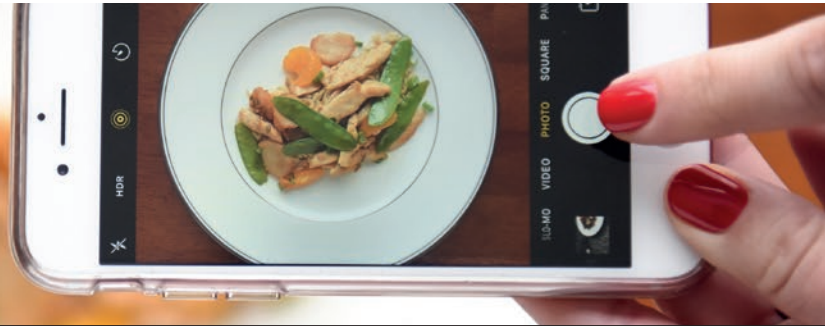


The logo for FRAMOS, consisting of the word "FRAMOS" in white capital letters on a black rectangular background with rounded corners.

FIGHTING DIABETES, FAKE FOOD AND FOOD WASTE

FoodPhone™ Takes Advanced Vision Technology To Turn Regular Mobile Phones Into Precise Food & Nutrition Analysis Devices Using AI, 3D and Hyperspectral Approaches

CUSTOMER & APPLICATION

Originally, FoodPhone™'s founder Christopher M. Mutti was only looking for an easy way to count calories. The engineer wanted to watch what he was eating in an easy way. Mutti started in 2013 with the basic idea to capture the nutritional content of a meal with one image from either a camera or a smartphone.

CHALLENGE

Bring together the computing power of smartphones and advanced vision-based AI technology by merging different imaging technologies from 3D and RGB to NIR in a very small form factor.

RESULT

FoodPhone™ provides a mobile solution using Intel®'s RealSense™ 3D technology to determine the volumes, texture and shapes of all types of food, with seemingly only one image capture. Embedded in a normal phone case, the FoodPhone™ device detects the ingredients of food based on their chemical composition and instantly displays FDA-formatted nutrition labels. Also, it recognizes any natural imperfections, both visible and non-visible, and helps in detecting food quality.

Over 200 Million people deal with Type-1 or Type-2 diabetes and obesity worldwide. Now, Vision technology now helps in fighting these diseases by taking a smartphone picture of a meal on a plate and instantly knowing its nutritional contents in scientific-like precision – as easy as sharing on social media. FoodPhone™ provides a mobile solution using Intel®'s RealSense™ (RS) 3D technology to determine the volumes, texture, and shapes of all types of food, with seemingly only one image capture. Besides identifying carbohydrates and counting calories, this new phone case, equipped with Embedded Vision, detects the ingredients of commercially prepared food based on their chemical composition and instantly displays FDA-formatted nutrition labels. The FoodPhone™ device's NIR (near IR) capabilities also recognize any natural imperfections, both visible and non-visible, and help in detecting the foods quality and freshness at the grocery store. Selecting the freshest fruits or vegetables like avocados, is made simple by instantly displaying "freshness" levels on the user's smartphone.

BILLIONS OF PEOPLE WORLDWIDE ARE WATCHING THEIR NUTRITIONAL INTAKE

Diabetics, athletes, fitness-lovers, and many others struggling with their weight need to watch what they are eating. In the US alone, over 100 million people use smartphones and smart devices to monitor their weight, fitness and diet each day. In all modern western and rising eastern societies, diabetes is rapidly increasing in



Scan QR code and read online!

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numbers. Especially for diabetics, counting carbs is key to managing their disease and, for them, it is a matter of life and death. Their carbohydrate intake influences their insulin levels. The carbohydrate total is the key meal information needed by a diabetic for using emerging technologies like CGM (Constant Glucose Monitoring) and automated tubeless insulin pumps. There lies the problem: These health-saving monitoring tools are only successful with the right user input. Manual input and user's food estimations tend to be very inaccurate, causing incorrect insulin dosages which can be very dangerous and even life threatening for the diabetic.

