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Mobile Based Applications for Nutritional Significance: Indian and Global perspective

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ABSTRACT

The colossal growth in Smart phone applications is proving to be a massive game-changer in almost every aspect of modern life and the food industry is no exception. An ever growing number of mobile apps designed for the food industry and which actively benefit the lives of smart phone users are in the area of health and nutrition. These smart phone Apps (Applications) are simple to use, can run on any platform and are hugely popular. For the purposes of this paper, numerous Applications that focused primarily on health and nutrition, such as Nutrition and Fitness Apps, Smart phone Sensor Apps, Apps based on Shelf life of Food, Nutrition/ Disease Apps and other Apps inclusive of Data image processing have been thoroughly researched and their 'user friendly' applicability tested. As shown in the paper, the analogous function of each App was evaluated with regard to how they enhanced user's ability to analyze the quality aspects of food through data image processing and other various significant upcoming features and digital tools to help analyze foods with regard to current App development requirements and a basic understanding of the Application.

Key words: Food applications, data image processing, digital food quality analysis.

Introduction

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"It is not the strongest of the species that survives, nor the most intelligent that survives. It is the one that is most adaptable to change."- Charles Darwin. Today is the Smartphone era where every human is adapting to the digital world, around 71% of the world population will reach 5.9 billion users of smart phones by 2025, mostly driven from China, India and the Other developing nations (The Moblie Economy Global, 2018). Recently, the use of mobile applications is rapidly soaring as users want instant information without having to turn on their computers (Islam and Muzumder, 2010). Digitization offers several opportunities and provide ready to use services in your hands, aiding it's users in areas such as health, nutrition, diets, food purchasing habit etc. (Okumus and Bilgihan, 2013). Smart phone applications are significant tools, proving users with information, support, record, instructions, monitoring and guiding individuals in every aspect of life. Novel evidence technologies have allowed the scientific community's and its participants to familiarize adopt, and control new approaches for almost 300 years. The digitization of scientific collections is an important technological advancement that is now being actively embraced by an ever increasing number of museums and academic institutions. The benefit of this digital technology is that it allows for the ease of access to vast amounts of information for research purposes to a vastly greater number of people which was not possible before. With vastly improved access to core biodiversity information, this has a transformative impact globally. Its usage increases and becomes more relevant to society which increases its value, for example, in the administration of natural resources, strategy improvement, food safety, and terrestrial and individual health (Ramesh et al., 2009).

An Application (Mobile App) can review, store up, homogenize on appliance. These are minute documentation libraries or identical record buildings stored on or associated with

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the mobile phones. A machine works parallel to software operating system hardware (Boulos et al., 2011). Numeral Apps have improved considerably, and additional more than forty thousand medical- fitness and health apps at present are handy (IMS institute of Healthcare, 2013). In India, during peak seasons, it is a difficult task, grading fruits manually due to non-availability of manpower and hence proves expensive as well as time consuming (Narvanker and Jha, 2005). Post-harvest, electronically controlled grading based on shape, size and color of highly perishable fruits and vegetables like apples, tomatoes, papayas, pineapples, etc., and this process corroborates more efficient results entirely based on scanning based on the external visible traits (Nalawade and Wandkar, 2013). Researchers are now trying to bring the supreme quality of food grading avoiding possible drawbacks usually faced by costly labor. One such study provides a sorting system for citrus fruits (lemons tangerines and oranges) on fundamental grounds of their size, color, defect and shape (Khojastehnahand and Tabatabaeefar, 2011). A study by Nahir (1986) proved, the impact pH and physical features like color, stiffness and weight based on Newton's law of motion in order to grade tomatoes via separating, measuring and data processing. Poor consumers of less developing countries do not stand a chance to distinguish between the grades and standards (Reardon et al, 2001). Clearly, the perishable fruits and vegetables are made available to the consumers straight from farms to the agents who manually on their own judgment sort, grade, package and transport to the wholesalers. The whole sale's traders sell the items into the retailers for making available the perishable fruits and vegetable by vending in shops, push carts, tricycles, vans, etc. During the food supply chain processes the perishable items are highly vulnerable to quick deterioration due to poor investment and regulation in food standardization as a result low quality food is supplied inconsiderably to the consumers everyday (Piali and Pati, 2011).

