Application Notes on APD Areametric App: Automated area quantification for both Android and iOS

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ABSTRACT

Area measurements have a wide range of uses from the monitoring of skin features in healthcare, celestial bodies in astronomy, to determining furniture sizes in everyday indoor uses. Current measurement methods utilize some form of measuring tool and unless performed by skilled and trained professionals, human errors leading to inaccurate measurements can often arise. This is especially so for irregularly shaped objects with complex dimensions. To alleviate such inaccuracies, we created the APD Areametric native Android and Apple mobile application that leveraged upon image processing to more accurately determine areas of the defined object in images by using pixel ratios. This not only makes such measurement more convenient, but also greatly improves the accuracy and speed of area determination.

INTRODUCTION

With its ever-growing versatility, smartphones are now increasingly leveraged for clinical (Gan et al., 2016) and biomedical research (Gan & Poon, 2016), where expensive laboratory equipment can now be displaced by the smartphone (for example, Gel App in Sim et al., 2015; Colony Counter Pro in Wong et al., 2016; VibraTilt in Ng et al., 2016; etc.). Other uses include on-the-go analysis (for example, DNAApp in Nguyen et al., 2014; DNA2app in Sim et al., 2016; StanXY in Budianto et al. 2015; PsychVey in Nguyen et al., 2016), and for education (for example, AniCare and Wound Education apps in the app stores). It is undeniable that there are still many opportunities for more smartphone apps to further increase the convenience of scientific research and daily life.

Area measurements are often indispensable in scientific and medical processes. There is often the need to calculate the area of skin features (Okasa & Rosenbery, 1996; Gruul & Leun, 1982), and cell/tissue/organ areas such as for carotid artery stenting (Bosier et al., 2017), sleep research (Liberman, 1980), immunity (Sixt et al., 2005) and many others. In astronomy, the calculation of areas of celestial bodies such as sunspots (Smith & King, 1981) can also be of interest. Beyond scientific uses, businesses and daily life can also benefit from area quality control processes, such as consistent pancake sizes in the food industry, and buying exact-fitting furniture. Manual measurements in these processes can often be affected by human errors such as parallax errors, and depending on the process, can lead to dire consequences, such as those in delicate clinical processes.

To streamline and improve the accuracy of area determination, we created an automated image-based pixel area calculation smartphone app for both Android OS and iOS called APD Areametric app. The APD Areametric app utilizes the OpenCV image processing library and the in-built smartphone camera to analyze the user-defined image for a convenient and quick calculation of the object area. Users have a choice of using either the camera function of the phone to take a new picture or uploading an existing picture from

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the phone gallery for analysis. To estimate the area more accurately, the picture of the object of interest should include a coin of known area.

Leveraging on the portability of the smartphone and the universal use of coins, the app transforms the smartphone into a tool for more accurate, faster and easier area measurements than typical manual methods.

DEVELOPMENT AND METHODOLOGY

The APD Areametric Application for Android was developed using Android Studio version 3.0, and for iOS XCode 9.4. The OpenCV library for image processing resources was used in both the operating systems.

Calculation of area

On the selection of the coin reference, the user can choose the particular reference coin from the various countries listed in the dropdown list (Figure 1 left panel). The current version of the app incudes coins from Singapore, the United States of America, India, and Europe.

Figure 2 Left: Automated coin detection, Right: Confirmation of coin detection

Once the picture with the object of interest and coin is loaded (Figure 1 right panel), the coin would be automatically detected (Figure 2 left panel). In the event when the coin detection is inaccurate, the user may manually mark the coin in the image (Figure 2 left & right panel) by dragging (Android) or tapping (iOS) the circle position with pinching in or out to enlarge or shrink the coin mark.

Figure 1 Left: Selecting the appropriate reference coin, Right: Source of image
Objects are automatically detected following satisfactory detection of the coin (Figure 3 left panel). Should the detection be inaccurate, it can be manually traced using the “Edit” function. Upon user confirmation of object detection cropping method (Figure 3 right panel), the object area will be calculated based on the pixels in comparison to the coin. The final area will be displayed (Figure 5).

Formula

\[
\text{Actual area of coin} \times \frac{\text{Total number of pixels of object}}{\text{Total number of pixels of coin}}
\]

Figure 4: Formula used for object area calculation

The formula (Figure 4) utilizes the total number of pixels of the coin in the image and the pre-defined coin area to determine the area represented by a single pixel. The result is then used to compute the area of the object by multiplying it with the number of pixels occupied by the object.

