The Art of the Possible
Sounding Out Wearables for Health Diagnostics

Discover how mobile, wearable and augmented intelligence systems are transforming how healthcare data is captured and curated. Professor Cecilia Mascolo, who heads up the Mobile Systems Research Laboratory at Cambridge University UK, shares insights on how her team's disruptive innovations and real-world digital apps are helping to change the future of population healthcare.

An innovation powerhouse based at Cambridge University's Department of Computer Science and Technology, the Mobile Systems Research Laboratory conducts research on how mobile systems, combined with new mobile data analytics approaches, can be applied to real world health applications.

A key focus for this dynamic academic research lab is devising new sensing and system techniques to accurately collect patient data remotely, as Cecilia explains."Wearable tech like fitness trackers, smart watches and biosensors presents us with novel opportunities to collect passively sensed data that can deliver deep insights into our health and wellbeing. Our task is to find the best way to efficiently collect the right data, using many of the technologies embedded in the devices we carry with us on a daily basis. Ultimately, our goal is to enable fast, affordable and sustainable mobile healthcare applications that can be rolled out at scale."

The group's pioneering work includes a COVID-19 Sounds app which over 43,000 volunteers downloaded to their smartphones so they could record themselves coughing, breathing and speaking. The research team then trained machine learning algorithms to use data captured from these recordings to correctly predict whether people were indeed suffering from COVID 19. Today, more than 400 institutions are making use of this ground-breaking audio data.

"Using a large-scale crowdsourced dataset of respiratory sounds, we were able to show it was possible to detect and remotely monitor the progression of COVID-19 in patients over time – and accurately predict their recovery. Compared to expensive PCR, lateral flow and antibody tests, audio-based screening offers great potential as an affordable and sustainable way to monitor and contain the spread of COVID-19 in these post-pandemic times. Furthermore, we've proved how it's possible to use the automatic analysis of respiratory patterns to monitor respiratory diseases in general."

Using digital technology to evaluate audio signals generated by the human body – such as sighs, breathing, heart and digestion – is just one of many research avenues currently being pursued. The research group is also developing and validating a suite of app-based tests for detecting the effect of early Alzheimer's disease (AD) on everyday functions like sleep and navigation. The end-to-end solution is set to transform clinical practice and deliver a low cost, scalable method for detecting AD in ageing populations.

"Our work in the field of AD diagnosis is a great example of how a single conversation with a neuroscientist resulted in us applying mobile phone sensors in new ways to capture and analyse the markers of early cognitive decline. It was kind of an 'aha' moment that completely redirected our thinking and approach – and all because one clinician asked that all-important 'what if' question and shared his expertise."

Finding creative ways to collect out-of-clinic data from patients and the general population using sensors and mobile devices is just part of the challenge. The next hurdle is finding ways to clean, use and analyse it, as Cecilia explains.

"Collecting data via commercial-grade mobile devices means we've had to find ways to cut out 'background noise' and apply uncertainty of prediction measures to our machine learning generated models. By working closely with clinicians as we build models, we're able to fill identified 'data gaps' using the additional samples they provide. It's a collaborative approach that works well for all concerned."

When it comes to optimising the use of wearable data based models for surfacing learning in the most cost-effective way possible, the research team is also pushing at the frontiers of self-supervised machine learning techniques that can be combined to create smarter models.

"Data labelling is a time consuming and expensive task but we've shown it's possible to develop efficient models that require minimal or zero annotations. This opens the door to creating smarter general-purpose models using data from multiple domains that can be transferred to low resource environments or to tasks that benefit clinicians, patients and the wider population."

Looking to the future, the research team has a number of exciting projects on the horizon. "Sleep is vital for health and well-being and the impact of sleep deprivation is a growing concern in the public health arena – making this research area a top focus for us in the next few years. We'll also be pushing forward our work on disease progression in the context of respiratory applications."