# Future sensors embedded in mobile phone devices

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# 1. Abstract

Nowadays, mobile phones have been becoming the most important and popular communication devices in people's lives. Sensors, as one vital data detectors and senders embedded in today's smart phones, such as an accelerometer, digital compass, GPS, microphone, gyroscope, and camera, are facing more and more challenges and opportunities in development and revolution. In the future, I believe that there will be other kinds of cheap and accurate sensors to detect different useful data which improve many parts of our society including business, health care, social networks, environmental monitoring, and transportation. In this essay, i survey new attempts to improve existing mobile phone sensing algorithms and the possibilities to incorporate more sensors which have different use onto mobile phones.

# 2. Introduction

This essay aims to give an overview of  sensors that will be incorporated onto the mobile phone devices.The material for this essay  was gathered from various papers and web sites which will be referred to later.

Today’s smart phones not only serves as the key computing and communication mobile device of choice, but it also comes with a rich set of embedded sensors, such as an accelerometer, digital compass, gyroscope, GPS, microphone, and camera. Collectively, these sensors are enabling new applications across a wide variety of domains, such as health care , social networks, safety, environmental monitoring, and transportation , and give rise to a new area of research called mobile phone sensing. [1]

# 3. Improvements on existing sensors

Nowadays, there are higher and higher requirements for sensors that embedded on the mobile phone devices. Sensors are required for higher accuracy, smaller volume and better materials to construct.

## 3.1 sensor algorithms

Basing on the obvious and appealing requirements, there are several improvements methods having been adverted. For example, researchers in College of Information Systems and Management, National University of Defense Technology, Changsha, China put up a paradigm to apply a machine learning algorithms for indoor-outdoor detection using Mobile GSM sensor and obtain base station's signal strength in different environments, and identifies the users' current context by signal pattern recognition.[2]. According to this 'Indoor-Outdoor Detection Using a Smart Phone Sensor' essay which was published in 2016, they tested the algorithm in four different environments. The results showed that the proposed algorithm was capable of identifying open outdoors, semi-outdoors, light indoors and deep indoors environments with 100% accuracy using the signal strength of four nearby GSM stations. The required hardware and signal are widely available in our daily lives, implying its high compatibility and availability.[2]

Another example is about Barometric and GPS altitude sensor. Basing on the essay called 'Barometric and GPS altitude sensor fusion' which was published in IEEE in 2014, an algorithm which improves accuracy and provides tighter confidence bounds of altitude measurements from a mobile phone (or any device equipped with GPS and barometric sensors) by means of sensor fusion techniques without the need for calibration was proposed. Their experiments have shown that the proposed algorithm provides more accurate measurements with tighter confidence bounds compared to using either of the two sensors, barometric or GPS, alone.[3]

It can be predicted that those two algorithms will be implemented in the mobile phone devices for the good of users. One common between these two proposal above is that they both improve the current algorithms of current mobile phone devices, providing higher accuracy and lower error rate. As long as the sensors have good enough physical material to afford the requirements of processing burden of algorithms, the practice of these two algorithms will have a bright future.

## 3.2 sensor materials

Apart from the replacements of old and unqualified algorithms that had been applied in mobile phone devices sensors for a long time, there are new materials for sensors constructing as well. For example, there was a paper published on ‘Advanced Materials’ in 2016 reported several progress in materials and devices for future wearable devices, such as inorganic, organic, and hybrid semiconductors with various structures (i.e., 1D, 2D and 3D) with printing capabilities[4]. It can be expected that these materials can be used on mobile phone devices once it breaks the barrier of large volume.

## 3.3 smaller volume sensors

Another future improvement that can be expected is smaller volume of sensors that incorporated into mobile phone devices. For example, essay ‘Poster: bPart - A Small and Versatile Bluetooth Low Energy Sensor Platform for Mobile Sensing‘ propose bPart, a highly integrated autonomous sensor platform for use with mobile phones and devices. It consists of a Bluetooth Low Energy (BLE) radio and several MEMS sensors, all integrated in a volume of less than 1cm³, including the battery. Aside from the wireless transceiver, the bPart features sensors for ambient illumination, 3D-acceleration, temperature and relative humidity. In addition, there is a button and a magnetic switch for binary input and a RGB-LED for user feedback. A secondary LED in the infrared spectrum enables camera-assisted identification and tracking of the node. [5]

