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An Experiment in Hierarchical Recognition of Group Activities using Wearable Sensors

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GOAL:
•In-network recognition of group activities (GAR), contexts and goals for multi-user intelligent environments using peer-to-peer mobile devices.
PROBLEM:
•What is the **correct data abstraction level** for recognition algorithms?
•Less abstract data representations contain **more information** but incur high **energy consumption** due to transmitting large amounts of data.
•More abstract representations **reduce data volumes** and therefore consumption, but may **adversely affect recognition** rates.
APPROACH:
•An empirical study of the effects of different sensor data abstraction levels on energy consumption and recognition rates in an intelligent office scenario.

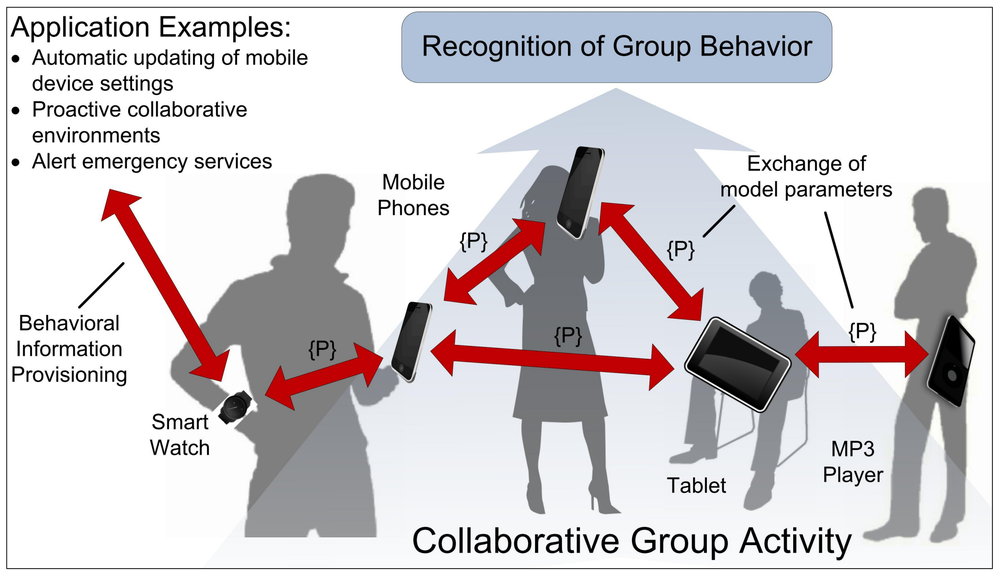

Fig. 1: Group Activity Recognition using Mobile P2P Devices

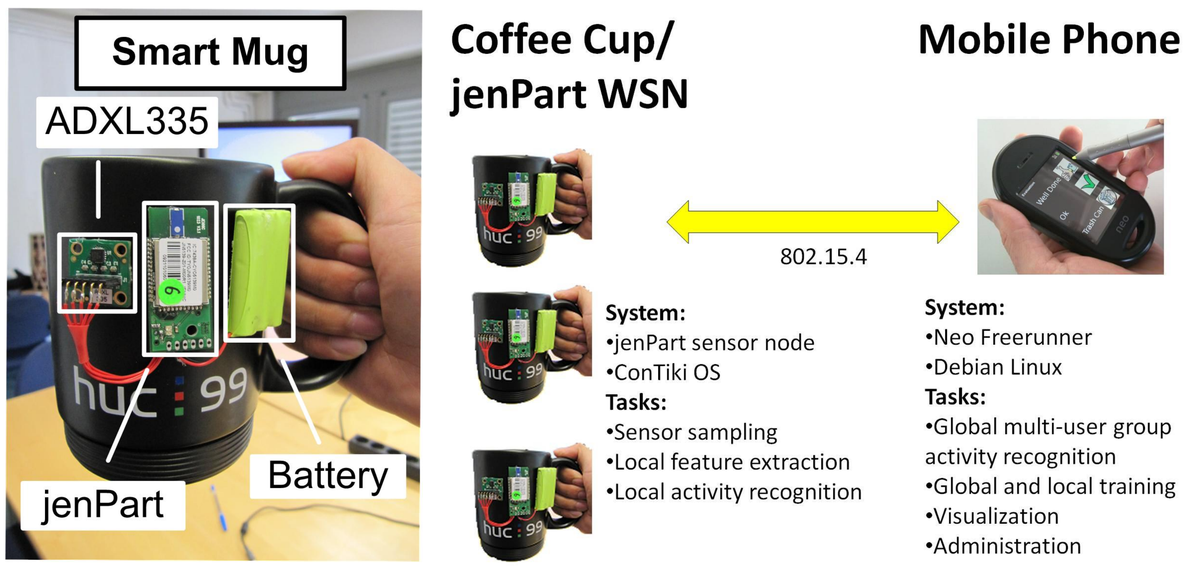

Fig. 2: Smart Mug and Neo FreeRunner Topology and Tasks

EXPERIMENT:
•Smart Mugs process data to different levels of abstraction before passing processed information to Neo for global recognition.
•**Low abstraction:** Smart Mugs sample sensors and forward raw data to the Neo for classification (only evaluated for consumption).
•**Medium abstraction:** Smart Mugs sample sensors and extract signal features (average and variance) before transmission.
•**High abstraction:** Smart Mugs sample sensors, extract features and classify these features into local activities (kNN, nB, C4.5) before transmitting this information to the Neo for global activity recognition.
•Modes evaluated in terms of **GAR rates / power consumption**

