Mini Review

BIOMEDICAL Journal of Scientific & Technical Research

ISSN: 2574 -1241

DOI: 10.26717/BJSTR.2020.31.005083

Survey, Assessment, and Improvement Suggestion of Mobile Food Scanner

Israel Agwu Etu* and Andreas König

Lehrstuhl Integrierte Sensorsysteme (ISE), TU Kaiserslautern Deutschland

Corresponding author: Israel Agwu Etu, Lehrstuhl Integrierte Sensorsysteme (ISE), TU Kaiserslautern Deutschland

ARTICLE INFO

Received: October 09, 2020

Published: October 21, 2020

Citation: Israel Agwu Etu, Andreas König. Survey, Assessment, and Improvement Suggestion of Mobile Food Scanner. Biomed J Sci & Tech Res 31(2)-2020. BJSTR. MS.ID.005083.

ABSTRACT

Increasing issues in food and medical products fraudery, contamination, and freshness urgently raises the need of on-site and immediate analysis and evaluation. The advent of more and more capable integrated sensory systems with Machine Learning allow the conception of low-cost mobile scanning devices. This paper presents a survey of state-of-the-art mobile food scanners, comparing their aptness by suitable criteria and features. The paper concludes with a suggestion of an improved approach and scanner architecture learning from disclosed deficiencies. With these information, some areas of deficiency in the functionalities of the scanners have been identified and there is an effort towards a contribution to address these perceived shortcomings.

Keywords: Mobile Food Scanners; MEMS; Spectroscopy; Fingerprints; Machine-Learning

Introduction

There are various laboratory desktop spectral analyzers, which are usually large, bulky, and expensive, such as mass spectrometer and gas chromatograph. Examples are ISQ 7000 Single Quadrupole GC-MS system by Thermofisher [1] and VERTEX 80/80v FT-IR spectrometer which offers a wide spectral band of 200nm-2000µm [2]. The analytical capability of these devices is unrivaled, but they are not immediately and continuously available for many application scenarios of growing importance. Furthermore, integrated and low-cost sensory systems exhibit a massive ramp-up of capability in real time inline monitoring and multi-sensing, including gas sniffing for point-of-care (PoC), as well as food and drug detection or water analysis. An established example is the low-cost mobile breath analyzer which e.g. uses ethanol gas sensor or IR spectroscopy to determine blood alcohol concentration. This work surveys a selection of relevant set of these products and solutions with a view to identifying their strengths and weaknesses. In addition to world-wide activities on food-scanners, here at ISE devices and system solutions in the frame of ambient assisted living, food authenticity, freshness, and adulteration detection have been pursued, leading to the Lab-on-Spoon and Lab-on-Fork, and the E-Taster system [3]. Visual and NIR as well as impedance spectroscopy have been applied in these devices to give a multi-sensory fingerprint of food samples. Currently, extensions to more fine-grained spectroscopy, have also been pursued by the AMS company (former MAZet) with a new family multi-spectral sensors in a device denoted as Tricorder, and IR/UV fluorescence are pursued and partially realized.

Table 1 shows a survey of relevant state-of-the-art food, drug and lubricant scanners. Lab-on-spoon/Fork use visual, NIR and impedance spectroscopy, with white LED and NIR-Vis and impedance sensors. Wavelength is 750nm and fingerprint database is local [3]. Tellspec, Fraunhofer scanner, Scio, Nirone, Trinamix Hertzstück and Bosch X-Spect use NIR spectroscopy to sense food [4-9]. Tellspec uses reflective two-integrated laser diodes as radiation source, operates at 900nm - 1700nm with 1mm InGaAs detector. Its database is cloud-based and results are displayed on a mobile app. Fraunhofer food scanner uses bluetooth and can also differentiate between plastic and wood. Scio also senses drugs and operates within a distance of 1.5cm. Nirone uses two integrated signal sources with Fabry Perot and RGB sensors. Wavelength is 1550nm -1950nm and database is cloud-based. Trinamix Hertzstück uses BASF infrared sensor and connects to mobile devices via USB cable for display. Bosch X-Spect also detects textiles and stain, and sends washing setting to a Bosch washing machine. It uses two optical detectors and displays results on a screen on

 DOI: 10.26717/BJSTR.2020.31.005083

its body. Foodsniffer through gas sensing detects CO_2 and ammonia and so determines rotten fish, poultry, and beef [10]. Grape scanner was realized through fluorescence spectroscopy [11]. It determines the ripeness of grapes in the farm and sends the information via WIFI to a central unit in the city. Nima uses chemical reaction to determine the proteins in gluten [12]. It uses a disposal capsule for each analysis. Bravo and TruNarc employ Raman Spectroscpy to detect prohibited drugs [13,14]. Both have touch-screen body display with cloud-based database. Bravo operates within a wave number range of 300cm^{-1}- 3200cm^{-1}.

Table 1: Survey of Relevant State-of-the-Art Food and Drug Scanners.