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Technically, the grading and sorting strategies require up gradation since the growers/suppliers take food standardization into their own hands despite of the ill knowledge and skills (Rais and Sheeran, 2015). Whereas, in the developing and developed world in recent years. Post harvest grading is easily evaluated by high automation infused with Mechatronics, robotics and near infrared check technologies in turn to warrant the proper food security of its citizens (Naoshi, 2010). In contrast to the developing India most farmers and agents manually sort fruits and vegetable items based on either size or appearance (Deodhar et al, 2006).

National Digital Initiatives and Goals

"Digital India" agenda inaugurated by The Honorable Prime Minister, Modi on July 2015, mapped out his plan to digitize services provided by central government departments such as health and education and deliver these services to citizens throughout India using Information and Communication Technology (ICT) and an integrated high-speed broadband internet network. The implementation of this plan will involve the setting up of Public-Private Partnerships where possible, further development of the National Informatics Centre and the appointment of 10 new Chief Information Officers. The project will be managed by the Department of Electronics and IT, which will appoint senior management positions to take charge of this initiative.

Food Safekeeping and International Millenium Development Goals

The Sustainable Goals 2030 (UNDP), based to endorse imperative benchmarks that in the improvement of human wellbeing, these goals constitute of the Goal No. 2 (Zero Hunger), Expand funds via international involvement, in bucolic infrastructure, growth in complete

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food production, technical enrichment. Worldwide, 1 out of 9 humans,(795 million) are undernourished. Further, Goal No. 4 (Quality Education), increasing the grant for training, education workforce in the developing and developed nations through the international support by the year 2030.Goal No. 9 (Industry, Innovation and Infrastructure) - Technological movement is essential to locate explanations for monetary and ecological challenges, such as promoting standardized industries and financially supporting researchers in science and innovation for quality disease free food availability. (Sustainable Development Summit, September 2015).Edible product evolution and transformation continue to be seen as an elemental approach for emerging spread and continued existence contained by a fast growing global market (Grunert, 1997). Despite of this knowledge, it is estimated that between 72 and 88 per cent of latest edible foodstuffs still persists to fall short. This is the difficulty that retailers/vendors account for in recent years. Marketing costs are rising,which, according to Peattie (1997) presents a challenge for non-first choice household brands to maintain sales. Traditional food packaging, up to recently, was used to market the produce, protect against contamination and maximize the holding capacity of the produce. Active Packaging, contrasting to local packaging, is much more successful in increasing the shelf life of the produce because of its contact with the contents or the adjoining environment. Active packaging frameworks are accurately assimilated to augment the holding capacity of foods, and can be categorized into releasing and absorbing frameworks (for example, moisture and liquid absorbers, antimicrobials, absorbers or releasers, flavor, odor, oxygen scavengers and ethylene scavengers, etc.). In addition, food purchases are adapting to the demands in conditions of standards and good options (Swinnen, 2007).

Quality Instability of the Food Sector

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The food production sector rates among the topmost ten industries applying computer visualization technology (Gunasekaran, 1996). The lack of technical and financial resources in developing countries, hamper the application of and compliance to the necessary strict food safety standards that are required. Lack of investment in infrastructure, newer technologies and testing facilities are well recognized limiting factors. To facilitate trade in these developing countries International agencies have assisted with capacity-building projects with help from agencies like UNIDO and FAO. Certain developing countries in Latin America, Asia, and the Caribbean and Africa, over the last ten years have been implemented and inspection procedures under the Hazard Analysis Critical Control Point (HACCP); (Orriss, 2000). However, as new hazards are acknowledged, developed countries introduce stricter standards in food security and quality reassurance for developing countries However, it common that standards differ for the same foods across industrial countries. Moreover, industrialized countries do not recognize inspections and standards of the developing countries as equivalent. The problem is that major importing industrial countries push for 'sameness' in processes rather than accept 'equivalence' in standards. Food exports continue to be a substantial source of foreign exchange for India as a rapidly industrializing the United States and Western Europe has laid foundations, Indian exporters more recently to focus on standardized products (Sawhney, 2005).

