

P3 Work Packages - Research & Novelties

WP1: Detection and interpretation of user behavior

A short text on the ICT/science/research

In this work package we aim to obtain and feedback information relevant to the optimizing of running performance from measurements obtained with the mobile phone and sensors communicating with the mobile phone. To this end, we determine physiological parameters, such as heart rate and respiration rate, and relate these to parameters reflecting running technique, such as step frequency at given speed.

Novelty

While this has been done previously in laboratory based research, the challenges are to develop algorithms that can determine the parameters of running technique from the sensor array available, robust against differences in sensor placement and attachment to the body and functioning quasi real-time. Furthermore, a challenge is to determine individual optima in running technique which may shift over time (due to training, injury, etc.). This requires an optimization process combining generic (group-based) data and accumulating individual data of the user. In addition to physiological parameters and physical parameters related to running, we will assess the physical state of the runner in a novel, automated and unobtrusive way by means of speech data. Both the verbal and non-verbal information content of speech will be used to estimate the level of exhaustion and exertion of the runner such that feedback can be given about the intensity of running.

What is the broader scope of research

Similar measurement approaches are currently used in other sports, such as rowing and speed skating, and in medical applications, such as assessment of movement disorders in neurological patients and of fall risk in elderly. The algorithms developed and tested in the current project, which will be innovative with respect to real-time use and robustness, can be of benefit in these fields as well. Similarly the envisioned dynamic optimization procedure, combining accumulating individual data with group-based reference data is likely to be useful in many sports and medical applications and possibly in a much wider field. The intention to develop measurement and analysis tools to extract information about objective and subjective aspects of fatigue and exertion constitutes a novel approach that is likely to generate both scientific and applied contributions.

WP2: Intervention strategies and user interaction

A short text on the ICT/science/research

This work package concerns the development of HOW the Sensei agent will motivate the user to exercise frequently and well. It involves three major components: 1) Understanding the health profile and exercise needs of the target user group; 2) Identify effective exercise strategies for users based on the physical, emotional and social context of the users as detected from the sensors (WP1, WP5); and 3) Design the interaction between agent and user to motivate the user to real-time adopt the strategies as identified in 2.

Novelty

The scientific novelty in this work package can be found in the design of the interaction between agent and user. Rather than a reactive machine (user does x and system responds y), or a surface level persuasive interface (adopt strategies such as politeness, social pressure and such), the interaction will focus on a longer-term therapy-like approach based on stages of behavior change and on acute knowledge of the user's emotional, physical and social state. We expect that this will inherently and deeply change the way the user feels about the obstacles he/she experiences to effective exercising. By systematically addressing of these obstacles as they occur, we expect to realize long-term adherence and satisfaction in exercise regimes.

What is the broader scope of research

The broader scope of the WP beyond health and fitness applications concerns the belief that surface level motivation to convince a person to behave in a certain way is not effective in the longer-term. When the technology is not used anymore, the user will stop displaying the desired behavior. Our intention instead is to use technology to change a user's attitude and feelings about the desired behavior in such a profound way, that real and inherent behavioral change is realized.

[WP3: Context framework on the smartphone with dynamic offloading to a Cloud](#)

A short text on the ICT/science/research

WP3 studies how to build a scalable and power efficient framework for distributed sensing using smartphones. The platform will combine sensor data from different phones (e.g., location, acceleration, sound level) and external sensors (e.g., heart beat monitors) and process all these distributed data partially on the phones and partially in an external cloud. A major challenge is how to do this in an efficient way, allowing (soft) real-time applications and how to make the whole system scalable to thousands of devices. In particular, optimizing the computations and communication between the many smartphones and external clouds is an unsolved problem.

Novelty

Existing frameworks typically process all the data on the smartphones (severely limiting the amount of data that can be handled) or they send all data to a cloud and process it there (making real-time interaction impossible).

What is the broader scope of research

The platform is generally applicable to applications that want to combine data from multiple phones. One generic type of applications is evaluating sensor-expressions that monitor the sensor data and take actions if certain conditions are fulfilled. Another example is clustering large numbers of phones into smaller groups based on their sensor data (e.g. location). There are numerous applications that can benefit from this, such as logistics, games, etc.

[WP4: Real-time data-intensive processing](#)

[A short text on the ICT/science/research](#)

In this work package, we aim to develop a cloud system for real-time parallel and distributed processing of sensor data at a large-scale for determining states of people. Over the past years, interest in processing so called “big-data” has increased, and has led to various map-reduce like solutions. These solutions take a batch-approach to processing large quantities of data, and allow the work to be distributed over multiple machines, making them scalable. A new class of big-data processing solutions is emerging that takes a more real-time approach, while preserving scalability. Examples of this kind of framework include STORM and Spark. Unfortunately, these frameworks are not applicable to our use case. These frameworks are targeted to processing problems where the objective is to calculate some single aggregated value over the entire body of data. However, in our use case, the goal is to calculate many aggregated values (one or more per user) on many small parts of the entire body of data.