Since the object area calculation is based on the pixel occupation of the coin and the object, the accuracy of the final measurement is highly dependent on the overall automated detection or manual object tracing process. If the automated object detection is incorrect, the user is advised to employ associated smartphone pens (generic soft round ball pens, or specialized pens of the Microsoft Surface Pro series, Samsung Tablets, and Samsung Galaxy Note series) for manual cropping, as was suggested for the APD Volumetric Application (Budianto & Gan, 2017).

APPLICATION AND LIMITATIONS

In skilled hands, efficient and accurate area measurements can be performed easily using APD Areametric App. The iPhone 7 smartphone with a manufacturer defined area of 92.80cm² could be reasonably accurately determined to be 92.71cm² in a matter of minutes (Figure 5). Other examples
of household items are also demonstrated in Supplementary Material. With the automated detection/skilled manual object outlining, we demonstrated convenient and reasonable accurate area calculation utilizing the app. Several limitations are present. Firstly, modifications cannot be made to the automatic cropping, requiring users to perform manual outlining from scratch if edits are to be made. Secondly, the coin database is limited. Lastly, both the coin and the object must be taken on the same plane; hence there may be decreased accuracy when calculating curved surface areas.

FUTURE WORK

Efforts are ongoing in expanding the coin reference database.

CONCLUSION

APD Areametric app is a native Android and Apple mobile application available in Google and Apple app stores that brings about convenience and efficiency in area measurements. The mobile application is stand-alone and does not require Internet connectivity or add-ons. In the effort towards convenience, accuracy and digitalization, APD Areametric app allows area determination on-the-go, doing away with laborious and tedious manual measurements.

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COMPETING INTEREST

SG is also the Editor-In-Chief of the journal. To avoid conflict of interest, the article was handled by an independent member of the editorial board. The article-processing-charge for this article was also waived for Bioinformatics Institute, A*STAR.

AUTHOR CONTRIBUTIONS

WWL drafted the manuscript and made the Android app. KYWY made the iOS version. IHB assisted with the algorithm for automated object detection. SKEG conceived the idea and supervised all aspects of the manuscript.

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Supplementary Material

Figure 1: Area of coaster determined by APD Areametric App

Figure 2: Calculated area of coaster measuring with ruler
Figure 3: Area of plate as determined by using APD Areametric App

Figure 4: Calculated area of plate from manual measurements
APD Areametric (APD 面积测量手机软件)

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简介

面积测量有着广泛的用途，例如用于在医学方面的皮肤疾病覆盖面积和天文学界的天体大小，甚至用于日常中的家具大小等等。然而，因为测量工具的局限和人为失误，现今对于不规则形状的精准面积测量仍存有挑战。为了改善面积测量的过程和精准度，一款使用图像分析技术的独立原生安卓和苹果系统手机软件—APD 面积测量手机软件（APD Areametric）因此而开发。此手机软件引用了OpenCV 图像处理方式和智能手机的拍摄功能对图像进行分析，从而带给使用者便捷、快速的物体面积的测量和计算。此过程非常简单、易操作。使用者只需使用手机内现有的相机进行拍摄（硬币需和物体一起拍摄）或者选择相册内已有的图像，便可通过手机软件得知物体的面积。

为解决以上的问题，一款使用图像像素比例来实现面积测量和计算的安卓和苹果原生手机软件—APD 面积测量手机软件（APD Areametric）因此而开发。APD 面积测量手机软件引用了 OpenCV 图像处理方式和智能手机的拍摄功能对图像进行分析，从而带给使用者便捷、快速的物体面积的测量和计算。此过程非常简单、易操作。使用者只需使用手机内现有的相机进行拍摄（硬币需和物体一起拍摄）或者选择相册内已有的图像，便可通过手机软件得知物体的面积。

在许多研究过程中，面积测量是不可缺乏的一部分。在生物医学研究中，时常需要被测量的包括皮肤疾病覆盖面积(Okasa & Rosenbeery, 1996; Gruul & Leun, 1982)、细胞/组织/器官面积、颈动脉支架手术(Bosier et al., 2017)、睡眠研究 (Liberman, 1980)、免疫学(Sixt et al., 2005) 等。在天文学中对天体区域的计算也存有意义，例如太阳黑子的面积 (Smith & King, 1981)。不仅如此，面积计算软件也对日常生活带来便捷，比如烘培时确保松饼大小的一致，装修时对家具大小的测量等。这些例子都体现了人们对面面积测量的需求。然而，传统人工测量方式容易产生视觉误差，尤其使用与专用的临床过程中从而导致不堪的后果。
减少了对工具的依赖，并且提升了测量及计算的速度和准确性。