Consumer Outlook Toward Food Selection

When it comes to the purchasing of fruits, vegetables and groceries, socio-demographic considerations such as age, gender, income and even education are significant influences. Purchasers also consider certain aspects such as price, quality and freshness, variety of choice, convenience and packaging and out of season obtain ability when buying

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food products. Consumers also place important value on where they choose to shop for groceries. The socio-demographic report of customers (age, education, income and gender,) notably impacts the primary factors of merchandise and food purchase decision. (Prema-Chandra and Sisira, 2003).

Apps Vitality for Quality Investigation of Food/Nutrition

The quality of a food product is determined by numeral factors like appearance, taste, nutritional quality and its ability to stay fresh. From a food safety aspect, it is important that the quality of a food product is monitored, which, when done effectively ensures that the product will be selected for purchase by a consumer. Sensory evaluation is multifaceted component consisting, interpretation, measurement and comprehension of a person's reaction to product characteristics as apprehended by the wits such a sight, smell, touch and taste (Singham et al., 2015). As a result administrations ought to question and impose food labeling legislation that heads to the consumer friendly, development of clear, transparent food systems (Perez-Escamilla et al., 2017).

Mobile Technology in Post Modern Age

Rise of smart phones and the immense multiplicity of applications offered of all types.Roughly 22% of the world's inhabitants own one Smartphone (Bert et al., 2014). Modern information technology and communication has tough possibility to facilitate generation of SMART(S- Specific, M-Measurable, A- Achievable, R- Realistic and T-Time bound) indicators are reasonable and expenditure effective, that supply valuable information on choice makers to make judicious decisions affecting diverse food from local to global stages (Prev-Escamilla et al., 2012). The exercise of technology has intended to lessen the

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individual load, progress reporting by plummeting measurement faults and predisposition, lessening expenses and resources associated with data assortment, reporting and coding (Ngo et al., 2009). Its application of food journals has concentrated on attuning them for application with personal computer based mobile assistance, smart phones (Wang et al., 2002). Assimilating the utilization of imagery (Lee et al., 2012), push notification (Nelson and Bingham et al, 1997), recording of voice options, reduce physical diet related coding (Puri et al., 2009).

Rated Functional Food Nutrition Android Based Applications and Their Prominent Features

Table 1 presents the distinguished features of various prominent android based applications. More than 50 Apps found in Android studio were downloaded and checked for their basic features such as, if they consist of the image processing unit, barcode scanning, nutritional information, health benefits, menus and the developer's website visited to look for any further information regarding particular Application under investigation. All these applications were studied on the basis of the rating given to them of Appstore, meaning that customers had used them prior to the study and were satisfied with its functionality. Such Apps can run on smartphone that has a good internet connection and by anyone who owns apersonal device.

Nutrition and Fitness Apps

Various Apps have functionalities for the wellbeing, fitness, weight loss through diet and nutrition. *My Fitness Pal*has peculiar features with over fifty million downloads comes with a barcode scanner, calorie counter and water tracker (Lee et al, 2010). Water is an

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essential element of life plays a vital role in nutrition and diet, intake of water is instantly recorded on *Waterlogged.* It is well suited to record consumption and fitted alerts/ smartphone generated alarms are setoff in order to meet daily fluid goals (Ritter et al, 2016). *Change-4-Life Food Scanner*finds out to contain calories, fat, salt and sugar in susceptible food and drinks available in 100 grams/portion/ml, provides information available only to users in the United Kingdom scheme offered and developed by National Health Services (National Health Service, 2018). *My Net Diary Calorie Counter* provides interactive platform for users and registered Dietitians/ Nutrition expert bloggers to analyze a potential users health status from the data enlisted in the Apps user information section enabling a mobile nutrition advise be generated by experts on the other side working from miles away, apart from this features like track diabetes, carbohydrate counter and meaningful insights inform of charts and displays forms a useful nutrition and health platform for users who prefer instant help relate to improving overall health and wellbeing (Hill and Smaliak, 2007). Calories eaten and burned in a day are graphically presentedby *MyPlate* App (Lee et al, 2015). For sports personnel *NutriSportEx* formulates dietary intake on basis of Malaysian food database and nutrient availability, giving aninfo graphic report of nutrition analysis and helpful tips according to competition sports guidelines making certain sports person's acquire their nutrition goals, weight aims and proper guidance that require them to be fit preferablyphysical fitness trainees participating in a game with set rules on their weight status and general health (Pushpa et al., 2018).

