

MEMS传感器解决方案
成就更好的生活

感知我们的世界

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我们是最值得信赖的创新传感解决方案提供者，旨在改善人们的幸福感和生活方式。
OUR
VISION

博世气压传感器的原理和应用



气压传感器工作原理



气压传感器参数



气压传感器应用

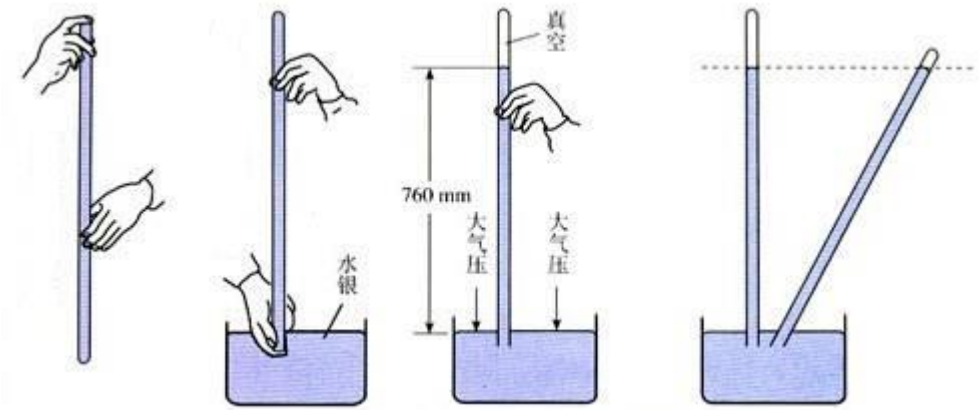


全新BMP390气压传感器

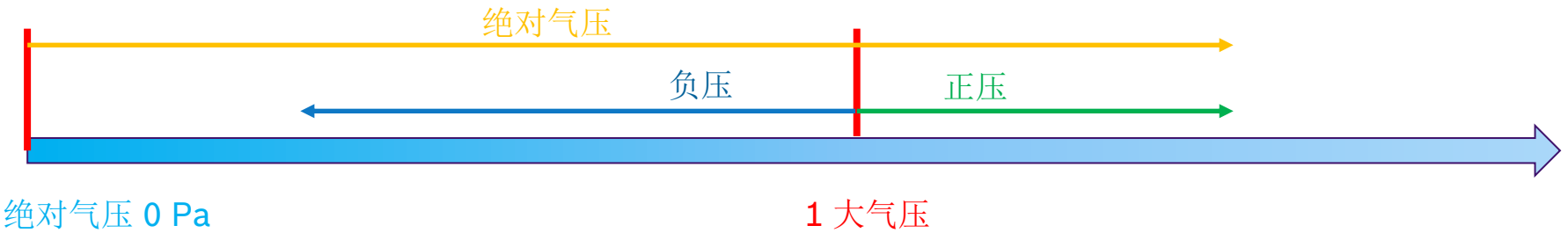
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博世气压传感器的原理和应用
气压传感器工作原理

- 气压和气压传感器
  - 气压是作用在单位面积上的气体压力，单位是Pa
  - 用于测量确定气体压力的仪器 — 气压传感器
- 大气压
  - 环境空气的压力，大气压不仅随高度变化，也随温度而异。气压的变化与天气变化密切相关
  - 标准大气压 ATM
    - 温度为0℃、纬度45度海平面上的气压称为1个大气压，水银气压表上的数值为760毫米水银柱高
- 绝对气压、正压（表压）和负压（真空）的关系



托里拆利实验

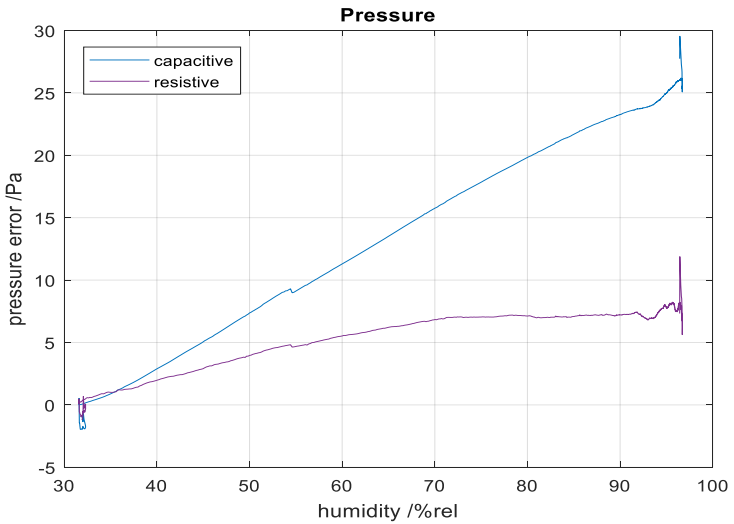


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博世气压传感器的原理和应用
气压传感器类型和特点

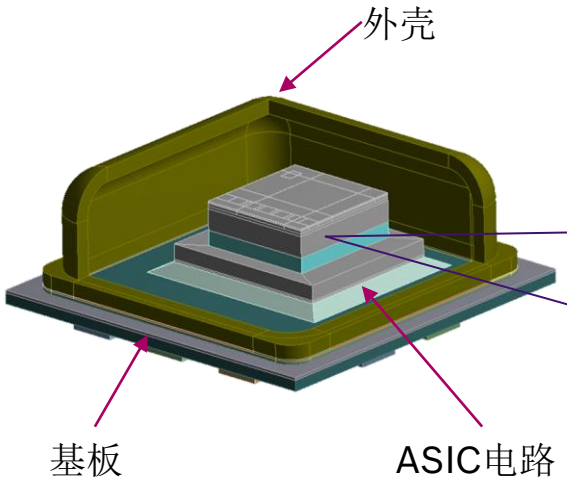
- 测量组件
  - 电阻式
    - 气压的变化会引起压阻材料的形变，从而改变压阻材料的电阻值
    - 通过压阻材料的阻值变化来反映测量气压的情况
  - 电容式
    - 气压的变化会引起电容基板的形变，包括基板间距或者正对面积等变化
    - 通过测量电容的容值来反映测量气压的情况