Name	Sensing Tech.	Substances Sensed	Illumination Mode	Spectral Wavelength	Detector	Filter	Comm. Mode	Other Features
Lab-on-spoon [3]	Visual, NIR & impedance spectroscopy	Cooking oil, liquid ingredients	White LED in an open mini bowl	750nm	NER.-Vis & impedance sensors	-	Xbee&USB CABLE	Handheld device in a spoon shape: local database (e-cookbook); charged via USB
Lab-on-fork [3]	Visual, NIR & impedance spectroscopy	Powdery; granular; solid foods	Open illumination, white LED	750nm	NIR-Vis & impedance sensors	-	Xbee&USB cable	Handheld device in a fork shape: e-cookbook; charged via USB
Tellspec [4]	NIR Spectroscopy	Foods substances	Reflective-two integrated lamps	900nm -1700nm	lmm ITIQR.,AA (uncooled)	Micro-mirror	Wireless with cloud	Size: 82.2mm x 66mm x 45mm; USB, built-in battery; Battery: 1200 scan
Fraunho fer Food Scanner [5]	NIR Spectroscopy	Foods substances	Infrared source	-	NIR sensor	-	Bluetooth with cloud	Can also differentiate between plastic, woods
Scio [6]	NIR Spectroscopy	Foods & drugs	Infrared source	-	NIR sensor	-	Bluetooth with cloud	Operational distance: 1.5cm: Size: 54x 36x 15.4
Nirone [7]	NIR Spectroscopy	Foods substances	Two integrated light sources	1550nm – 1950nm	Fabry- Perot; RGB sensor	-	Bluetooth with cloud	1000 measurements in a single charge
Foodsniffer [10]	Gas sensing	Beef, poultry and fish	Not applicable	Not applicable	Senses CO2 and NH2,	Not applicable	Bluetooth with cloud	Handheld device
Trinamix Hertzstuck [8]	NIR Spectroscopy	Plastic, protein, oil, sugar, starch	Infrared source	-	BASF infrared sensor	-	Micro USB cable	Handheld device
Grape Scanner [11]	Fluorescence spectroscopy	Grape ripeness	Visible light	-	-	-	Wifi from farm to city	Handheld scanner
Bosch X-Spect [9]	NIR Spectroscopy	Foods, textile and stain	Open illumination	-	2 optical detectors	-	Wireless to cloud	Handheld device
Nima Gluten Sensor [12]	Chemical reaction	Proteins in gluten	Anti-body	Not applicable	Not applicable	Not applicable	Not applicable	Handheld device: uses disposable capsule
Bravo [13]	Raman spectroscopy	Drugs	Open illumination	300 cm-1 to 3200 cm-1	-	-	WLAN	Body display touch screen, Handheld device, SSE
TruNarc [14]	Raman spectroscopy	Drugs	Open illumination	-	-	-	-	Body display touch screen, Handheld device

So far, none of these surveyed devices analyzes in an enclosure, to avoid influence of straying light. None of them has the provision to accommodate both substances that are not infrared-active and those that are not Raman-active alike. Only Lab-on-spoon/Fork, Nirone and Bosch X-Spect employ more than one sensor. Only Tellspec and Nirone excite with more than one signal source. The rest use only one excitation source and one detector. To match the competitiveness of existing devices, this work aims to achieve an integrated measurement system that in domain-specific application sufficiently approaches the capabilities of established laboratory analytics [13,14]. The goal is to realize an improved hand-held device with both extending ranges of methods (e.g. spectroscopy), in combination with several sensory modes, such as gas/smell (for rotten food and PoC), viscosity and pH, for higher accuracy and enhanced versatility. Radiation sources would comprise ultraviolet, visible, NIR and MIR emitters. This is to take care of substances that are only IR-active and those that are only Raman-active alike. The viscosity and pH sensors are to improve detection of aqueous substances. Point-of-Care (PoC) would be achieved with gas sensor and aimed to estimate blood glucose. This is to enable the user of the device control their diet. All these sensory modes would produce rich fingerprints needed to achieve improved accurate predictions. The casing would have a mini bowl with a flip lid for analysis of aqueous substances in an enclosure. The bowl can be shifted away from the sensing window of the device, to carry out analysis with open illumination. Moreover, a provision would be made to grant the user the privilege to add more fingerprints to the database of the device.

By the foregoing, a survey of relevant food, drug and lubricant scanners has been presented. Deficiencies have been observed in the range of substances analyzed, with achievable accuracy, and PoC extension. Emerging device would implement the multi-sensory and ML-technique in a way that these weaknesses would be addressed and further approach SoA laboratory equipment.

References

1. https://www.thermofisher.com/order/catalog/product/ISQ7K-VPI#/ISQ7K-VPI
2. https://www.bruker.com/products/infrared-near-infrared-and-raman-spectroscopy/ft-ir-research-spectrometers/vertex-series/vertex-8080v.html
3. https://www.eit.uni-kl.de/koenig/gemeinsame_seiten/projects/E-Taster.html (Ac. 11th Mar, 2020).
4. https://tellspec.com (Ac. 11th March, 2020).
5. https://www.fraunhofer.de/en/press/research-news/2019/january/pocket-size-food-scanner.html (Ac. 11th Mar, 2020).
6. https://www.consumerphysics.com/scio-for-consumers
7. https://www.spectralengines.com
8. https://trinamix.de/nir-spectroscopy/applications/#app-3
9. https://www.ireviews.com/news/2017/09/05/bosch-x-spect-food-fabric (Ac. 11th Mar, 2020).
10. https://steamykitchen.com/42865-foodsniffer-review-giveaway.html
11. http://www.pr.uni-freiburg.de/pm-en/online-magazine
12. https://medicalfuturist.com/testing-food-gluten-home-nima-sensor-review (Ac. 9th Feb, 2020).
13. https://www.bruker.com/de/products/infrared-near-infrared-and-raman-spectroscopy/raman/bravo.html (Ac. 11th May, 2020).
14. https://assets.thermofisher.com/TFS-Assets/CAD/brochures/trunarc-handheld-narcotics-analyzer-brochure.pdf

ISSN: 2574-1241

DOI: 10.26717/BJSTR.2020.31.005083

Israel Agwu Etu. Biomed J Sci & Tech Res