Smart Phone Sensor Apps

Dietsensor provides a premium plan for users consisting of fast logging in, personalized nutrition coach, food suggestions, habit analysis and is equipped with a Scio

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scanner for analyzing food homogeneity (Bonnasse et al, 2018). Another technologically marvelous App is *Tellspec*,which uses a reflective near infrared spectroscopy ranging from 900nm to1700nm spectral wavelength using a (DLP) Digital Light Processing chipsets Spectrograph is generated showing the number of photons per wavelength and these graphs are sent to cloud database for further analysis and matching before any results are generated in a time span of less than 5 seconds. It proves ideal for testing flavor, ripeness and quality of fresh fruits and white fish. Its major contribution towards weight fraud testing melamine adulteration in powdered baby food formula. Such portable testing App reduced the costs of food, fear associated with eating adulterated food and reduced laboratory testing time that consumers find deterring (Hoffman et al 2015).

Healthy- Scanalyze Food Scan App displays nutritional information of more than sixty thousand products also provide considerable panels of calorie chart, shopping list preparation and nutritional grading of a scale A to E (Vogelzang et al, 2019). *Foodscan* screens foods via a Scio infrared scanner in connection with only specific Ph7 models, allowing sorting data for further references (Atul et al, 2017). *Bitsnap*also scans and records meal's images and checks for parameters (Anantharaman, 2017). Certain organizations like *Scan Halal* made Android App for barcode (EAN/UPC) scanning of packed food items resulting in the halal status within a few seconds (Mufti et al, 2015). Another significant App known as *Gluten Free Food Finder* displays to users a directory of thousands plus gluten free food items. Other features ranging from viewing nutritional facts, creating a shopping list and barcode scanning through the phone's inbuilt camera (Brad, 2016). Open Food Facts offers a special feature, a 'A'-'E' nutrition score and NOVA Scale of 1-4 for ultra-processed foods which tend to be highly attractive and palatable, the holding capacity is unusually long and are low quality nutrients

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and additives which are generally energy rich, cheap type fat, starches, micronutrient, salt, sugar and dietary fibers (Maux et al, 2012).Similar nutrition scores were presented by *Scanalyze* for the purpose of scanning foods like foods and vegetables, all those edible products available in the market place by using a QR barcode inbuilt scanner facilitated by phone picture scan (Levoy & Agathos, 2018).For vegans an App offered by *Veganeamos* uses the open Food Facts world's database to check additives and distinguish a vegan food by simple phone camera barcode scanning (Hiro et al, 2017).

App based on Shelf life of Food

According to the USDA (United States Department of Agriculture Food Safety and Inspection Service, all customers are entitled to look for the sell by, best before and use by details of products stamped by United States food companies. *Food Storage and Shelflife* provides all these valuable information along with freezer and storage safety guidance when purchasing perishable foods (Davis, 2013). Android App *Best Before,* used by consumers, employees of supermarket and stores can add the production and shelf life of a perishable item whereby calculation is achieved by App resulting in date of expiry (Puytu, 2013).

Nutrition App for Disaese

Heart diseases, according to *WHO* is a major cause of death and people suffering are huge. It is a voice-assisted *Hearty Scan*App featured grocery food scanner uses barcode for heart safe foods alerts on screening them. The shopping list can be made on the bases of favorable brands under heart health risk list. Other features include prescription reminders and an instant diet report for user and medical personnel to record (Poole et al, 2016). The scanner provides the basic nutritional composition of food, certain intolerant allergens and disease

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causing macro-nutrients tracking (Vladimir et al, 2016).*Calorie Counter by Fat Secret*include weight tracker, meal reminders, food recognition by photo clicking, meal planning and nutrition calculator. All these features make it suitable for obesity, weight loss, hypertension and weight gain diet plans (Moses, 2018). In contrast *Calorie Counter* Application by *Nutracheck*provides water intake tracking, links to Fitbit and counts serving of fresh vegetables and fruits daily intake (Vogelzang et al, 2019). *Check-Food* offers outstanding high demand inspection of food via camera barcode scanning. It alerts users on identifying harm full food additives, allergens, genetically modified organisms, irradiation treatments and list of nutritional facts on selected item (Krantz et al, 2013).