**开发方式**

APD 面积测量安卓系统手机软件开发于 Android Studio 3.0 平台，苹果系统手机软件则开发于 XCode 9.4 平台。手机软件中的图像分析则参考并使用了 OpenCV 中的些许资源。

**面积测量方式**

![图一，左：选择所使用于拍摄的硬币，右：选择图像获取方式](image1)

由于硬币在图像中扮演着参考对象的角色，使用者可从界面中选择所用于做参考的硬币（图一左）。现手机软件内包含的硬币为：新加坡、美国、欧洲以及印度。

![图二，左：自动识别硬币，右：确认硬币识别或更改](image2)

同时，使用者可直接使用智能手机中现有的相机拍摄功能或选择相册中存有的图像（图一右）来进行分析。使用者随后可选择此款手机软件内独有的自动化识别模式来找图像中的硬币，用于辅助后续的面积计算（图二：左）。若在硬币自动识别过程有误时，使用者只需通过拖动图像中的硬币标记以及放大或缩小的手势对硬币识别进行修改。

![图三，左：自动生成形识别，右：确定裁剪或更改](image3)
紧接着，就是对图像中的物体进行识别。使用者可同样使用自动化模式（图三左）来获取物体在图像中的所在处，若出现不准确物体识别，使用者可使用“更改”功能进行手描勾取物体轮廓。当图像中的物体和硬币被准确识别/手描勾取后，按照计算公式，可得出物体的实际面积。

公式

\[
\text{硬币面积} \times \frac{\text{物体形成像素数}}{\text{硬币形成总像素数}}
\]

图四：计算公式

该公式（图四）应用了硬币的实际面积以及硬币在图像中所占有的总像素数量的比例来计算出每面积的像素数量，再将此结果与物体在图像中所占有的总像素数量相乘，从而得出物体的实际面积。

由于物体实际面积的计算方式与像素息息相关，最终测量的准确度将依赖于整体自动化识别/手描勾取物体的过程。从这层面来说，要充分利用该手机软件，在进行手描时，建议使用智能手机笔，如同使用APD Volumetric app（Budianto & Gan, 2017）时使用微软Surface Pro 、三星平板电脑与Galaxy Note系列等的手机笔来进行手描勾取。

应用和限制

图五：面积测量结果

APD 面积测量手机软件是谷歌应用商店（Google Play Store）和苹果应用商店（Apple App Store）上唯一测量面积的软件，用途十分广泛。通过此方便的面积测量手机软件大幅度的提高了效率和测量的准确性。根据我们的实验，一部实际面积为92.80平方厘米的iPhone 7，通过APD 面积测量手机软件，可测量出的面积为92.71平方厘米（图五）。其次，在补充资料中也包含了其他实验的例子。由此可见，正确的使用自动化识别/手描勾取，我们可获得相当准确的面积。但随之会有所不足之处在于无法对自动化模式中识别出的物体做出实际的修改。其次，目前APD面积测量手机软件的硬币数据库偏小，但随着后续的发展，数据库将会逐渐扩大。同时，所应用的图像中硬币和物体需在同个平面角上，否者测量的准确度将受到影响。

未来计划

我们将继续扩大硬币数据库使更多硬币能被应用于测量。
结 论

APD 面积测量手机软件是一款安卓和苹果系统的原生手机软件为测量及面积计算带来了便利与效率。该手机软件无需互联网以及其他设备的支持。面积的测量和计算只需通过分析便可获得，省去繁琐的手动测量和计算，促使整个过程更加便捷，准确和数码化。

致 谢

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利 益 冲 突

颜庆应是此期刊总主编。为了避免利益冲突，文章的审查及评论将由其他期刊编辑委员执行。此文章免除了出版费。

作 者 贡 献

吴炜铃起草了手稿并制作了安卓手机软件。杨裕伟制作了 iOS 手机软件。任德峻协助于硬币自动化识别算法的过程。颜庆应构思了软件的概念并监督了程序的全过程。

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补充资料

图一：通过 APD Areametric 手机软件对杯垫进行的面积计算

图二：通过尺子对杯垫进行的测量与计算
图三：通过 APD Areametric 手机软件对盘子进行的面积计算

图四：通过尺子对盘子进行的测量与计算