# 4. Different sensors

## 4.1 health care sensors

Sensors that concerned with health care have always been paid much attention because of the benefits of improving people's lives. Nowadays, no matter what user markets are, health are always a crucial topic. Parents are willing to pay for a health care detection mobile device to take care of their children; adults who care about their elder parents would like to have a mobile detection device to monitor the health condition of their elder parents or grandparents. In this case, different kinds of sensors have been put up with to deal with different problems and to meet up different requirements.For example, according to essay called 'An Intelligent Sensor Based System for Real Time Heart Rate Monitoring (HRM)', a method and apparatus for monitoring heart rate of the heart using a wearable system is designed and implemented in this paper. A heart rate receives from heart beat signals and stores the data to a database and after a time period this method can determine an idle heart rate of the monitoring body. This idle heart rate is compared with the stored data and can determine the normal and abnormal heart rate variability. After the certain time period this system can detect the heart rate and also can send a signal to the user in time of abnormalities. Consequent estimations of heart rate variability are contrasted with this.[6]

However, in the prospect of sensors that incorporated into mobile phones, it still faces a lot of challenges though it has a huge user market. Sensors that focus on diseases may lead to a smaller user market, because not everyone need a phone that have the ability to detect the health condition. Besides, only a limited number of diseases can be detected such as heart rate and blood pressure. Moreover, although mobile phones are carried by people everyday, they are not directly attached to human body all the time. Therefore, health care sensor not only have the concerns on business market, also have the worries about accuracy. In general, however, health care sensors still have a bright future, because new developments and revolution are full of possibilities. People can never tell the future cause people can never tell when deterministic discoveries will taken place.

## 4.2 environmental detection sensors

Since the environmental problems have been on the spotlight for several decades, it is possible to have sensors concerning about environmental data gathering appeared and embedded into mobile phone devices.

According to essay ‘Innovations in Environmental Monitoring Using Mobile Phone Technology – A Review’, There are a number of different systems available on the market that are at least partially relevant for environmental monitoring, or that can inform developments in that direction. We have identified a number with particular promise, as well as categorizing the examples that we could find within a conceptual framework that enables comparison. Field-based environmental monitoring using off-the-shelf components is an area that is developing extremely rapidly, and trends in what is available would seem to indicate that more functionality and integration between sensors and mobile phone technology is highly likely in the near future. [8]

However, there are apparent limits of mobile phones of this kind of sensors. If this sensor is aimed for temperature or the pollution condition detection of real time, it can be assured that have a huge user market, but for detection of more advanced geographical or chemical detection, there is a doubt that whether mobile phone devices should have this kind of ability or not. It can be seen that mobile phones are used for daily life while detection such as polluted rate of water is barely used in daily life around general people. It is possible that geographical or chemical researchers or fanatics may have an interest into this kind of phone devices, but this user market cannot be able to balance the cost for releasing special phones into the market.

## 4.3 sensors aiming for pedestrian users

It can be seen that sensors aiming for pedestrian users are facing better passion from user market. However, sensors for pedestrian uses have been developed far more than other rare uses. Except that there are revolutions in some important fields, the current incorporated sensors are actually be able to be responsible for pedestrian uses. However, we can still expect some new discoveries or developments.

For example, according to essay ‘Wireless mobile charging:A revolution’, a new idea is proposed. Microwaves are the radio waves that are used to communicate through two mobile phones. Here we use microwaves as a power transmitter to our mobile phones. For this we require a sensor, a rectenna circuit and a filer in our mobile phone. The microwave is sent with the message by the transmitter using antenna at frequency 2.24 GHz.[7]

However, according to essay ‘Wearable Chemical Sensors: Present Challenges and Future Prospects’ , Sensor stability and on-body sensor surface regeneration constitute key analytical challenges. Similarly, present wearable power sources are incapable of meeting the requirements for wearable electronics owing to their low energy densities and slow recharging. Several energy-harvesting methodologies have inherent issues, including inconsistent power supply and limited stability. There are also major challenges pertaining to handling and securing the big data generated by wearable sensors. [9]

## 5. Privacy

Privacy problems have always been a critical problem that been concerned by the society.Today's prevalence of smartphones has granted us new opportunities to observe and understand how the personal data collected by smartphone sensors and apps can help create personalized secret questions without violating the users' privacy concerns. In this paper, researchers present a Secret-Question based Authentication system, called "Secret-QA", [10].

## 6. Conclusion

In conclusion, sensors will be experienced a huge improvement in the future to meet the requirements of higher accuracy and variable uses and different situations. Sensors will face the challenges on volume,accuracy,usefulness and privacy. There is no doubt that more regulations will be set up to guarantee the privacy of users of mobile phone devices.

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