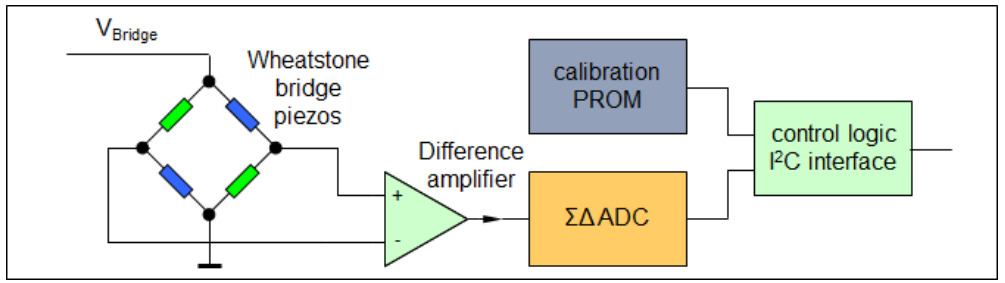
- 压阻与电容式气压传感器的比较
  - 压阻采用惠斯通电桥可以实现很好的精度、线性度、EMC可靠性以及长期稳定性
  - 通过调整电阻值和脉冲操作可以降低气压计功耗，并达到和电容式接近的功耗
  - 压阻采用的单晶膜比电容的多晶硅膜有更好的机械性能
  - 电容气压计的寄生电容容易收到湿度变化和灰尘颗粒的影响

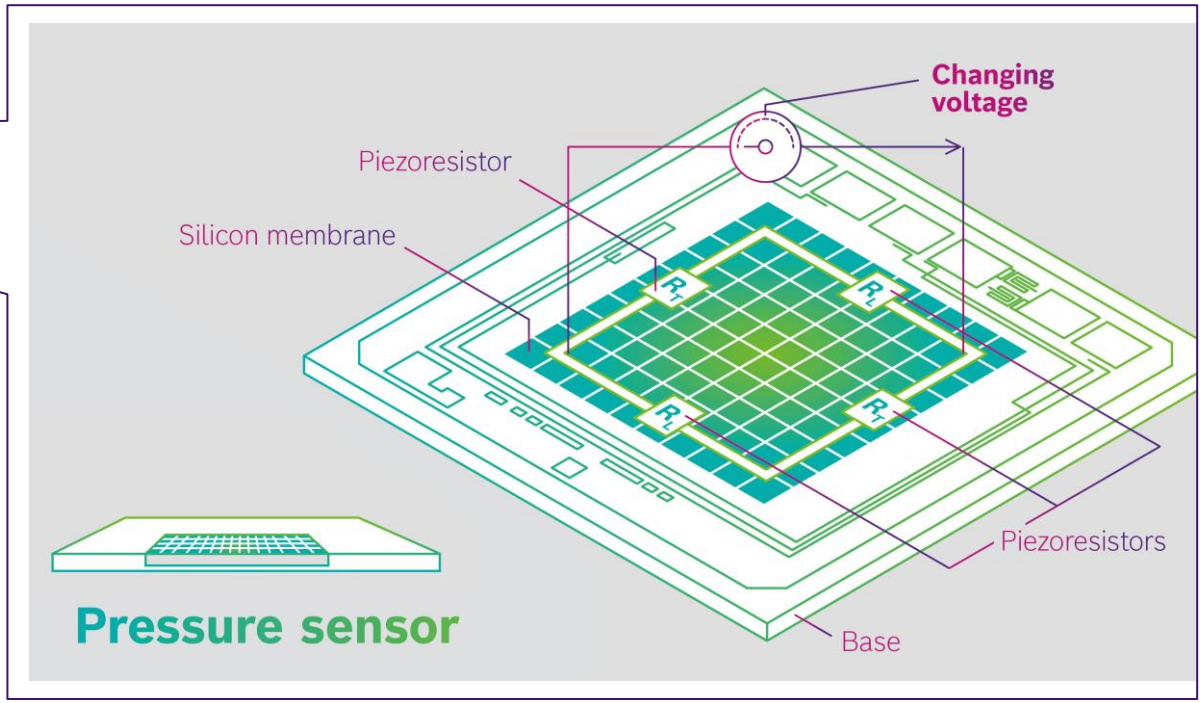


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博世气压传感器的原理和应用
电阻式气压传感器工作原理







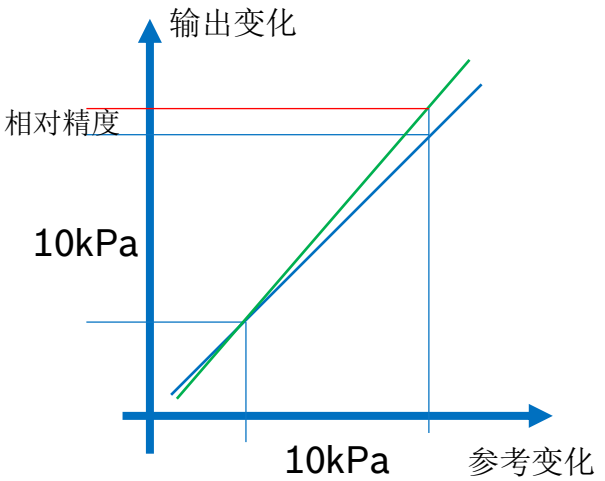
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博世气压传感器的原理和应用

气压传感器参数

- 量程范围
  - 压力范围 和 温度范围
- 绝对精度
  - 用于和参考设备的绝对气压作比较
  - 满量程 和 部分量程
- 相对精度
  - 随待测气压变化，气压传感器输出变化的精度
- TCO 温漂系数
- 噪声
  - 滤波器
  - 过采样率，避免数据混叠，控制噪声和功耗
- 功耗
- 长期稳定性

- 气压传感器的相对精度是指
  - 在精度定义范围内，以BMP390为例，从700hPa到1100hPa
  - 每变化100hPa（10kPa），气压传感器输出的变化量与100hPa的差
  - 不同的传感器厂商有不同的气压变化要求
    - +/-1Pa @step < 1kPa, 25C
    - +/-3Pa @step < 10kPa, 25C



