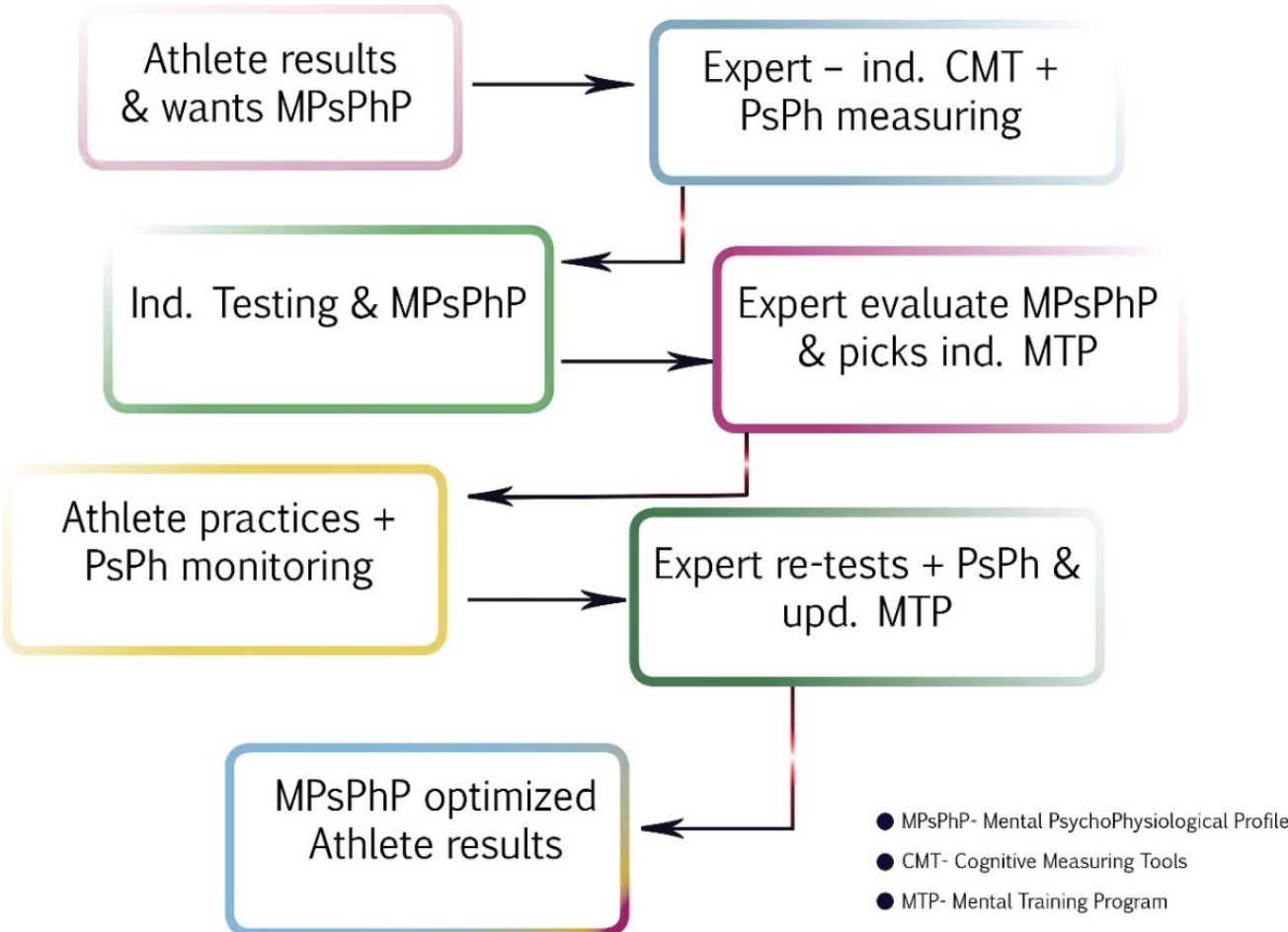
Partners in Lithuania:



The aim of this project is to stimulate innovation in continuous health and fitness monitoring to inform patients and their treating physician regarding the readiness associated with surgery and the ability to recover rapidly from invasive treatment. In sports, the same technology will be used to continuously assess fitness and health to provide information to athletes and their coaches and to help them optimize performance during competitions. In this project sensing technologies, emerging IoT communication capabilities and artificial intelligence for embedded data interpretation and user analytics will be combined.

