Smartphone-based Motion Video Tracking in Patients with Parkinson's Disease

Nikita A. Bazhenov, Dmitry G. Korzun
Petrozavodsk State University (PetrSU)
Petrozavodsk, Russia
{bazhenov, dkorzun}@cs.karelia.ru

Abstract—**Mobile treatment is an important component in regular medical support for people in their everyday life. A mobile application on a smartphone can recognize human images. thus tracking the behavior and gait. In this demo, we show simple use of a smartphone and its camera for motion video tracking of patients with Parkinson's Disease. Our results indicate that such low-cost cameras can provide reliable capture quality in at-home settings.**

Many digital healthcare services, and PD in particular, now employ the opportunities of mobile and smart Internet technologies [1], [2]. Recent methods for motion video tracking are essentially restricted with clinical and laboratory setting. They require powerful digital equipment and sophisticated algorithms to make video capture and subsequent data mining. Parkinson's disease (PD) is in the focus of modern neurosciences and healthcare, e.g., see [3].

Traditional medical software for PD support is difficult to use with smartphone or surveillance camera. In particular, we meet this problem when considered a customary available motion video capture complex Videoanaliz Biosoft 3D (Biosoft Ltd., Moscow, Russia) with smartphones Xiaomi Mi on the Android platform. Such widely used cameras have poor characteristics of video capture.

There are mobile applications for motion detection that can be found at Google Play, see examples presented in our work [4] in Table I. These applications use image recognition, but they do not affect medical topics.

We consider existing solutions for using smartphones in PD people monitoring, assessment, and management. In particular, we utilize a novel remote approach to enrollment, in which participants self-guide through visually engaging yet complete informed consent process prior to deciding to join the study. A critical aspect of this transparent consent process is providing the participants with an explicit decision point specifying if the data they donate to the study can also be used for secondary research purposes. In the experiments, special tools are used to support developing the motor skills and mental abilities of the PD patients.

We studied algorithms and techniques for pattern recognition, which can be applied in such motion video tracking services [5], [6]. Work [5] presents a method for detecting anomalies in high-dimensional large-scale unmarked datasets. Work [6] presents a method for estimation of head posutre in walking.

For the simplest case of our demo, we use only one smartphone. Smartphone Xiaomi Mi 5 with a recording video camera is used with aspect ratio 16:9 and a resolution of 1920x1080. Video records are for 5-6 seconds without the HDR function (High Dynamic Range), i.e. the camera can see more type of colors, different shades. Such video takes about 15 Mb. We use only 1 self-reflective element (attached to the head). Smartphone has a flashlight to utilize the self-reflecting element on the person's head. Such a flashlight is needed to ensure that the light falling on the element is reflected and better detected on the video.

The Simple Particle Filter Demo (by Eiji Ota, https://www.mathworks.com/matlabcentral/fileexchange/33666-simple-particle-filter-demo?s tid=prof contriblnk) is used as a base algorithm for the motion video recognition, see also [7]. The particle filter starts with a bunch of samples (called particles), evolves the state by running each particle through the state equation and re-samples the particles based on the observation that can be observed in order to make the distribution of particles consistent with the observations.

The architectural scheme is shown in Fig. 1. The patient's gait is recorded with the smartphone. Main attributes are the reflective element on the patient's head and the flashlight on the smartphone. Therefore, the element is better reflected on the video. After recording, the video is sending to a computer (laptop or other computing device) that uses a particle algorithm to recognize a white object (reflective element) and build graphics.