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博世气压传感器的原理和应用

气压传感器的应用方向



楼层检测

辅助室内导航



GPS辅助定位

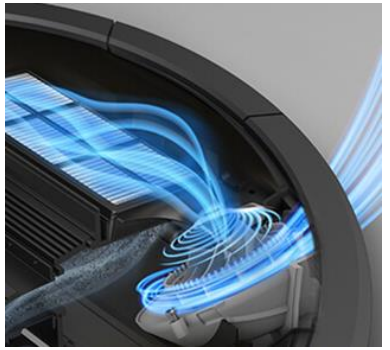
改善高架导航体验



辅助运动识别以及卡路里追踪



无人机高度稳定



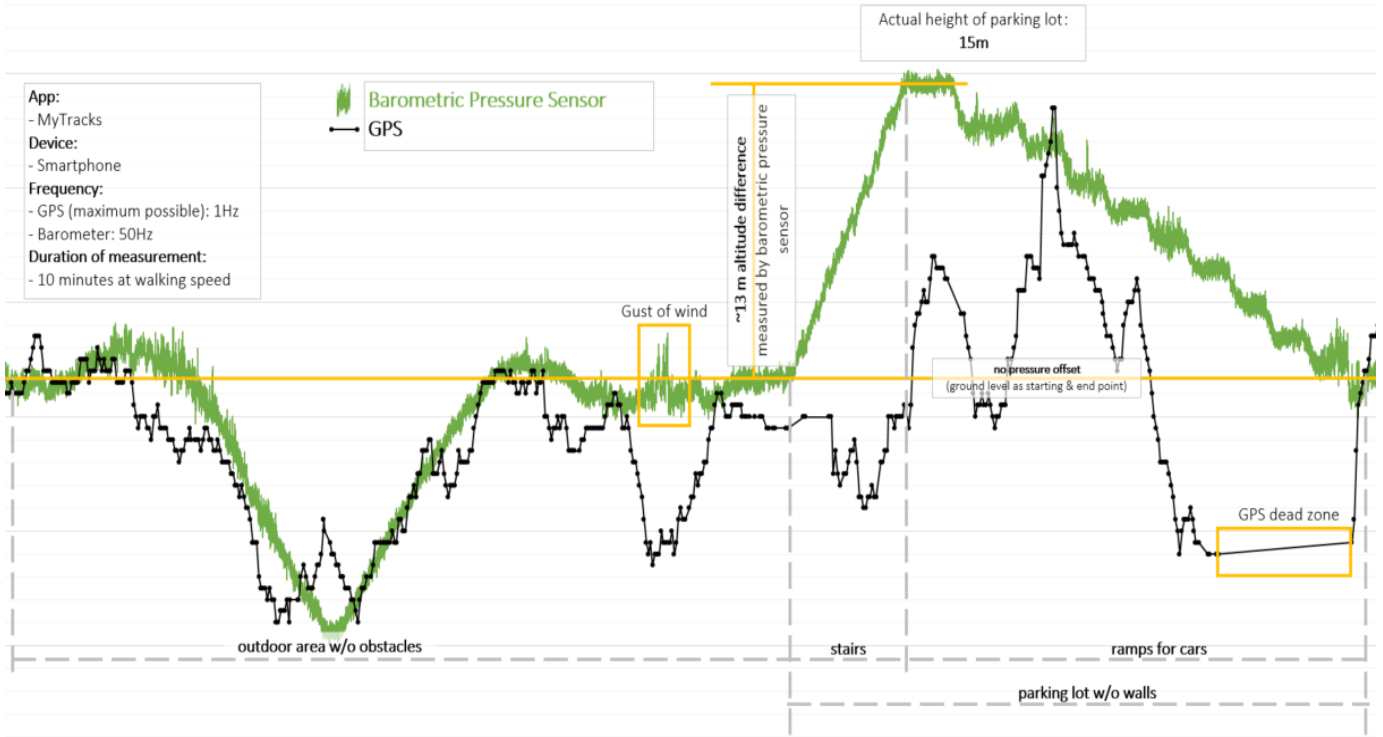
堵塞检测

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博世气压传感器的原理和应用

高度检测 改善导航体验



GPS

- 在楼宇内GPS信号会被遮蔽
- 楼层信息也没有办法通过GPS获得
- 因此室内导航也无法实现

Wi-Fi/Beacon

- 没有高度信息
- 三角定位

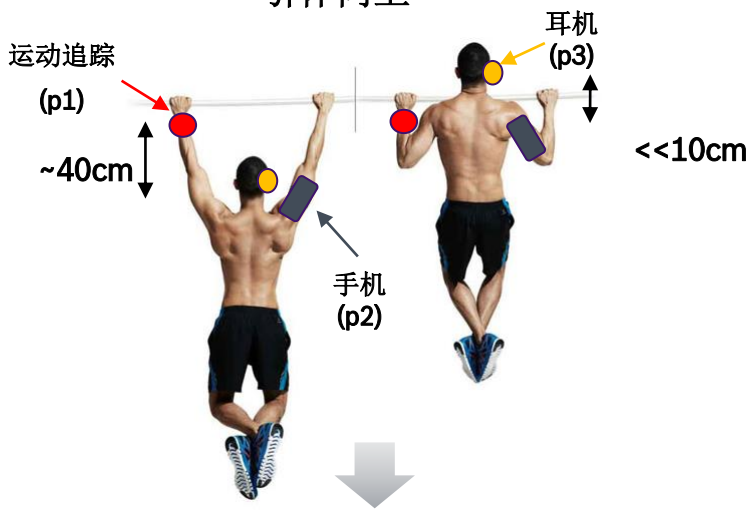
气压传感器

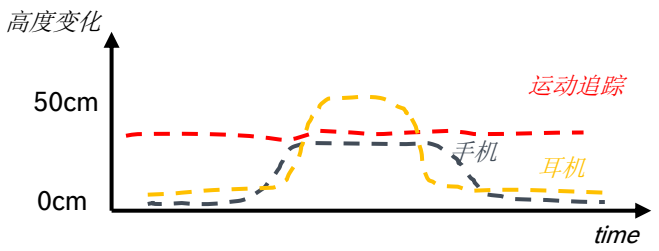
- 气压传感器可以通过测量气压获得精确的高度信息
- 通过地图信息可以将高度信息转化为楼层信息
- 楼层信息可以用于室内导航

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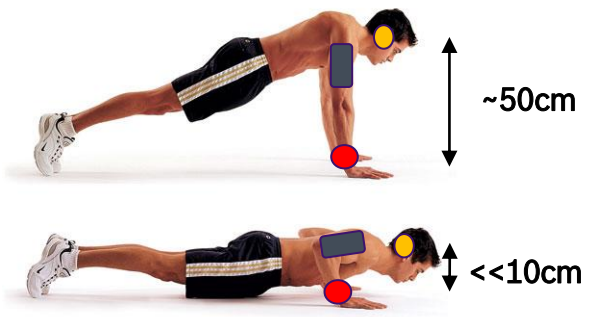
博世气压传感器的原理和应用
更多的姿态和动作识别

