Activity Recognition Using Optical Sensors on Mobile Phones

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Each mobile phone with a built-in CMOS sensor can inherently be seen as sophisticated optical sensor being able to analyze its environment in terms of visual events and its own mobility. Due to mass production their price decreases steadily, although their processing capacity increases. Mobile phones are usually attached to people, who are driven by mobility. We define activities arising from this mobility as *internal* activities in contrast to *external* activities, that are caused by visual events. Both activities can be recognized by measuring the sensor's optical flow. We present a method to identify internal activities based on optical flow measurements and probabilistic reasoning. We implement a lifelogging application, running on a Linux-based mobile phone, that can detect internal activities such as moving left-hand, right-hand or walking with a recognition rate of 80%. While standing still external activities are recognized using object detection.

Realizing this application requires a number of basic functionalities. First of all, the mobile device must *capture and analyze* a stream of images from the built- in camera to detect internal and external activities. In many cases, the stream has to be segmented into activities stemming from the owner's (i.e. *internal activities*) movement or from external visual events (i.e. *external activities*). Afterward, the recognized internal activity has to be analyzed in terms of its motion patterns, e.g. left-hand or right-hand movement. Analyzing the single movements over time enables us to interpret the activity in terms of *motion sequences*. Answering these questions requires services for *video segmentation* and *pattern recognition* on mobile devices. To recognize external activities computer vision algorithms from the realm of *object detection* are required. Our methodology provides portable implementations of these services.