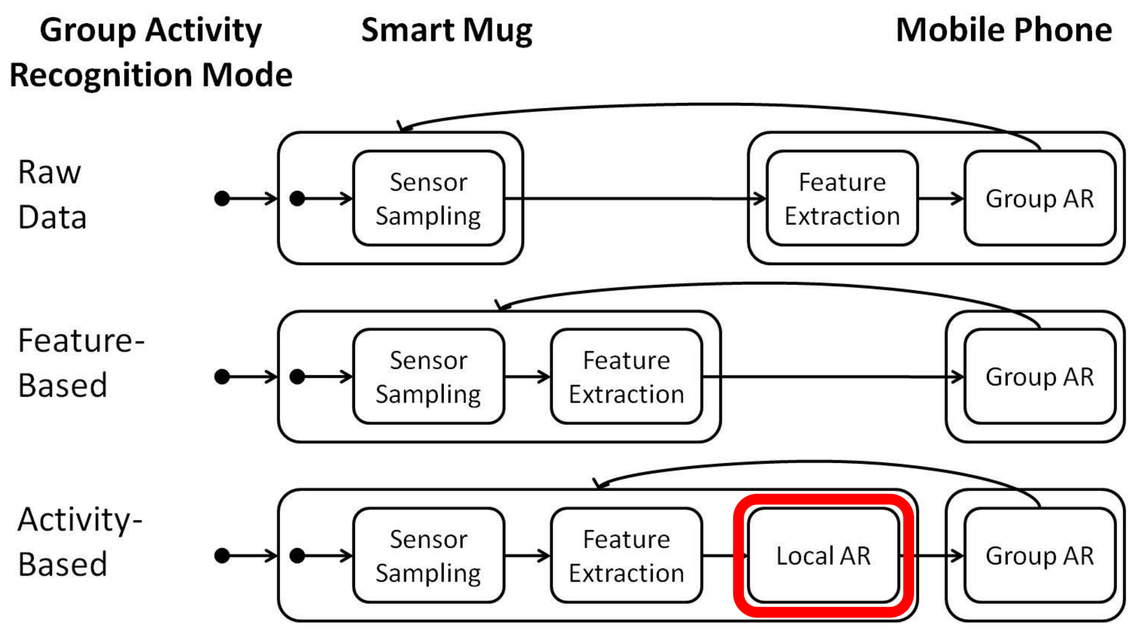

Fig. 3: Different Modes of the Experimental Set-Up

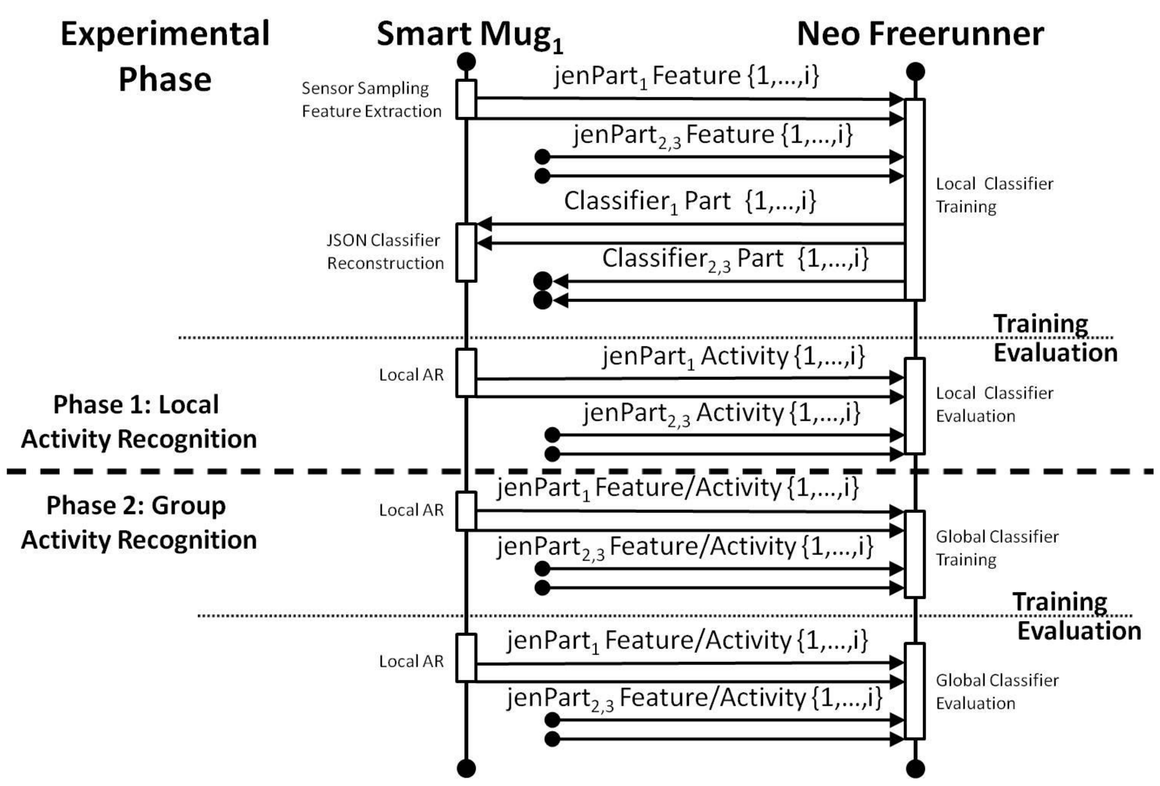

Fig. 4: Flow-Chart of Training and Evaluation Phases

EXPERIMENT HARDWARE:
•**Smart Mugs:** intelligent coffee mugs consisting of acceleration sensors, NXP JENNIC wireless communication module running Contiki OS (open source / hardware project Jennisense).
  •Subjects performed activities with the mugs: **drinking** from the cup, **holding** the cup, **gesticulating**, or **setting it down**.
•**Neo FreeRunner:** mobile phone connected to a JENNIC bridge
  •The Neo attempted to recognize the following group activities: attending a **presentation**, taking part in a **meeting**, having a **coffee break**.

USABILITY ISSUE:
•Local recognition using supervised learning makes the following assumptions:
  •The system designer knows which local activities will be conducted (**doubly labeling problem**).
  •The designers knows which local activities are significant for global recognition.
•Activity-level abstraction **not feasible for real applications.**
HYPOTHESIS:
•Using unsupervised techniques such as clustering allows devices to define their own patterns.
•Clustering requires less data for training (no local evaluation required).
•Avoids the need for local labeling.
EVALUATION:
•Compare clustering local data (k-Means) with local AR in Phase 2 of the evaluation.