Social and sentiment sensing and assisting using on-body sensors

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Time and Work Plan

We divide the work into four main components: building sensing system, utilizing it to collect data, analyzing the data, building prediction models and feedback components. These components are connected and related to each other, and the flow from one to another is not linear, but circular.

We now sketch the components in details and then we discuss nature of circular flow. The expected time schedule is depicted in table **??**. A detailed description of the distribution of work packages to personnel is given in the following. The figures represent three person months (equal to one person quarter). The notation '40' represents an allocation of 40 percent of one person quarter.

A first workpackage (WP-1) is a review of recent advances in the topic in general, and for each component (sensing, analysis, modeling, prediction) in particular. Thus, the work of this workpackage is spread across the entire project. The estimated effort is 6 PM (during all project in both institutes).

The goal of the next workpackage (WP-2) is to build a sensing system and infrastructure for collecting data. We estimate the effort required for this part by 5 man-quarters (15 PM), divided into five stages, each will take about 1 man-quarter (3 PM). The task will be performed in both institutes.

In stage 1, we will develop a basic recognition system, that will have interfaces for various sensor types, such as medical, body, smartphone and environmental sensors. It will include a server backend where the data is collected and processed. During the development we will evaluate various aspects, such as, robustness, noise, and redundancy. In the second stage we will integrate medical sensing equipment, such as EMG and EOG. It will be performed in collaboration with the medical center at Georg-

August University Goettingen. We will stat preliminary analysis of this source. In the third stage we will integrate smartphone and body sensors. In particular, we will utilize INGA[1] sensor nodes to which we have access through a cooperation with TU Braunschweig, Germany. In addition we plan to integrate sensors from wristbands. We will evaluate the amount of sensor information such that we will be able to minimize usage of the phone's resource, and extend battery life. In the third stage we will integrate environmental sensors, namely USRP. Finally, in the fifth state we will develop an Android mobile sensing application that will incorporate smartphone sensors and enable the addition of further body sensors, for instance, via bluetooth. In addition to the collection of data, the application will enable feedback to the user based on the sensed patterns.

The goal of the third workpackage (WP-3) is to perform experiments, which again will be done in stages, during most of our project. The goal of the first stage is to collect data that will be analyzed. The analysis will be used to generate a representation (features) and a prediction model. Here, we plan to collect from user their sentimental-state, as well as the output of sensors. In the next state, which essentially lasts for six quarters we plan to collect data from individuals using their smartphones and apply our predictive models. Our goal is to test and improve our models. Int the third stage we will also experiment with a feedback component that would assist users to achieve certain goals, e.g. by messaging them textual reminders and alerts.

WP-4: Sentiment analysis

WP-4.1: Sentiment analysis from medical sensors

Estimated effort	3 PMs
Precondition	WP-3
Milestone	*Suitable features and a classifier for sentiment from at least two types of medical sensors*

In this workpackage we investigate the identification of sentiment from data of medical sensors. We will develop new learning methods for detecting sentiment from EMG and EOG data. These methods will take into consideration the special nature of these signals.

[1] https://www.ibr.cs.tu-bs.de/projects/inga/

WP-4.2: Sentiment analysis from body and smartphone sensors

Estimated effort 6 PMs
Precondition WP-3, WP-4.1
Milestone *Correlations between features from medical and smartphone sensors and a classifier for sentiment from these sensors*

We will in this workpackage develop suitable features for the prediction of sentiment from body and smartphone sensors. Our goal is to have a small number of predictive features. In particular, similarly to previous work regarding movement, gestures and pose as indicators of emotion, classifiers for the detection of such classes will be developed and linked to the classification of sentiment. In addition, building on the results from WP-4.1 we will further investigate correlations between sensor readings of medical and acceleration sensors in order to give an estimation to which extent medical sensors can be substituted by cheaper acceleration sensors for the application in large scale on-phone sensing applications.

WP-4.3: Sentiment classification from body and smartphone sensors

Estimated effort 6 PMs
Precondition WP-3, WP-4.1, WP-4.2
Milestone *Classifier for sentiment over extended period of time*

In this workpackage, we focus the analysis of sentiment over an extended period of time. In particular, we investigate the identification of typical sentiment patterns from the observed sensor data. From this, we focus on the prediction of sentiment based not only on current sensor input, but also on recent historical data. That is, modelling the state-of-mind of a person, and use it to improve prediction of future state-of-mind. In particular, similar to our previous work [**?**, **?**], we consider the use of alignment matching approaches to identify approximately similar sub-patterns in sentiment time series and to predict probable continuation of these patterns.

WP-4.4: Sentiment analysis from environmental sensors

Estimated effort 6 PMs
Precondition WP-3
Milestone *Features and a classifier for sentiment from received RF-signals*

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	
Recent advances													
WP-1	25	25	20	20	20	20	20	15	10	10	10	5	200
Sensing system													
WP-2.1	100												100
WP-2.2	50	50											100
WP-2.3	25	75											100
WP-2.4		50	50										100
WP-2.5				30	30	40							100
Experiments													
WP-3.1			130	70									200
WP-3.2							50	30	30	45	30	15	200
WP-3.3									60			40	100
Analysis													
WP-4.1				80	20								100
WP-4.2					130	70							200
WP-4.3						70	130						200
WP-4.4								100	55	45			200
WP-4.5										50	100	50	200
Prediction													
WP-5.1								55	45				100
WP-5.2										50	60	90	200
Sum	200	200	200	200	200	200	200	200	200	200	200	200	2400

Table 1: Occupation (1PM) subject to the quarterly period and project task.

We will in this workpackage develop features for the prediction of sentiment from received RF signals. Building on our and other previous work detecting movement and gestures from received RF-signals, we will detect gestures, movement and pose of individuals. Then, we will devise new methods to predict from the output of these prediction regarding physical state (movement, gestures and pose) mental state, such as emotion and sentiment.

WP-4.5: Sensor output analysis and fusion

Estimated effort 3 PMs

Precondition WP-2.1,WP-2.2,WP-2.3

Milestone *Analysis and fusion of output from all sensors.*

In this workpackage we will analyse the sensor data and evaluate their redundancy. This study will be used to develop methods to fuze data from all sensors into a single coherent and compact stream. We will develop methods to remove noise and outliers readings. These tools will be used to process sensor data before feeding it into sentiment prediction models.

WP-5: Prediction of sentiment based on past data and provide feedback for future

WP-5.1: Integrating past sentiment

Estimated effort	3 PMs
Precondition	WP-3, WP-4
Milestone	*A document describing the potential of sentiment analysis of long sensor traces*

We will analyse long sequences of sensor-input and sentimental-state. Our goal is to find long-correlations between the state of the sentiment across in various time scales (minutes, hours, days). Based on these results we will develop models to predict sentiment based on both current sensor data and previous (or historical) sentiment, either predicted (or also given via interface).

WP-5.2: Generating user feedback

Estimated effort	3 PMs
Precondition	WP-5-1
Milestone	*A document describing the potential of sentiment prediction from long sensor traces*

We will develop few feedback methods to users about current and future predicted sentiment. Our goal is to build an automatic system that will find an optimal feedback mechanism to achieve certain goals, defined by the user. We plan to build on recent advances [**?**] in multi-armed bandit algorithms based on context which are optimizing exploration of methods and exploiting them.