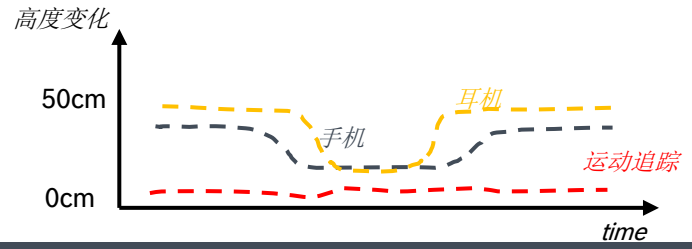
引体向上





俯卧撑





噪声，功率，环境可靠性，相对精度是运动追踪应用的主要参数

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卡路里追踪

BMP390

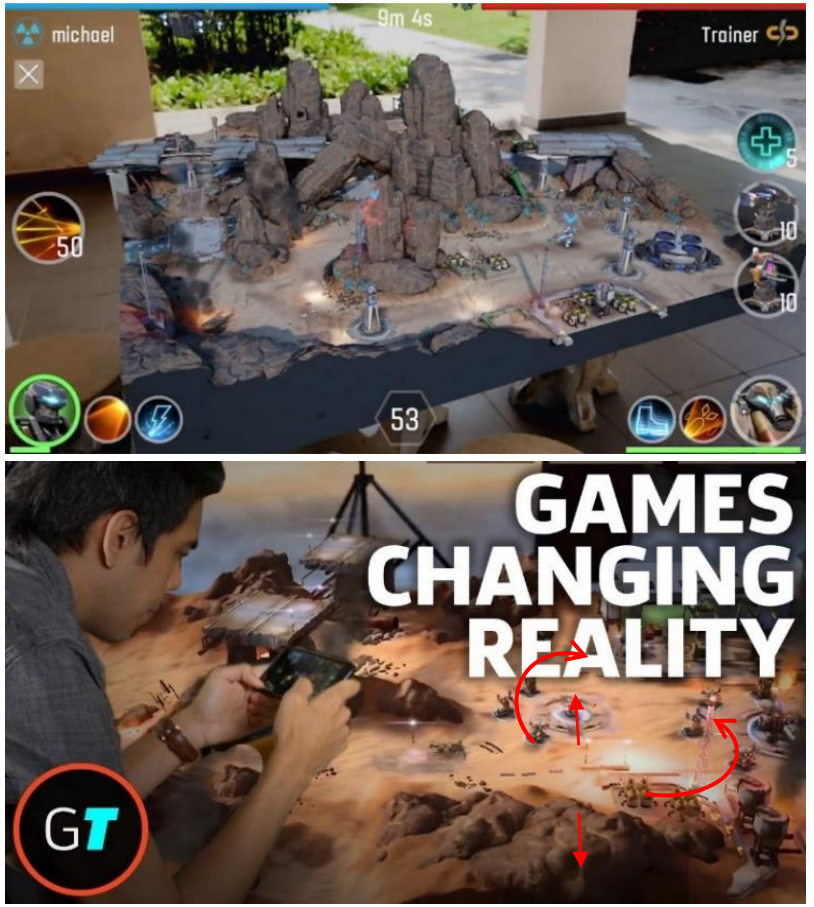
气压传感器可以确定用户在健身训练期间是上楼梯还是下楼梯或举重。这些可将卡路里跟踪的精度提升高达15%。

博世气压传感器的原理和应用
助力AR/VR 6DoF



应用于AR/VR的6DoF追踪

- IMU可用于X，Y和Z方向的旋转检测
- IMU和摄像头可以实现X和Y方向移动的检测
- 气压传感器可以实现Z方向移动的检测
  - ✓ 用于检测玩家是否蹲下后者跳起

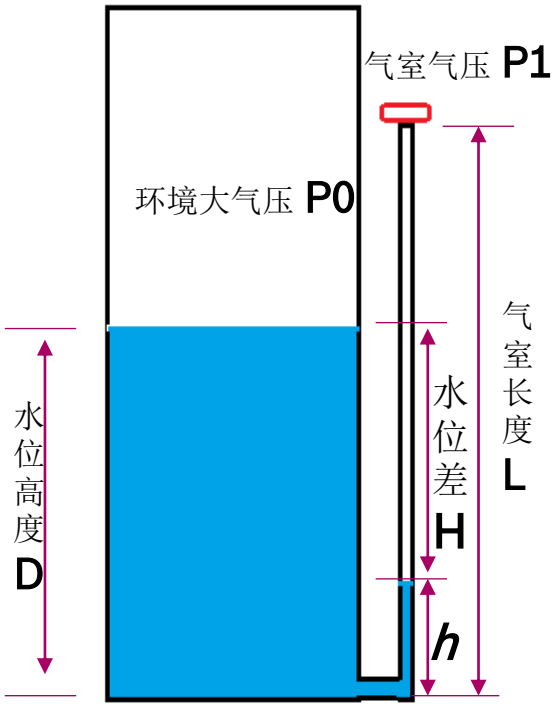


压力传感器有助于移动游戏的动态分辨率变化

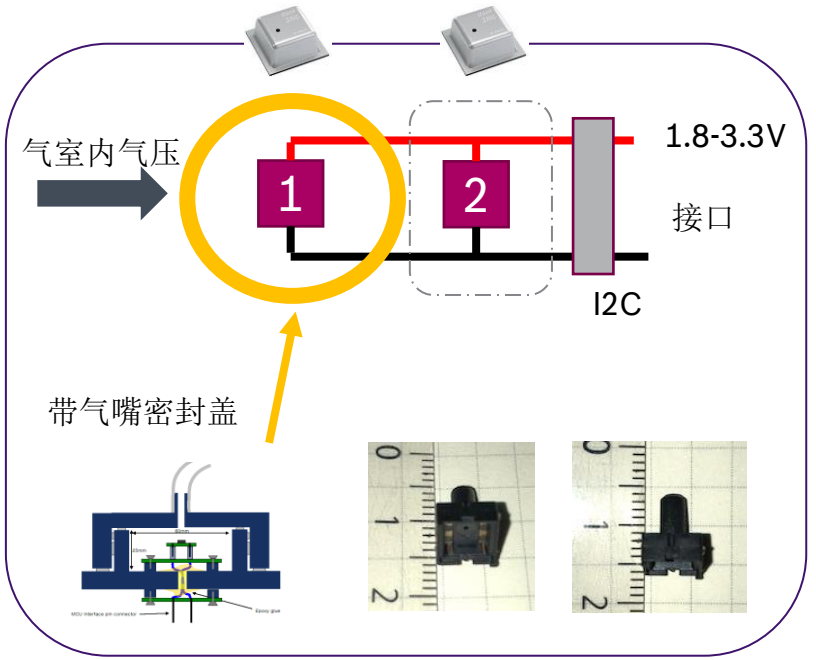
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博世气压传感器的原理和应用