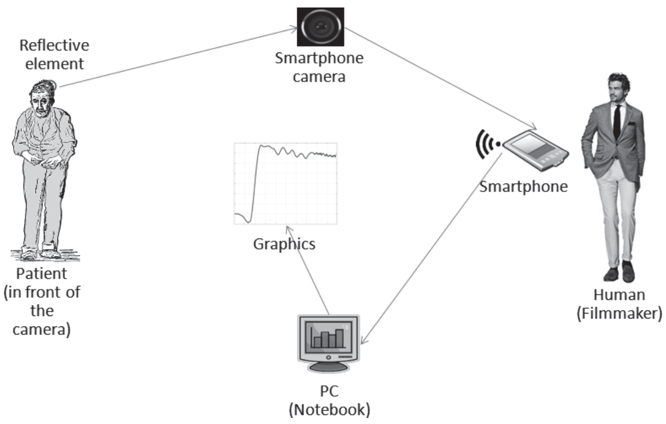

Fig. 1. Demo architectural scheme

TABLE I. EXAMPLE SMARTPHONE APPLICATIONS FOR MOBILE MOTION DETECTION

Application	Description	Available at Google Play	Votes
Salienteye	Home security system with use of the camera.	https://play.google.com/store/apps/details?id=com.mantishrimp.salienteye	17471
Motion Detector Pro	Application that uses built-in camera to detect movements in the surrounding area.	https://play.google.com/store/apps/details?id=dk.mvainformatics.android.motiondetectorpro.activity	11441
Motion Detector Video Recorder	HD video recorder that triggers on motion detection.	https://play.google.com/store/apps/details?id=com.zenaapps.motiondetectorvideorecorder	699
Motion Detector	Application that detects motion automatically by smart use of smartphone camera.	https://play.google.com/store/apps/details?id=com.mtat.motiondetector	545
Realvisor	Video surveillance via smartphone camera.	https://play.google.com/store/apps/details?id=com.reallyvision.realvisor3	138

Examples of provided visual analytics are presented in Figs. 2 and 3. The height of reflective element (Fig. 2) is evolved in time (measured in frames). Trajectory of movement (Fig. 3) is shown in the observed width and height directions.

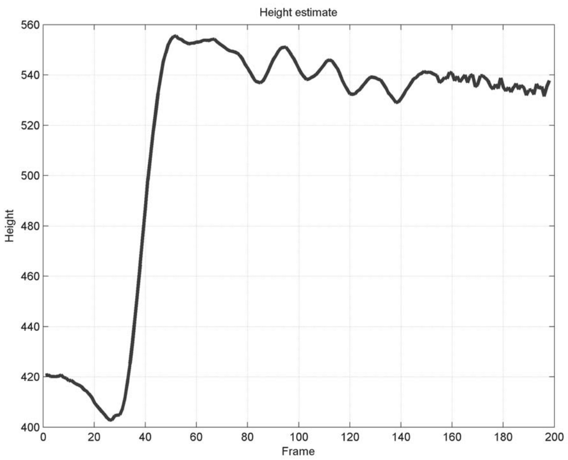

Fig. 2. Height of Frame

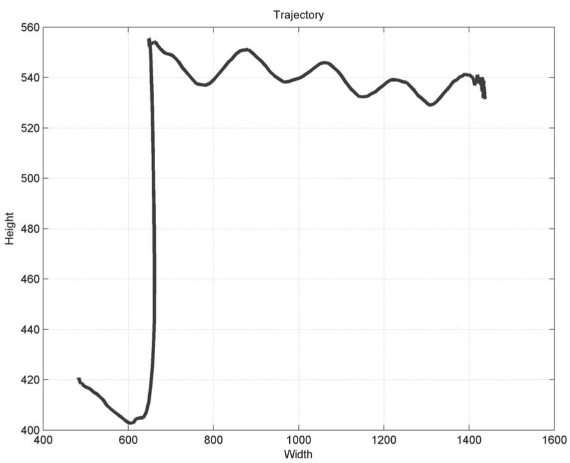

Fig. 3. Trajectory

The results show that even the simple use with a smartphone allows motion video tracking of patients with Parkinson's Disease. Such low-cost cameras in smartphones can operate in at-home settings and capture reliable video for motion recognition and gait analysis.

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