[Novelty](#)

We take an agent-based approach to our real-time distributed and scalable data processing system, where data flows between agents in a complex topology to obtain the desired aggregated results. Agent based systems, where agents are made responsible for their own correct operation, are a good fit for systems that need to be distributable, as it mitigates the need for a central coordinating entity that becomes both a bottleneck for scalability as well as a single point of failure.

However, it is not yet clear how to facilitate agents in an environment where they can freely roam between pieces of hardware (servers) that are part of the system, while maintaining coordination between one another. For instance, how can agent A communicate with agent B if it is not aware of the current whereabouts of agent B, and there is no central authority where this information is available? With this agent-based approach firmly in mind we will work on a system where agents are physically confined to one machine initially, and introduce mechanisms for increasing autonomy of the agents. This way we can split up the research challenge into smaller pieces that will be individually solvable.

[What is the broader scope of research](#)

The data processing system we are developing can be used in any application domain where the objective is to have many individual and independent data processing pipelines. Where humans are concerned, one can think of health care applications, smart homes, etc.

In general however, we believe the approach we take is generic enough to be applicable to many application domains where current map-reduce inspired frameworks do not offer enough flexibility.

[WP5: Long Term Pattern Analytics](#)

[A short text on the ICT/science/research](#)

Watch the movie "Her", a smartphone AI who makes the life of Theodore Twombly worth living after his impending divorce from his childhood sweetheart. She tells him stories, she corrects his letters, she tells him to go on a blind date, and she becomes very dear to him. An actual AI coach with all these abilities is science fiction, but it sets the stage for what we might want to expect from a recommendation system that helps us in being active and in good health!

Novelty

There are two novel characteristics to our approach. First, we gather data from a smartphone application that allows people to send motivational, inspirational, and challenging messages to their friends and record the success of these personal recommendations. Our AI coach will use this data to learn about what kind of recommendations work best.

Second, we enrich this data with online data about weather, traffic, season, etc. to make the AI coach even smarter: it won't send you running in the rain if you never do that, or at least, it will have a good reason to do so! What we use to build these analysis and recommendation systems are so-called nonparametric Bayesian methods. These are methods that on one hand can reason about uncertainty and on the other hand are extremely scalable: there is no need for example to limit the AI coach to only five types of recommendations.

Existing applications only allow you to record how long you sport or allow you to compete with other people that sport. Competition is only a very small subset of the possible motivational tools of a smartphone application. There is nothing like the AI coach available at all.

What is the broader scope of research

The broader scope of research is twofold. First, the AI coach is able to motivate people. These motivations can be healthcare related, but do not need to be. The technology can be used to get people motivated to help each other, or get people motivated to organize a flash mob, or to get people motivated to start demonstrating against an evil government, or to get people motivated to spend less money on certain commercial products.

Second, the underlying techniques, briefly described, the nonparametric Bayesian methods, originally stem from big data analysis of tweets and alike. However, they currently start to get applied to other machine learning problems, from tracking people in a video, filtering the background within an image, extracting the person talking in a noisy meeting, to building up a 3D model from depth data (as from the Kinect). These techniques can be used in virtual reality games, in Google Glass applications, in robotics, and many other modern applications that generate a lot of "big data", in specific, "big sensor data".

[WP6: Security and privacy of data in the cloud](#)

A short text on the ICT/science/research

WP6 analysis and addresses the challenges in ensuring the availability, security and privacy of the data collected. Sensor driven coaching involves a huge volume of diverse data collection and the data needs to be accessed only by specified users on a need to know basis. The goal of this work package is to propose a novel security solution that assures privacy and also supports fine grained access control. In particular, we will propose technique for searching without affecting the privacy of the users and the challenge is how to do this in an efficient way.

Novelty

The existing encryption and access control schemes provide data security and privacy but they limit usability. If you want to perform search on encrypted data, either the data needs to be decrypted or the overhead is too high. Also the existing Role based access control systems are not dynamic i.e. doesn't perform runtime decisions and Attribute based access control systems (dynamic) has the drawback of inefficient auditing process (who is accessing what and when)

What is the broader scope of research

Many companies store highly sensitive information about customers or employees and use them for analysis. Strong security measures are required to protect that sensitive data, prevent unauthorized access, ensure the privacy of the users and also meet the legal obligations. Our solution is generally applicable to applications that need privacy protection and fine grained access control. One example is organizational database which has employee's personal and financial information. There are numerous domain that can benefit from this, such as banking, education, business, etc.

[WP7: Systems Integration and Application development for Golden demo](#)

This WP is for integrating all the research components and effectively showcasing the innovations coming out of COMMIT-P3 project.

[WP8: Valorization, demonstration, deployment, long-term user evaluation](#)

Objectives:

1. Deployment of intermediate prototypes built in WP7
2. Long-term user evaluation of application and post experiment surveillance