水位监测



$$D=H+h=(P1-P0)/\rho g + (P1-P0)L/P1$$

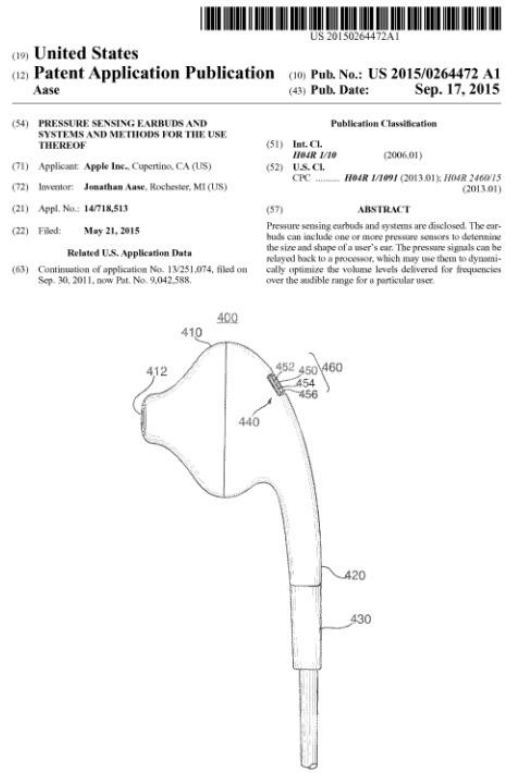




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博世气压传感器的原理和应用

气压传感器妙用多多



US 20150264472A1

(19) **United States**

(12) **Patent Application Publication**

Aase

(10) **Pub. No.: US 2015/0264472 A1**

(43) **Pub. Date: Sep. 17, 2015**

(54) **PRESSURE SENSING EARBUDS AND SYSTEMS AND METHODS FOR THE USE THEREOF**

(71) Applicant: **Apple Inc.**, Cupertino, CA (US)

(72) Inventor: **Jonathan Aase**, Rochester, MI (US)

(21) Appl. No.: **14/718,513**

(22) Filed: **May 21, 2015**

Related U.S. Application Data

(63) Continuation of application No. 13/251,074, filed on Sep. 30, 2011, now Pat. No. 9,042,588.

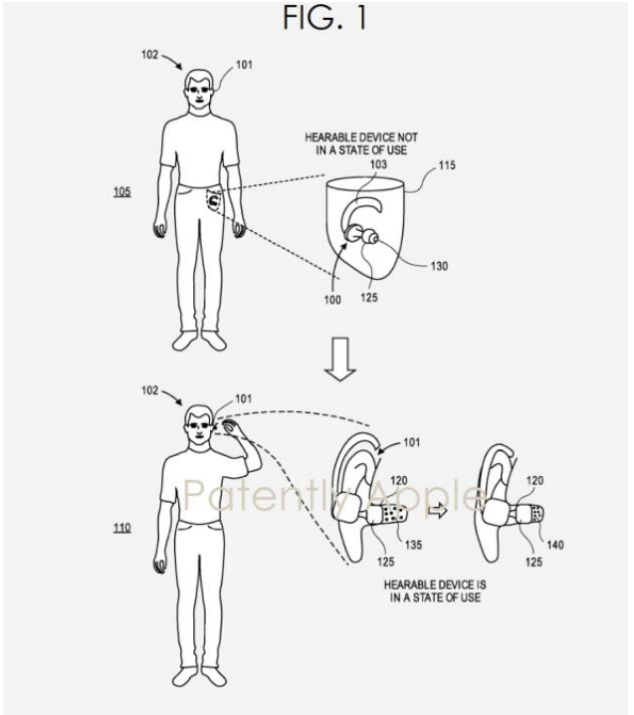
Publication Classification

(51) **Int. Cl.**
H04R 1/10 (2006.01)

(52) **U.S. Cl.**
CPC ***H04R 1/1091*** (2013.01); *H04R 2460/15* (2013.01)

(57) **ABSTRACT**

Pressure sensing earbuds and systems are disclosed. The earbuds can include one or more pressure sensors to determine the size and shape of a user's ear. The pressure signals can be relayed back to a processor, which may use them to dynamically optimize the volume levels delivered for frequencies over the audible range for a particular user.



一些行业知名公司在耳戴产品方面，自2011年就开始进行专利布局， 有多项基于气压传感器的解决方案。

[检测耳朵尺寸并相应调整音量]

[融合气压计数据监测入耳出耳]