ONLY ONE SMARTPHONE IMAGE NEEDED TO CREATE FDA-LIKE NUTRITION FACT LABEL

Today, smartphones have cameras, access to the internet, include modern, powerful Artificial Intelligence (AI) algorithms, and are used to take millions of food images every minute. The FoodPhone idea is to turn these smartphones into diet-helpers by analyzing the food directly on the plate. By snapping what seemingly is one image of the meal, the FoodPhone app, with its SpectraPixel™ technology, connects with the company's proprietary cloud-based AI to recognize the meal's content, specifically its chemical composition, quantity in ounces/grams and quality, while also segmenting mixed meals. With the help of the multispectral cameras

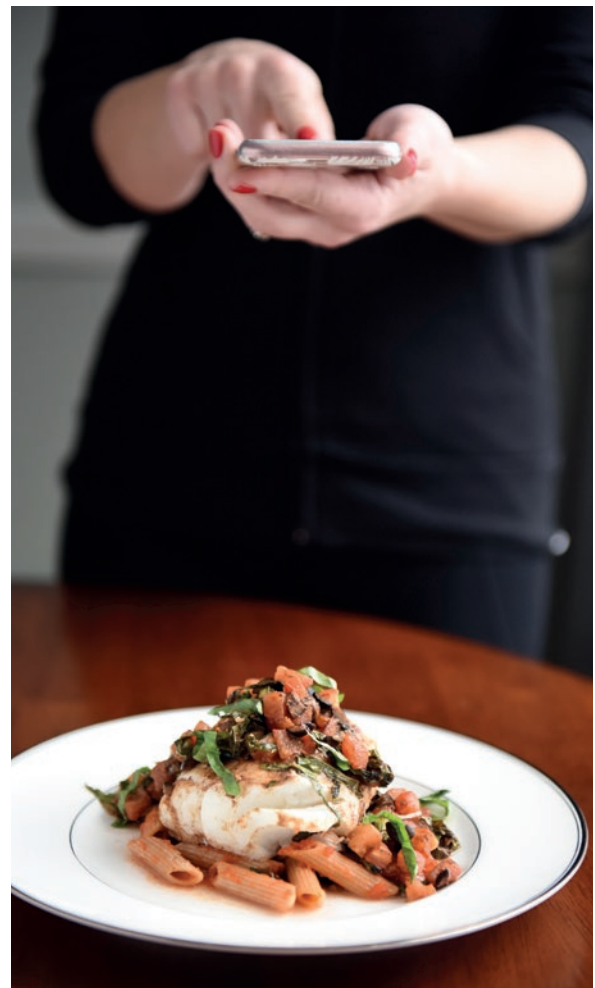
and NIR sensors embedded in the FoodPhone's new smartphone case design, the user instantly gets a scientific analysis of their meal. composition, quantity in ounces/grams and quality, while also segmenting mixed meals. With the help of the multispectral cameras and NIR sensors embedded in the FoodPhone's new smartphone case design, the user instantly gets a scientific analysis of their meal.

This one-shot analysis provides details on the carbohydrates, fats, proteins and other nutritional contents along with the true portion size of the prepared meal. Combining different imaging technologies with AI based intelligence, FoodPhone precisely identifies the amount and composition of food. There is no need to input any information into the application, nor touch or probe the food, or guess its volume. The analysis is fast. In a very user friendly and efficient way, the FoodPhone case delivers exact Nutrition Fact sheets with accuracies beyond 90%. With a mix of AI and AR, the technology will impact the spread of diabetes and support food-watchers in reaching their goals.

For Meal

Nutrition Facts	
Lunch Serving	
Serving size	1 plate
Amount per this 3D image	
Calories	626
%DV*	
28% Total Fat g	18
53% Saturated Fat g	11
Trans Fat g	1
57% Cholesterol mg	172
34% Sodium mg	819
14% Total Carbs g	43
23% Dietary Fiber g	6
Sugars g	7
Protein g	69
0% Vitamin A mcg	0
66% Vitamin C mg	40
261% Vitamin D mcg	26
12% Calcium mg	121
27% Iron mg	5
30% Potassium mg	1394

Picture 1: FoodPhone's FDA-like Nutrition Fact Label for a lunch serving



Picture 2: By taking seemingly one image, users instantly get a scientific analysis of their meal

FIGHTING DIABETES, FAKE FOOD AND FOOD WASTE



IDEA, INNOVATION AND IMPLEMENTATION

“Originally, I was only looking for an easy way to count calories,” says Christopher M. Mutti, CEO & Founder of FoodPhone. As a passionate hockey player, he was forced to watch his nutrition, and monitor his weight and calories to stay in shape. But for him, this multi-step procedure was not only inaccurate, but also extremely complicated. This qualified mechanical engineer wanted to watch what he was eating in an easy way. Mutti started in 2013 with the basic idea to capture the nutritional content of a meal with one image from a either a camera or a smartphone.



