Scientific Research Abstracts
Vol. 5, p. 23, 2016
ISSN 2464-9147 (Online)
Atmospheric Dust - DUST 2016

ADVANCES IN SMARTPHONE-BASED FINE DUST SENSING

MATTHIAS BUDDE, MICHAEL BEIGL

Karlsruhe Institute of Technology (KIT), Pervasive Computing / TECO, 76131 Karlsruhe, Germany

budde@teco.edu, michael@teco.edu

Low-cost particulate matter sensing has received increasing attention in the last years. Especially scenarios that enable end-users to perform mobile air quality measurements with portable miniaturized samplers are challenging [1]. Such settings require instrumentation that is cheap and (ideally) can be integrated into handheld personal devices, like e.g. smartphones. Different promising approaches to achieve this exist, ranging from capacitive detection [2] over air-microfluidic MEMS sensors [3] to the adoption of classical optical sensing to mobile phones [4]. This talk will present advances in the latter approach: optical fine dust measurements using camera smartphones.

Regardless which technology will ultimately prevail: As sensors will eventually disappear into end-user devices in the future, untrained non-experts will perform the sampling to an increasing degree. This can be problematic in terms of data quality, as typical requirements for correct measurement procedures cannot be ensured. In professional measurement, results of high validity are warranted through a number of constraints that are typically not fulfilled in mobile and/or wearable environmental sensing. This usually includes a standardized measurement process in a controlled environment with a defined placement of the sensors that are periodically calibrated. In contrast, mobile low-cost end-user measurements are prone to systematic error in sensor readings.

This talk will explore different ways of dealing with such problems. In order to ensure that novice or untrained users perform a correct measurement procedure, those users typically have to be trained in advance. This is not feasible in participatory sensing scenarios, so other ways need to be found. As smartphones are equipped with multiple sensors and communication interfaces, an appropriate interface design can deliver in-situ training, help to encourage correct measurement, or even prevent measurement in case of incorrect device handling. Sampling could for example be prohibited, if the accelerometer in the smartphone detects motion or an undesired device orientation.

Aside from presenting approaches that target the user handling, we discuss an elegant approach for on-device signal processing that can directly stabilize sensor readings. It is agnostic to the employed sensing mechanism, as it is based on properties that are specific to the physical character of phenomena that can be modelled as particles. The idea behind the approach is to exploit the fact that such measurements are afflicted with sensor-dependent noise. Thus, it is possible to reconstruct the true signal from the noisy one [5]. In this way, certain sensor-aging effects may be disregarded, which can potentially reduce the need for frequent calibration.

Finally, aside from sensing techniques, we will discuss approaches that can be used to incentivize people to take part in participatory sensing, e.g. by embedding sensing as a mechanism into smartphone-based games.

REFERENCES

[1] Budde M., Zhang L., Beigl M. (2014). Distributed, Low-cost Particulate Matter Sensing: Scenarios, Challenges, Approaches. ProScience Vol. 1, 1st Int. Conference on Atmospheric Dust (DUST'14), pp. 230-236. DOI:10.14644/dust.2014.038

[2] Carminati M., Pedalà L., Nason F., Bianchi E., Dubini G., Cortelezzi L., Ferrari G., Sampietro M. (2014). Capacitive single-particle microdetector for real-time pervasive PM10 monitoring. ProScience Vol. 1, 1st Int. Conf. on Atmospheric Dust (DUST'14), pp. 237-242

[3] Doering F., Paprotny I., White R. (2012). MEMS air-microfluidic sensor for portable monitoring of airborne particulates. The Technical Digest of the 15th Solid-State Sensor and Actuator Workshop (2012), pp. 315–319.

[4] Budde M., Barbera P., El Masri, R., Riedel T., Beigl M. (2013). Retrofitting Smartphones to be Used as Particulate Matter Dosimeters. International Symposium on Wearable Computing (ISWC'13), pp. 139-140.

[5] Budde M., Köpke M., Beigl M. (2015). Robust, In-situ Data Reconstruction from Poisson Noise for Low-cost, Mobile, Non-Expert Environmental Sensing. International Symposium on Wearable Computing (ISWC'15), pp. 179-182.

Ackn.: Partially funded by the German Federal Ministry of Education and Research (BMBF) as part of Software Campus (grant 01IS12051).