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博世气压传感器的原理和应用

谁的儿童表更厉害



- 通信 – 电话 视频 短消息
- 安全 – 定位和追踪
- 社交 – 交友
- 辅助 – 购物 拍照 学习

儿童手表的新应用



跳绳是要考试的哦！！

学校里面乖不乖？？







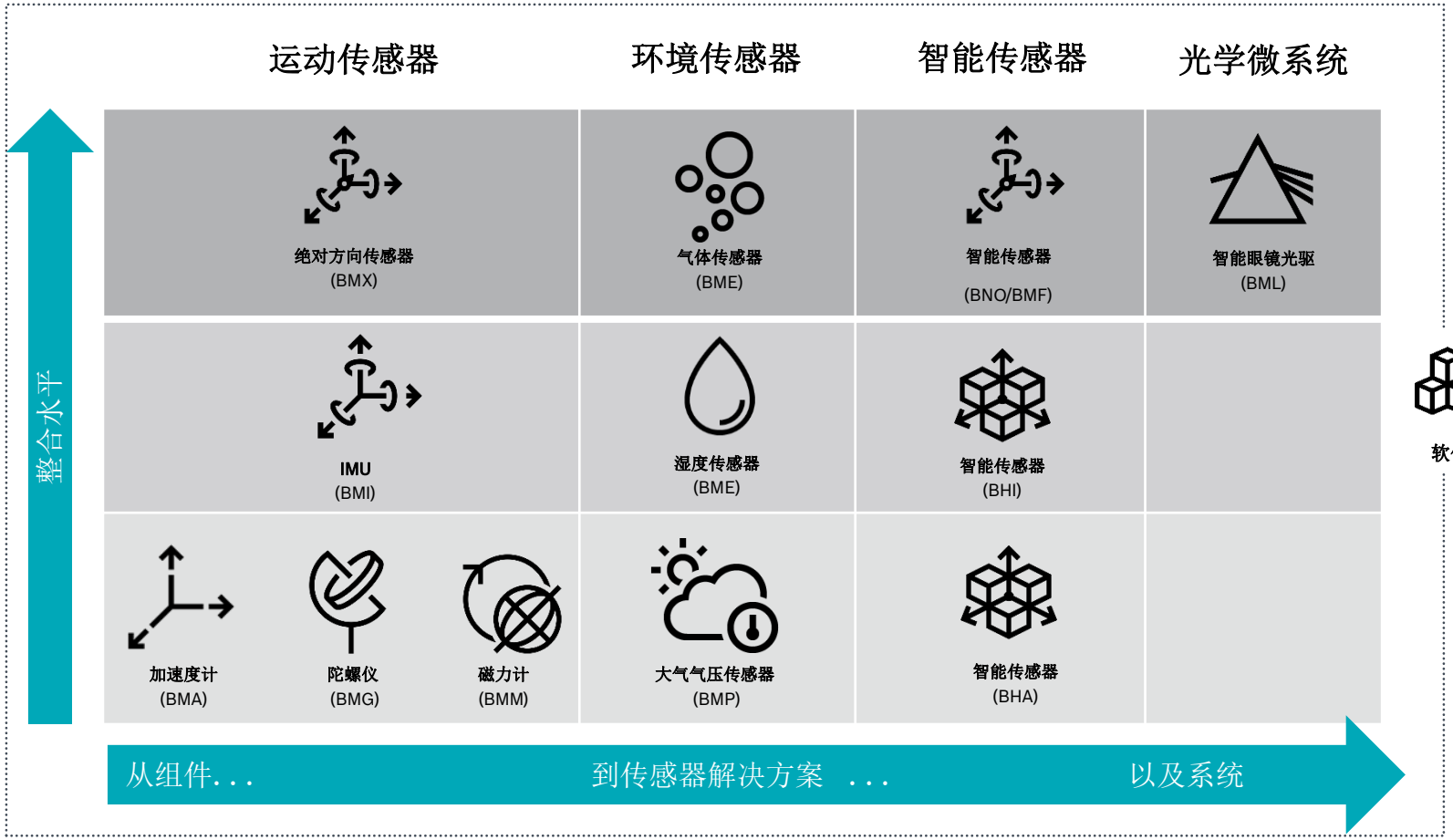


上下楼太拥挤，别摔了

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博世气压传感器的原理和应用

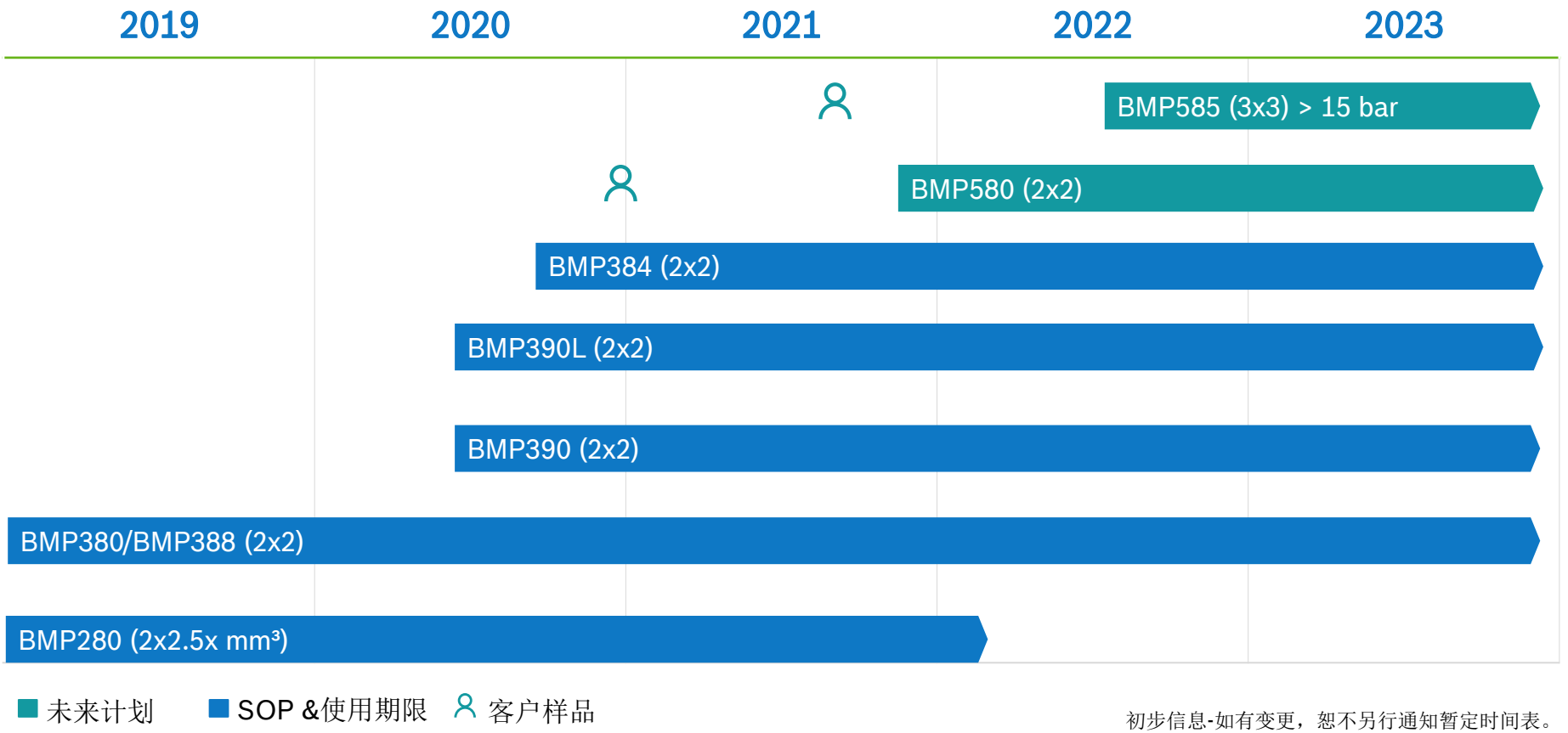
Bosch Sensortec传感器产品组合