There are three main goals in Lithuanian use case:

- Development of test platform in order to monitor the athlete's mental condition in testing day and in coaching process;
- Data collection and analysis – the athletes' data will be collected and then analysed in order to assess the patient's current state;
- Coaching and supervising algorithms will be developed to stimulate the athletes to improve its mental health state.

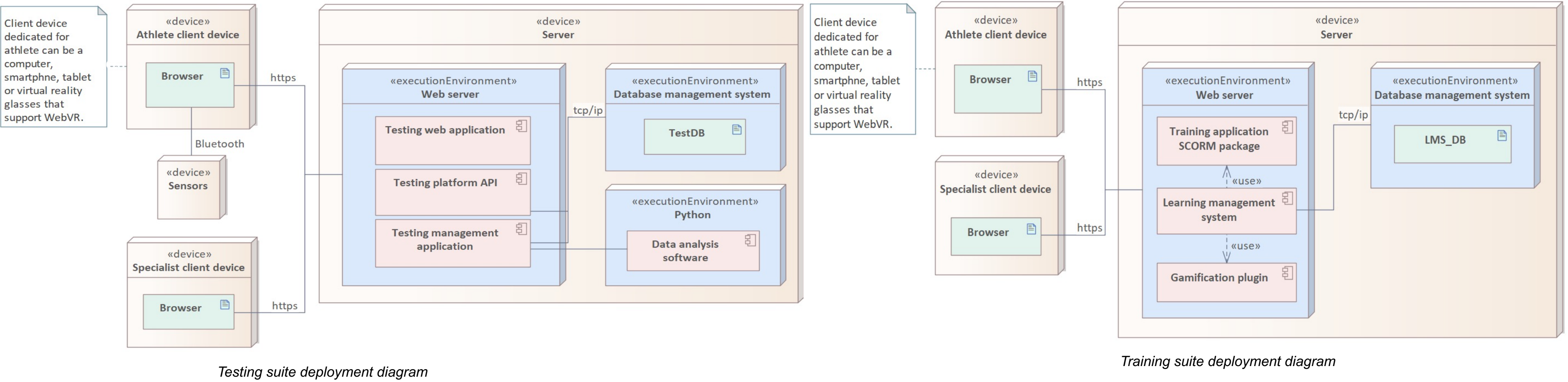


2. PLATFORM ARCHITECTURE

The focus in this project is on mental health evaluation using cognitive tests. The improvement of mental state may lead to better performance in sports. The athlete's client device has two main parts:

