Smartphones for sensing

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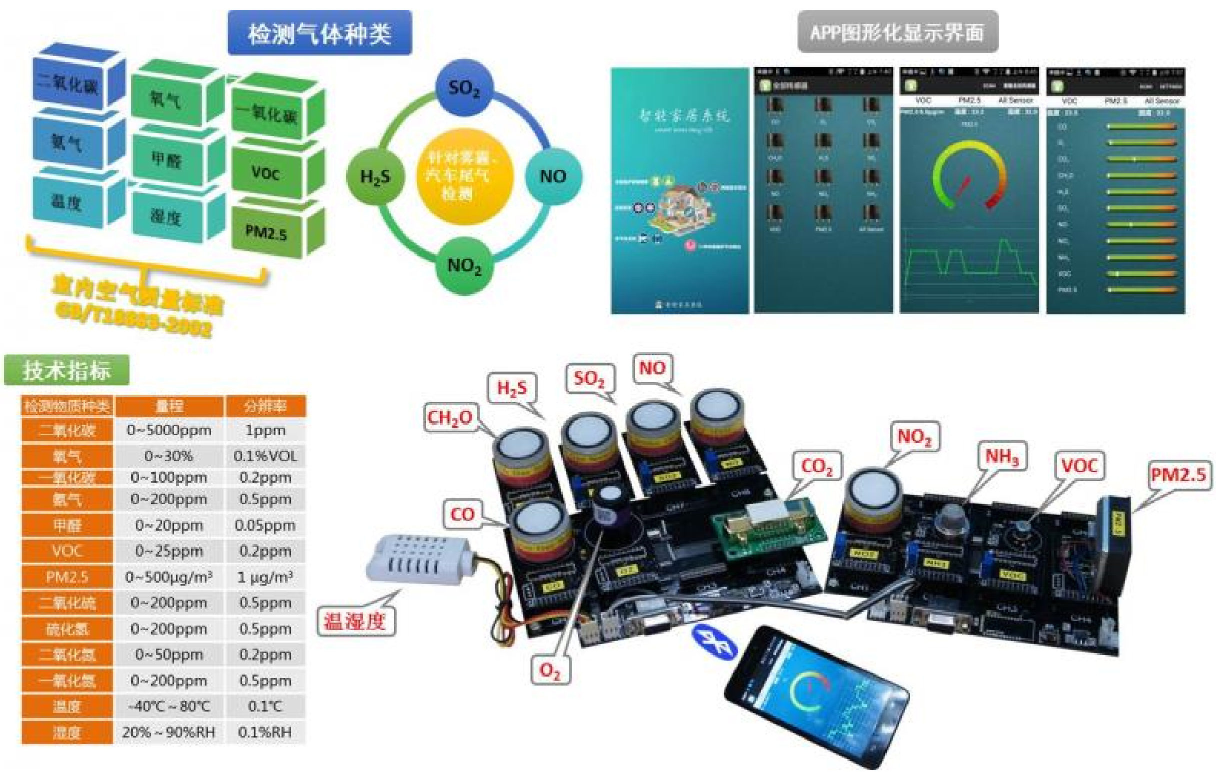

Photographs and results from our homebuilt smart home system. Credit: ©Science China Press

As a core communication device, the mobile phone is increasingly popular in our daily lives. A wide variety of functional units and friendly operating systems make mobile phones eminently suitable for smart technological applications, and mobile phones have also attracted the interest of scientists.

Recently, sensing applications at multiple scales, such as personal, group, and community sensing, have been developed. Sensing software is increasingly being developed for smartphones, providing both convenience and pleasure—for example, angles in pictures and photos can be measured using the smartphone measurement app Partometer. Many people have used camera measurement tools downloaded from Google Play (http://www.new-itechnologies.com/, http://www.vistechprojects.com/). And much effort has been directed toward using mobile phone sensing devices for collecting health data and environmental monitoring. Examples of such sensors include those measuring the ultraviolet index, those used for monitoring heart rate, respiratory rate, and blood oxygen saturation, and those used for air monitoring, ultrasonic scanning, 3D scanning, and the detection of chemicals. Inertial magnetic sensors, earphones, cameras, and Wi-Fi or 3G all play important roles in mobile phone sensing.

A review published in 2016 issue of *Science Bulletin* discusses the fabrication and application of mobile phone sensors. Smartphone sensors can be classified as electromagnetic sensors, audio-frequency sensors, optical sensors, electrochemical sensors, and others. The future development of smartphone sensing and perspectives are also summarized in this review.

A smart home system has been developed by Prof. Niu's research group, which consists of a homebuilt electrochemical workstation, gas sensors and a mobile phone programmed with specific software. CO2, CO, O2, NH3, formaldehyde, VOC, PM2.5, SO2, H2S, NO2, NO, temperature and humidity are detected by smartphones and instantly communicated via the Internet (Fig. 1). It can communicate over the Internet for information exchange and communication for intelligent identification, monitoring and management. The Internet of Things will be widely applied in industrial production, smart homes, intelligent security, environmental protection, medical diagnosis, and biotechnology.

The development of smartphone sensing depends on various technologies including microelectronics, software, and communications. In the future, mobile phone devices will benefit from (i) having better operating systems to achieve data acquisition and processing by inexperienced users, (ii) improvements in access point technology for increased processing power and reduced power consumption, (iii) improved smart display technology with more power efficiency and flexibility, (iv) new sensor types to acquire various new physical quantities, (v) faster battery charging, wireless battery charging, and adaptive battery management, (vi) advances in material technology to enable a new generation of lighter, more flexible, and durable devices, (vii) trends in web technology to make data transformation more universal, convenient, and rapid, (vii) expansion of cloud services to permit online data storage and data sharing between different users, (ix) the development of user interfaces that can use gestures and retina tracking, an infrared keyboard, and context-aware user interfaces, and (x) faster and safer mobile network capabilities.

More information: Fenghua Li et al. Smartphones for sensing, *Science Bulletin* (2015). DOI: 10.1007/s11434-015-0954-1

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