Scientists use smartphone gyroscopes to sync time across devices

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Skoltech researchers have designed a software-based algorithm for synchronizing time across smartphones that can be used in practical tasks requiring simultaneous measurements. This algorithm can essentially help turn several devices into a full-fledged network of sensors. The

paper was published in the journal *Sensors*.

If you want a network of intelligent devices—say, an array of cameras capturing a dynamic scene or another kind of network of sensors—to work properly, one of the fundamental tasks you have to solve is clock synchronization: all devices should have the same timeline, often up to sub-millisecond for the more challenging tasks. Modern smartphones can easily be used as multipurpose sensors tied into a network, but they lack the interface for hardware clock synchronization, especially in environments where GPS, which can also be used as a global clock, is not available. And due to all non-atomic clocks slowly but inevitably drifting, they have to be periodically resynchronized.

"Smartphone networks can work as microphone arrays to capture sound waves and gather more information about not just sound but also direction. This is useful for noise cancelation techniques: noise cancelation algorithms pass the signal only from a specific direction, for instance, a voice of a person among office or city noise," Marsel Faizullin, Skoltech Ph.D. student and a coauthor of the paper, says.

Microphone arrays can also be used for what's called sound-based trilateration: a user's smartphone produces ultrasound, and an array of other smartphones receives this signal. By the delay between received signals, one can determine the position of a user.

"You can also use this technique for soft-synchronization of mobile phones with hardware-based systems. One example is a flash in cameras; with our method, any mobile phone could become part of a professional photography system," Skoltech Assistant Professor Gonzalo Ferrer adds.

Faizullin, Ferrer and their colleagues from Skoltech and Saint Petersburg State University developed a clock synchronization method based on micro-electro-mechanical systems (MEMS) gyroscopes, now installed in

every smartphone. They were able to design an algorithm that, in experiments with two smartphones capturing simultaneous photos, showed better performance than existing synchronization software, achieving an accuracy of several microseconds.

"This accuracy is enough for making a panoramic photo of a football or hockey game with a smartphone rig. An ice hockey puck achieves velocities of up to 160 kilometers per hour; in one millisecond it travels roughly for four centimeters, and in 20 microseconds it's 0.9mm. This is much less than a single-pixel field of view of any professional camera. It means that this is also enough for multi-camera synchronization capturing a hockey game. Definitely, an accuracy of microseconds is more than enough for any tasks involving consumer grade photo or video cameras," Marsel Faizullin says.

To use the algorithm, one needs to grab the smartphones in one hand, twist them a little and let the software do the rest in terms of all processing and computations for clock synchronization—it is literally a "twist and sync" approach.

For future research, the team decided to apply their method to systems that include not just smartphones but other sensors such as lidars, depth cameras and so on. "This task is more complicated because of very different software and hardware compared to just several identical smartphones. We are developing our method in this direction to be more practically useful," Faizullin says.

More information: Marsel Faizullin et al. Twist-n-Sync: Software Clock Synchronization with Microseconds Accuracy Using MEMS-Gyroscopes, *Sensors* (2020). DOI: 10.3390/s21010068