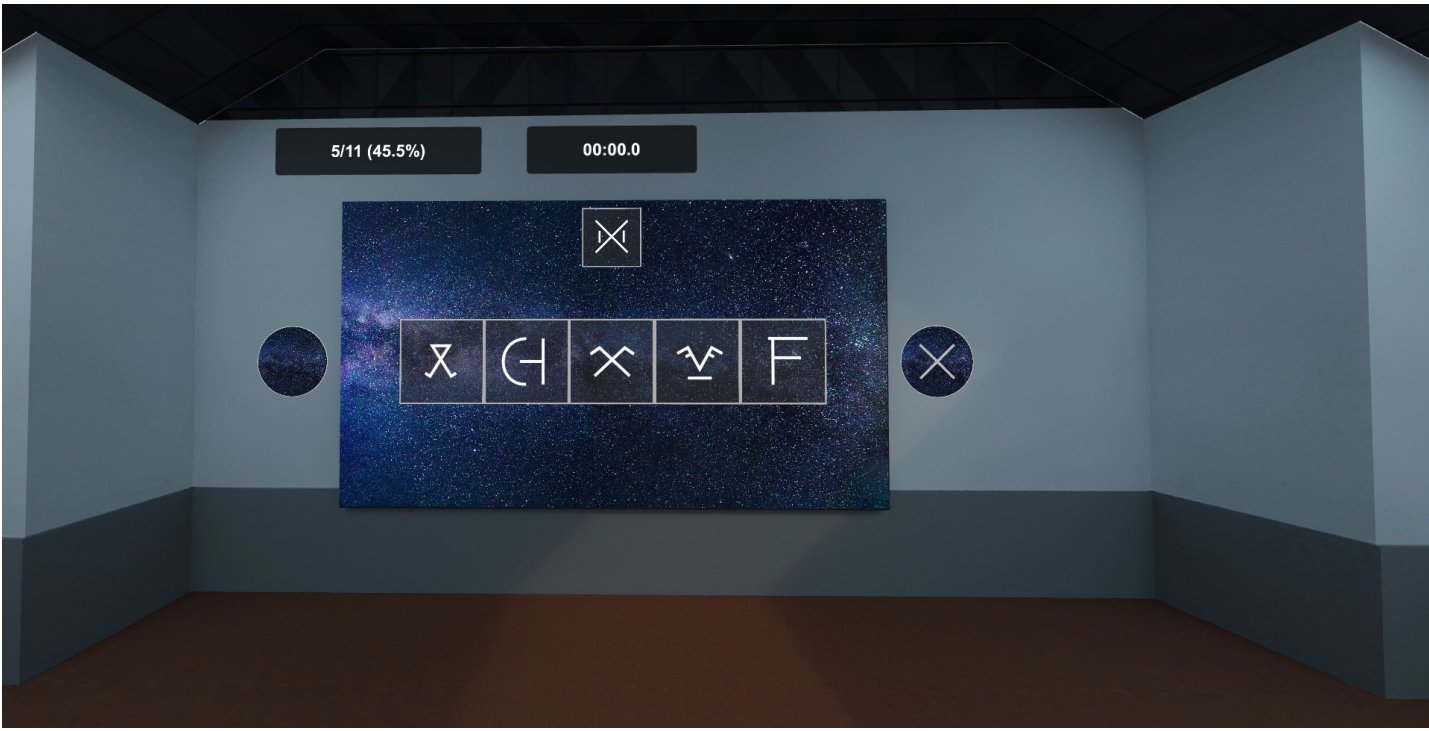
- The **athlete testing** suite includes an application that is used to perform cognitive tests and a platform which is used for data storage and analysis. Together with cognitive tests results the physiological data is recorded using several sensors.
- The **athlete training** suite is a lightweight version of the testing suite. It does not include a testing platform and sensors. Instead, it includes an application used to perform cognitive tests and a learning management system which is used to provide training materials, training plans, user management, training session and gamification functionalities.

The **specialist** can **manage** the athletes by registering them on the system and entering personal information such as age, sex and other. The specialist can review training session results as well as statistical data. The specialist can manage generated training plans and export them for usage in training suite.



Tests for the cognitive health evaluation:

There are various cognitive tests and scores for five cognitive health domains: **verbal memory, visual memory, visual motor, reaction time and impulse control** [1]. In literature different cognitive tests could be found such as Stroop Test, Trail-Making Test, Wechsler Digit-Span Test [2], Word List Recall, Story Recall, Digit Symbol Substitution, Digit Symbol Copy [3], etc. Cognitive tests together with physiological data are being used in military applications [4], for people with dementia [5] and many other fields. In this project two physiological parameters will be evaluated for athletes: ECG (HRV and LF/HF ratio) and breathing ratio/oxygen saturation. Besides the usual device athletes may use virtual reality devices that support WebVR as well. Cognitive Test platform will include measurements of attention, anticipation and decision making that combine all five cognitive health domains.



3. EXPECTED RESULTS

The data from wearable sensors (for ECG, HRV and breathing ratio recordings) will be used for athletes health condition testing. Together with various cognitive tests the mental health training exercises will be selected individually. AI technology will be used to develop algorithms for performance, fitness and health assessment that could be optimized locally at the user-level or scaled up to populations of athletes. The final application will include training, testing and specialists (for monitoring) suites.

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