

Integrated Tool Chain for Recording and Handling Large, Multimodal Context Recognition Data Sets

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ABSTRACT

The demo will present a tool chain for recording, monitoring, labeling, and manipulation of complex multimodal data sets for activity recognition. The tool chain is comprehensive (going from logging, through labeling, monitoring to post processing and managing the data), integrated (with all tools being able to cooperate on joint data sets), and build around comfortable graphical user interfaces.

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ACM Classification Keywords J.0 General; D.0 General

General Terms Design, Documentation, Experimentation

INTRODUCTION

Activity and context recognition research is increasingly moving away from small-scale lab setups towards large, complex and often long-term experiments in unstructured real life environments [1,2]. Recording and labeling the corresponding data sets can be a significant challenge. So can be the post processing (re-labeling, identifying missing data, synchronizing different signals etc.) and working with it (e.g. selecting streams for recognition and training, testing). Based on our experience with a number of such recordings [3,4,5] we have developed an integrated tool chain that supports the above functionalities. It consists of a multiplatform set of data loggers (with extensive labeling functionality) that feed into an open source database (CouchDB), combined with comfortable, GUI based software for real time monitoring complex multimodal data streams, and a graphical data labeling tool.

RECORDING OF SENSOR DATA STREAMS

Context Logger

As it is a growing trend to develop context sensitive applications for mobile devices [6,7], we decided to implement a data recording tool for the iPhone and the Google Android platforms. The application allows for an easy recording and labeling of all sensors on the device (accelerometer (40-100 Hz), GPS (position, altitude, speed, course, accuracy), compass (magnetic- and true heading, geomagnetic data), sound, WiFi information (name, MAC address, signal strength, protection, visibility) and the state of the iPhone's proximity sensor. This *Context Logger* has been used in a broad range of student projects and a long term (one month) real life recording in a geriatric hospital

as part of the EU ALLOW project. It is currently being made available through the iPhone AppStore.

CRN Toolbox

For data recording in general, e.g. with wearable or stationary sensors that are not integrated into a mobile computing platform, we use the *Context Recognition Network (CRN) Toolbox* [8]. The CRN Toolbox allows for a fast implementation of activity and context recognition systems and for simple recording of data streams. It utilizes parameterizable and reusable software components and provides a broad set of online algorithms for multimodal sensor input, signal processing, and pattern recognition. It features mechanisms for distributed processing and support for mobile and wearable devices.

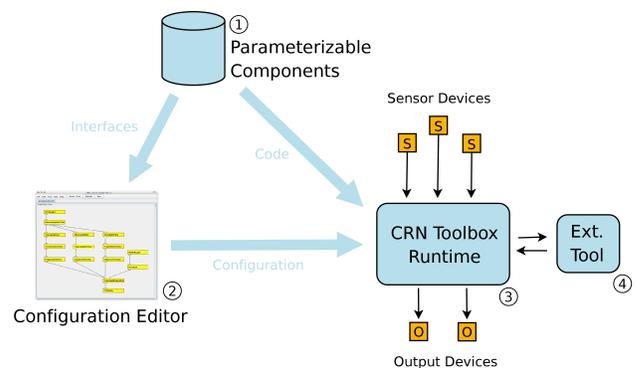


Figure 1: CRN Toolbox Concept: (1) a repository of parameterizable software components including I/O device readers and writers, filtering- and classification algorithms, components for splitting, merging, and synchronizing data streams, (2) a graphical editor for specifying data flow and configuring components, (3) the runtime environment for online executing the configured software components, (4) arbitrary external tools, communicating with the runtime, e.g. live data stream plotting or another Toolbox (local or remote).

The concept of the CRN Toolbox (see Fig. 2) is derived from the observation that most systems for online context recognition are built from a relatively small set of algorithms selected from sliding-window signal partitioning, standard time and frequency domain features, classifiers, and time series or event-based modeling algorithms. Often such systems differ only in their parameterization and combination of the algorithms.

Context Database

For the purpose of organizing unified data access we store the recordings in a database. We use the Apache CouchDB to implement the *Context Database* because of its

scalability and its support for replication. Users may easily replicate parts of the database locally, e.g. for performance reasons, and still continue to work on exactly the same interface. The CRN Toolbox and Context Logger can upload data recordings directly to the Context Database.

LIVE MONITORING OF RECORDINGS

During recordings with larger number of sensors it is crucial to monitor the state of each sensor and also to document the recording sessions. Sensor failures can occur often (for various reasons) and would make whole multi-hours of recordings unusable if not detected early enough. For this purpose we developed *MASS* (Monitoring Application for Sensor Systems). *MASS* is a software tool that helps monitoring and documenting experiments with multimodal sensor setups. It features graphical and tabular views for visualizing sensor uptimes and dynamic plots of live sensor signals for quick checking of signal quality (see Fig. 3). Users may visually place sensor status icons on images and maps to document sensor positioning and to get an intuitive, location-based overview of sensor states. All modifications and events during a recording are logged for documentation purposes. *MASS* integrates seamlessly with the CRN Toolbox and Context Logger. The recording tools advertise their service through Multicast-DNS such that *MASS* can find them and connect to them. *MASS* receives sensor status updates via UDP multicast messages from the recording tools and can monitor the sample rate to detect anomalies. For displaying live sensor signals *MASS* dynamically opens a TCP connection to the recording tool.

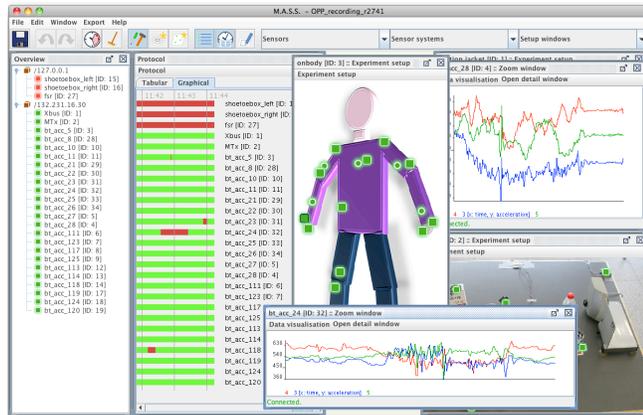


Figure 2: MASS screenshot.

REVIEWING AND LABELING RECORDED DATA

Once a dataset is recorded it has to be prepared for utilization in training and evaluation of context recognition algorithms. For that purpose all sensor streams must be synchronized properly and the segments of interest must be determined and labeled. We developed the *Labeling Tool* for exactly this purpose. It synchronously displays several video- and sensor data streams in parallel alongside with several label tracks (see Fig. 4). It allows the user to, (1) synchronize video- and sensor data streams by aligning them in the timeline view, (2) playback and seek all streams

in parallel, (3) assign labels to selected sections, (4) configure number and type of label tracks, and (5) generate data traces by following a configurable scenario of appearing and disappearing sensors. It integrates with the tools described above using the Context Database.



Figure 3: Labeling Tool screenshot.

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