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博世气压传感器的原理和应用

气压传感器路线图



初步信息-如有变更，恕不另行通知暂定时间表。

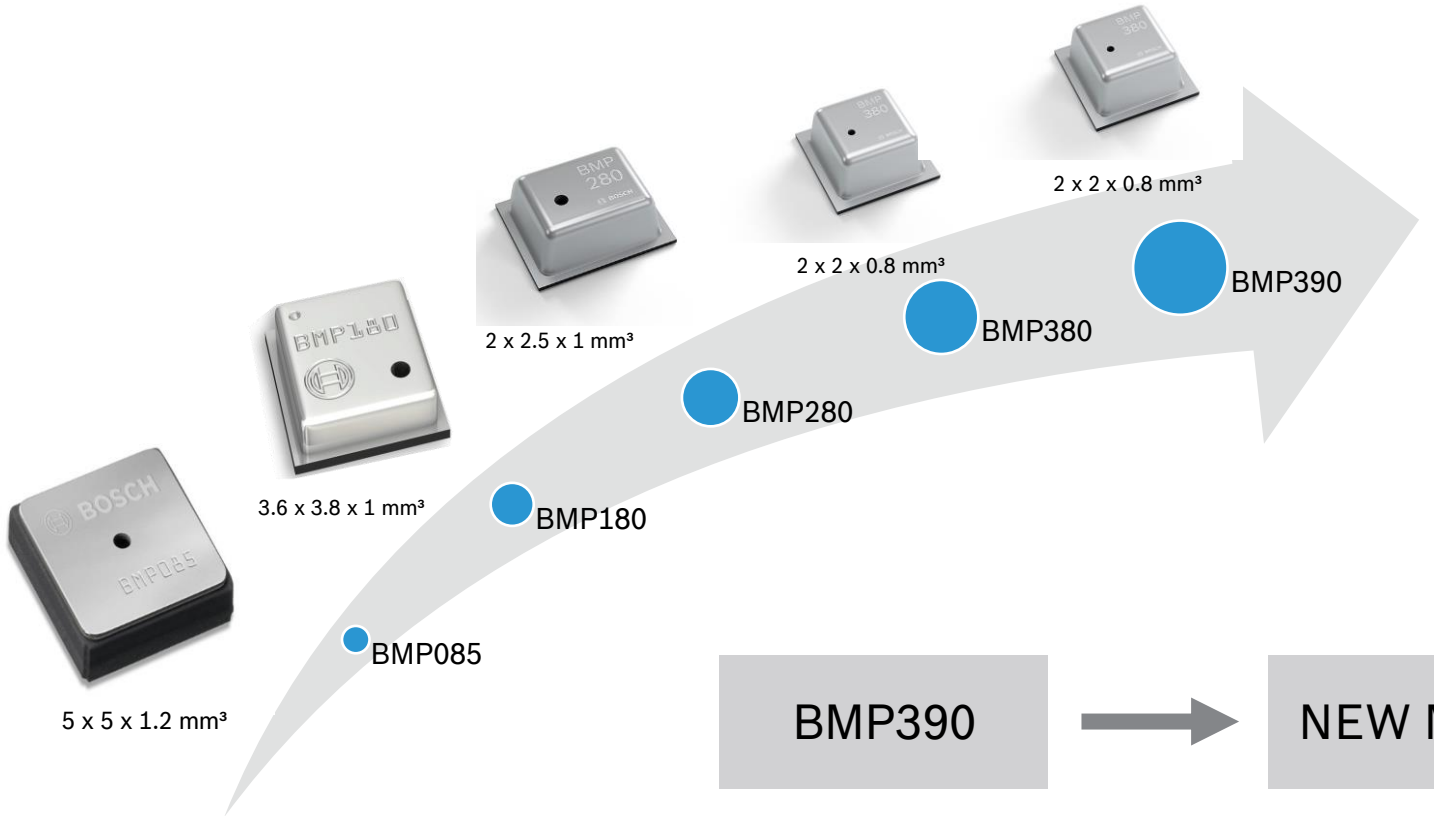
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博世气压传感器的原理和应用

气压传感器的演进

- 持续不断对产品的性能和尺寸进行改进和提升



BMP390 → NEW MEMS + NEW ASIC

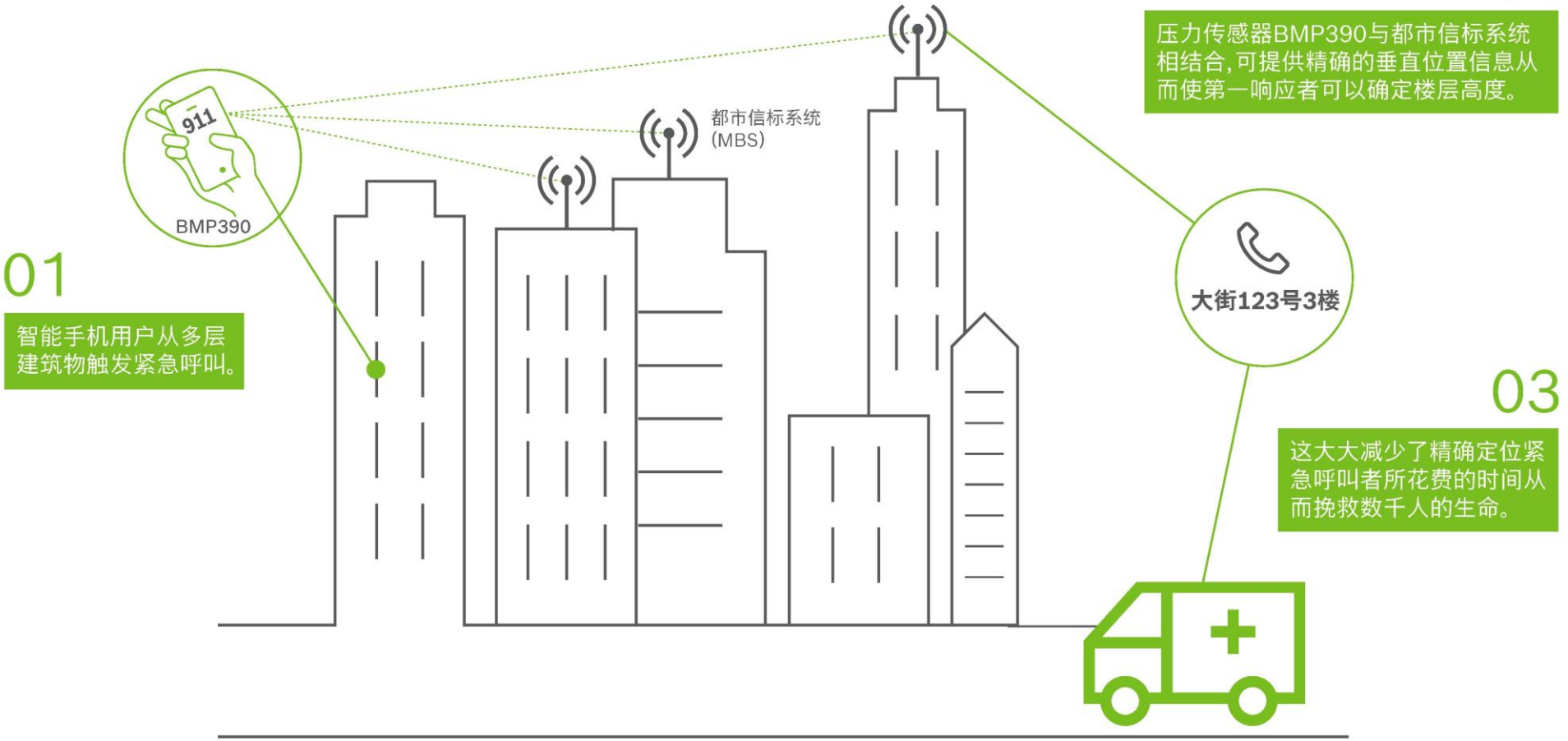
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博世气压传感器的原理和应用
BMP390在性能上有显著提升