A study was carried out by Bathgate, assessing young people with Down's Syndrome, recording their diet and meals with the help of mobile application aimed at helping them with daily recording. However, also according to (Brody, 2013). *Check GMO* App checks for genetically modified organisms in edible produce. Food Intolerance is based on data extracted from SIGHI (Swiss Histamine Intolerance Interest Group provided users with food's navigation system related to intolerances from lactose, histamine, fructose, gluten, tyramine, sorbitol and salicylate. Another well used App known by the name *Vitamin Deficiency Finder* matches food suggestion corresponding to vitamin deficiencies. Additional features are dosage of supplements, vitamin information along with general consumed food's nutritional values (Abdulla, 2012).

Other Apps inclusive of Data image processing

Leaf Doctor processes photo pixels of plant leaves, making a result judgement on the health status of plants using percentile calculation (Pethbridge et al, 2015). *Unlock*

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Fingerprint Scanner uses simple App versions that use biometric fingerprints to unlock the device through an external scanner (Taylor et al, 2015). Picture sample can be sent instantly to *Department of Primary Industries and Regional Development* (DPIRD, 2015) for quick disease assessment, gives information of plant damage and pathogens when using *My Pest Guide Disease* App. *Plantix,*enables photo analysis and offers diagnosis, treatments of fifteen significant global crops (Strey, 2015). Integrated pest management is supported by *MyIPM*Applisting fruits. It allows users to choose any fruits. A gallery version appears featuring 6 images about signs, symptoms and management of susceptible diseases (Mercado-Paredes et al, 2018). Visual search engines can identify any object ranging from food products belonging to anything affiliated to the physical world. *Cam-Find* is a similar App, is a perfect example of such a virtual search engine working on photo sensor/ identifier (Fulkens et al, 2018). Several universities in the U.S are working on visual recognition software to examine images *Leafsnap*identifies species of trees from snaps giving a set of instruction for proper image capturing of any part of the unknown plant (Jian et al, 2015). National Institute of Health, National Eye Institute and Veterans Administration collaborated in bringing out a mobile health care system.

Data Image Processing in Quality Testing

Quality is the key factor in a modern food industry because the high-quality of product is the basis for success in today's highly competitive market. Within the food industry, the quality evaluation still heavily depends on manual inspection, which is not only time-consuming and costly, but because it is subjective the resulting evaluations can also be inconsistent. In order to satisfy the increased awareness, sophistication and consumer expectations, it is essential that the methods used to evaluate food products be improved.

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According to Brosnan & Son (2004), automatic quality evaluation results not only in evaluating accuracy, but also increased the speed of manufacture and efficiency. If quality evaluation is achieved automatically, production speed and efficiency can be improved in addition to the increased evaluation accuracy, with an accompanying reduction in production costs. In a pilot study, a small number of adults and students were assigned to use a food oriented app called 'Recaller' in order to test its usability. Using this app, participants took 'before and after' pictures of their food and beverages, taken directly above the food item or at a 45 degree angle, and these digital images were automatically time-stamped and submitted to the secure Recaller website. Each image could then be reviewed by nutritionists and health professionals for dietary intake at any time and from any location. The usability was defined as the ease of use of the smart phone app in taking the before and after food images, and the study results showed that 50% of the users would consider using the app on a daily basis. The requirement (including built-in prompting) to take both a before and after image ensured that any uneaten portion was captured and could be taken into account during analysis. In addition, the MFR (Mobile Field Report) app indicated if the marker was not in the frame, prompting another image to be taken, and immediate feedback through the use of a color border indicated if the angle of the photograph was optimal (green) or not (red) for analysis (Bathgate et al, 2017). Consequently, using reference particulars, a learning system can create an updated basis for enhanced classification of successive data from similar sources, and craft the latest basis in the intelligible symbolic form (Michie, 1991). In literature, a variety of different methods have been developed to measure size, shape, color, and texture features, which have been reviewed elaborately by (Du and Sun 2004)

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Artificial Neural Network (ANN) technology allows the extension of computer vision technology in the areas of color, content, shape, and texture inspection at near-human levels of performance, and can provide the decision making and classification capabilities to succeed in these inspection tasks (Domenico& Gary, 1994). Recently, ANNs have been used for predication, classification and segmentation in quality evaluation of food products using computer vision (Cheng and Da, 2006). It has been noted by,Blasco et al that 90% accuracy is obtained in pomegranate grading by color. In meats lean color is the primary factor that determines the fresh meat quality. In case of fruits and vegetables the sooty blotches, flyspeck and patchy appearance represent the color measurements (Pujari, 2013). The quality testing of milk and milk products, cereals and grains will be based on the same analysis parameters like color, diseases and other deformities (Haymann et al, 2010).