Picture 3: Christopher M. Mutti, FoodPhone’s CEO, is a passionate hockey player and was originally looking for an easy way to count calories.

The technologies were ready: Computing power of smartphones had evolved to the point that they could take on complex algorithms; and more advanced vision-based AI technology was available through projects like Wikipedia ImageNet from Stanford University. Together, with a team of experienced scientists in Neural Network AI, 3D and hyperspectral imaging along with experienced engineers in camera and lens design, Mutti decided to develop the patents to make his idea into reality.

The first prototype was built with off-the-shelf components and had dimensions of 8” x 7” x 3”; what Mutti refers to as the “Million Dollar Blue Box”. At the time, it was the smallest available solution to merge 3D, RGB, and NIR and the cost was about \$3,000. It took more than 5 years for technological advancements to reach the level of performance and affordability to make FoodPhone a practical solution. Mutti

often refers to this “perfect technological storm” that was perfectly timed as the basis for bringing his idea into reality. Nowadays, Intel®’s RealSense™ cameras are the size of a little finger, enabling new devices, like smartphones, to enter into a new world of 3D data collection and processing. With this, Mutti and his team have now found the perfect product, both in size and price, to provide the necessary information needed for the food recognition and analysis. They embed the Intel® RealSense™ cameras into a normal-looking phone case, maintaining a similar form factor to standard phone cases. With all the advancements in the technology used in their application that now come at a lower cost, the product can now be offered for just a few hundred dollars. Users will simply swap their existing phone case with the FoodPhone’s embed phone case and download the app. From there, they can start capturing images of their actual meals and get its nutritional information within seconds.



Picture 4 and 5: Design Study and prototype of the FoodPhone mobile phone case

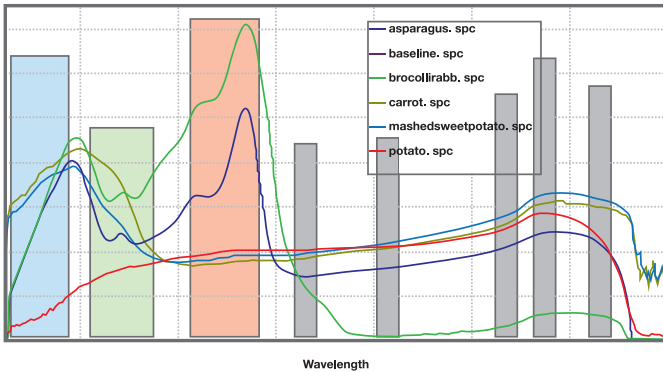
COMBINING MULTIPLE VISION DATA TYPES WITH AI?

The FoodPhone solution uses multi-spectral imaging to precisely identify the macronutrients and volume, or portion sizes. Mutti developed FoodPhone’s measurement IP without using a “Fiducial Object” on the plate of food or within the FOV (field of view) of the imaging system. The engineers decided to use the Intel® D435 RealSense depth camera because it is a USB -powered depth camera consisting of a pair of depth sensors, RGB sensor, and an infrared projector. Mutti holds a patent for producing hyperspectral images by merging the output of multiple cameras. This vision technology closely emulates the way humans identify their food.