Parameter		BMP280	BMP380	BMP390
	Operating Range	300 – 1100 hPa -40 – 85°C	300 – 1250 hPa -40 – 85°C	300 – 1250 hPa -40 – 85°C
Performance	Relative Accuracy (typ.)	+/-0.12 hPa (+/-1.0 m) (900 – 1100 hPa @25 – 40°C)	+/-0.08 hPa (+/-0.66 m) (900 – 1100 hPa @25 – 40°C)	**+/-0.03 hPa (+/-0.25 m)** **(700 – 1100 hPa @25 – 40°C)**
	Absolute Accuracy (typ.)	+/-1.0 hPa (900 – 1100 hPa @0 – 65°C)	+/- 0.5 hPa (300 – 1100 hPa @0 – 65°C)	**+/- 0.3 hPa** **(300 – 1100 hPa @0 – 65°C)**
	TCO (typ.)	+/-1.5 Pa/K (25 – 40°C @900 hPa)	+/-0.75 Pa/K (0 – 55°C @700-1100 hPa)	**+/-0.6 Pa/K** **(0 – 55°C @700-1100 hPa)**
	RMS Noise	0.2 Pa (lowest bandwidth, ultra-high resolution	0.03 Pa (lowest bandwidth, highest resolution)	**0.02Pa** **(lowest bandwidth, highest resolution)**
	Long Term Stability (1 yr)	+/- 1.0 hPa	+/- 0.33 hPa	**+/- 0.16 hPa**
	Power Consumption	2.8 µA @ 1Hz (typ)	3.4 µA @ 1Hz (typ)	3.2 µA @ 1Hz (typ)
	Solder Drift	-0.5 - 2 hPa	< +/- 1 hPa	**< +/- 0.8 hPa**
	Footprint	2.0 mm x 2.5 mm	2.0 mm x 2.0 mm	2.0 mm x 2.0 mm
	Height (typ.)	0.95 mm	0.75 mm	0.75 mm
	ASIC	No FIFO/interrupt	FIFO buffer/Interrupt pin	FIFO buffer/Interrupt pin
	Supported Protocols	I2C, SPI	I2C, SPI	I2C, SPI
	SOD	In MP	In MP	Jun 2020

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BMP390助力增强紧急呼叫功能



01

智能手机用户从多层建筑物触发紧急呼叫。

02

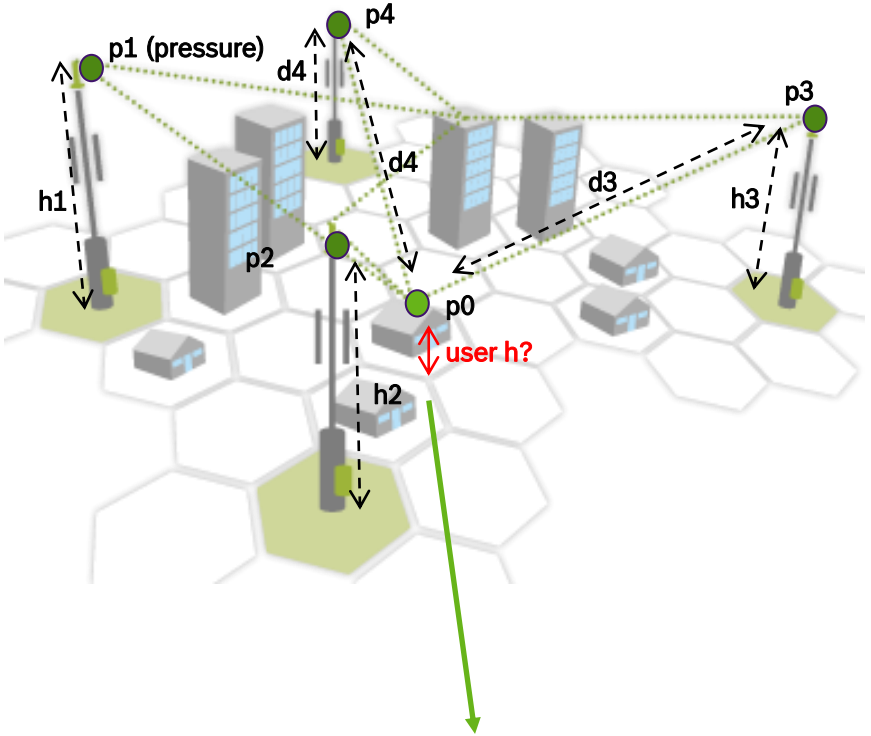
压力传感器BMP390与都市信标系统相结合，可提供精确的垂直位置信息从而使第一响应者可以确定楼层高度。

03

这大大减少了精确定位紧急呼叫者所花费的时间从而挽救数千人的生命。

博世气压传感器的原理和应用

3D位置和定位服务: 911 紧急电话





高精度气压计对快速定位有重要的帮助

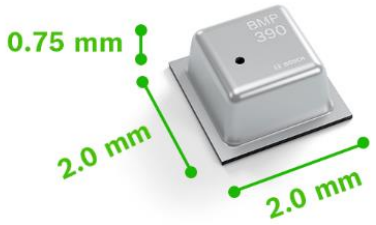


*user **location** (x,y,z) = **func(p1 – p0**, p2 – p0, p3 – p0, d1, **h1**, d2, h2, …)*

绝对精度，相对精度, TCO, 气压漂移，长期稳定性都是关键指标

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BMP390:
高性能气压传感器可应用于精确的海拔识别应用，
例如智能手机中的增强紧急呼叫功能。





博世气压传感器的原理和应用
长期供货的产品概念

- 更多的需求来自物联网/工业客户要求**延长我们产品的供货周期**。典型的要求是**10年**。
- 驱动程序:
  - 设计周期长>2年
  - 再鉴定费
  - 新开发的成本/风险
- 必须区分**长期供货**和**永久供货**的概念区别
  - 我们客户的主要需求是是**长期供货（10年）**
  - **永久供货**根据特定于客户/应用来规划：受特定应用案例的操作环境的影响
- 产品封装和其他非长期供货产品兼容



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