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Graph-based representation of behavior in detection and prediction of daily living activities

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***Abstract*— Various surveillance systems capture signs of human activities of daily living (ADLs) and store multimodal information as time line behavioral records. In this paper, we present a novel approach to the analysis of a behavioral record used in a surveillance system designed for use in elderly smart homes. The description of a subject's activity is first decomposed into elementary poses - easily detectable by dedicated intelligent sensors - and represented by the share coefficients. Then, the activity is represented in the form of an attributed graph, where nodes correspond to elementary poses. As share coefficients of poses are expressed as attributes assigned to graph nodes, their change corresponding to a subject's action is represented by flow in graph edges. The behavioral record is thus a time series of graphs, which tiny size facilitates storage and management of long-term monitoring results. At the system learning stage, the contribution of elementary poses is accumulated, discretized and probability-ordered leading to a finite list representing the possible transitions between states. Such a list is independently built for each room in the supervised residence, and employed for assessment of the current action in the context of subject's habits and a room purpose.**

The proposed format of a behavioral record, applied to an adaptive surveillance system, is particularly advantageous for representing new activities not known at the setup stage, for providing a quantitative measure of transitions between poses and for expressing the difference between a predicted and actual action in a numerical way.

***Keywords*— behavior understanding, smart homes, assisted living, machine learning, graph-based structures.**

I. INTRODUCTION

TRACKING all day human activity is a very interesting topic related to human-environment interaction (including operation of various machines), personal security and ubiquitous health monitoring and assistance. Numerous purpose-oriented systems were proposed, prototyped and commercialized for allowing an objective description and joint automated analysis of coincident human factors such as movement and position of the body, load of the cardiovascular system and environmental parameters like temperature, lighting or humidity. While most authors focus on reliable sensing and accurate recognition of the status of a supervised human, we aim at analyzing the prerequisites and proposing a universal, purpose-independent storage format for a human behavioral record.

In the simplest and most frequent case of surveillance, the secured object is supervised by a dedicated sensor and, due to preferences of human senses, video surveillance systems are currently widespread in public areas [1], [2]. In case of a living subject, some physiology-based measurements are necessary to complete the description of the subject's state [3], [4]. In this field surveillance systems employ telemedical tools. Consequently, the system consists of two kinds of sensors with complementary features: premise-embedded sensors capturing the status of the specified area, and wearable sensors acquiring the environment-independent action and internal status of the subject. The use of a dynamically configurable network of various sensors benefits from mutually supplemental information which makes the recognition task more reliable at a price of increased complexity. The recognition process has to support various sensor sets, data types, sampling frequencies and delays caused by sensor-side signal processing and asynchronous transmission.