After pre-processing, image segmentation is crucial. The digital image must be separated into two clearly definable parts; the background and the object to be evaluated. A proper segmentation is essential for proper analysis of the object image and anything less will produce unsatisfactory results. It is used in various applications such as in the field of agriculture (Payne et al., 2013, Deepa and Geethalakshmi, 2012).

Conclusions

The Application development requires multidisciplinary efforts.App development and technologies are playing a vital role in the todays digitized world, where consumers can effectively use applications if they possess very basic amenities like a smart phone, internet access. Nutrition and Food industry is ever growing since the evolution of man and now in this new post modern technological era new way of communications and information is

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available at a click of a button, or maybe just a touch. Yet very few studies have been conducted in the field of data image processing where the phone and android platform can detect the food quality,neither is there any application available that can grade perishable food items on the image analysis. Attention should be directed to create more such useful application that would ease the life of the consumer.

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Table 1. Comparative analysis of Apps demonstrating data image processing.s

Food/Nutrition Apps	Quality Scan/ Image Processing	Bar Code Scan	Nutritional Information	Self-Life/Storage	Health Benefits	Description	References
1. CamFind	√	X	X	X	X	Clicks for any object and opens Wikipedia page	Fulkens et al, 2018
2. DietSensor	√	X	√	√	X	SCiO (Portable Spectrometer) used.	Bonnasse et al, 2014
3. MyIPM	X	X	X	X	X	Surface diseases are demonstrated	Mercado et al, 2018
4. Tellspec Food Scannerx	√	√	√	X	√	No quality analysis, need a portable device.	Hoffmann, 2014
5. Waterlogged	X	X	X	X	√	Sets alarms	Ritter et al, 2016
6. My Fitness Pal	√	√	√	X	√	Calorie counter, barcode scanner and water	Lee et al, 2018

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						tracker.	
7. CheckFood	X	√	√	X	√	Food additives, allergens, treatments	Krantz et al,2013
8. Hearty Scan	X	√	√	X	√	Medication reminder, food risk scaling (low to high)	Poole et al, 2016
9. Open Food Facts	X	√	√	X	√	Nutrition score level (A-E), product detailed ingredients	Maux et al, 2012
10. Foodscan	√	X	√	X	X	Requires Scio sensor and companion app analyser	Atul et al, 2017
11. Plantix	√	X	X	X	X	Detects plant diseases and deficiency based on picture sensing.	Strey et al, 2015
12. Bitesnap	√	√	√	X	X	Scans and records meals images and checks parameter.	Anantharaman, 2017

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13. FatSecret	√	√	√	X	√	Image recognition to track meal nutrition with clicked image.	Moses, 2018
14. Calorie Counter (Nutracheck)	√	√	√	X	√	Food photo for quick recognition	Vongelzang et al, 2019
15. Scanalyze	√	√	√	X	√	-	Levoy et al, 2018
16. Best Before	√	X	X	√	X	Customization of categories, locations, notifications and units.	Peytu, 2013
17. Food Storage and Shelf Life	X	X	√	√	X	Seasonal availability of fruits and vegetables	Davis, 2013
18. Leaf Snap	√	X	X	X	X	App's visual-recognition feature identifies the plant by clicking a leaf's picture.	Ma et al,2015
19. LookTel	√	X	X	X	X	Recognizes the images and speaks	Willyard et al ,2009

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20. MyPestGuide Diseases	√	X	X	X	X	Picture sample can be sent to Department of Primary Industries and Regional Development for disease detection. Gives info on plant damage and pathogens	DPIRD,2015
21. Leaf Doctor	√	X	X	X	X	The app's estimation algorithm is based on the user-aided identification of color pixels for disease free plant body	Pethybridge et al, 2015
22. ICE Unlock Fingerprint Scanner	√	X	X	X	X	Biometric, uses fingerprints to unlock device Powered by ONYX (biometric based software)	Taylor et al, 2015

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						No external hardware or scanner needed	