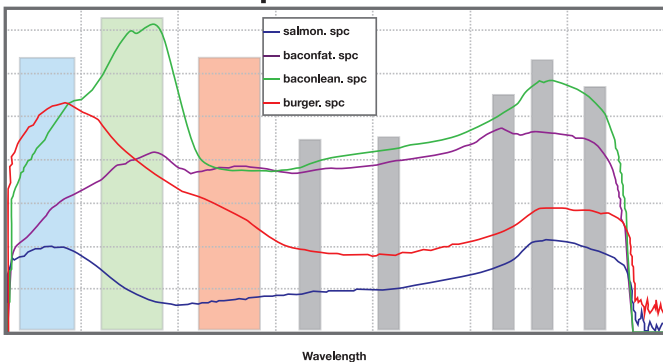
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Vegetable Spectral Profiles



Meat Spectral Profiles



Picture 6 and 7: Different spectral profiles as unique fingerprint for any vegetables and meat

Color is the first element that people look at in a meal and, for this reason, FoodPhone uses the RGB camera to identify colors in the captured image. Then, the 3D stereo pair generates the data needed to identify the shape, outline, and texture of the elements in a similar way to how people experience it. The raw 3D image data gives the dimensions and total volume or portion size of the food on the plate. By using the NIR data in the images captured by the multiple cameras and sensors, FoodPhone's image processing (IP) algorithms are able to interpret the chemical composition of the food; kind of like how people taste and smell the aromas of the food they eat.

An overlay of more than ten images and raw data are categorized into components of visible light, color, spectral data, and 3D information. The optical, spectral and physical information retrieved from these images are used to find the specific and individual characteristics of each morsel. The spectral profiles captured from the images are used to compare and

classify against the different food types, as each one has a unique spectral fingerprint.

"Millions of images are used to train this powerful AI machine", says Mutti. "To reach accuracy levels beyond 90%, it was a lot of hard work performing tens of thousands of food classifications, confusion tables and other processing steps. In order to calculate the individual food labels and weight correctly, the color, texture, spectral signature, and volume have to match. Raw image data are first processed by an Intel® Edison, a very small computer on a module, to identify carbohydrates, proteins, fats, and water content. From there, all the information that is collected is then sent to the cloud and processed by FoodPhone's AI driven database. The smartphone receives the results and displays the nutrition fact label.

ADDITIONAL TECHNOLOGICAL BENEFITS

Grocery shopping can be optimized by wasting less time looking for the freshest and healthiest products while saving money in the process. FoodPhone's technology can also be used to detect food's quality and freshness, with consumers receiving the food's freshness in real-time, displayed on their smartphone. People with food allergies can check the stated ingredients of their food through a single image capture and not by attempting to decipher "cryptic" ingredient lists on the packages. A simple scan of the food provides a more detailed list of the ingredients along with a more exact shelf-life. By using information in the NIR spectrum, FoodPhone's technology helps detect imperfections, like the ripeness and presence of bacteria, regardless of the product's "Best Before" date. Picking the freshest and ripest avocado is just a click away.

Forward-thinking but already-now realistic scenarios include FoodPhone's technology that is integrated into every home kitchen. The company's cabinet mounted device could scan each food or a meal's separate ingredients as its being prepared will give the user a scientific analysis instantly with the display of a Nutritional Fact Label of their daily menu. All of this information can occur, while FoodPhone's software automatically updates the user's weekly grocery shopping list or their food delivery list.

FIGHTING DIABETES, FAKE FOOD AND FOOD WASTE



Picture 8: Cabinet mounted FoodPhone device scans readily prepared meal

An intelligent IoT-based refrigerator, equipped with FoodPhone's intelligent device, would be able to track the use of what was purchased and stored within it, and what has been consumed, linking directly with and updating shopping and delivery lists. A family could track and plan if they are running out of a popular item easily by having their fridge do this for them.

In addition, this vision and AI-based food check can fight food fraud as well. The FoodPhone technology can help people make better, healthier choices by recognizing added chemicals or secret ingredients used to prolong shelf life or make products more appealing or desirable.

TOP-NOTCH EXAMPLE FOR FUTURE-LEADING USE OF VISION

The innovative FoodPhone technology is a perfect example how vision-based solutions, in a very small footprint, with cutting-edge new applications, can be used in every day devices, like smartphones and smart home appliances. Merging different types of AI-based imaging, in this case 3D, RGB and NIR, to extract additional information shows how powerful modern vision can be. Off-the-shelf cameras with integrated Depth Technology and infrared projectors are available at reasonable prices, ready-to-use and in a very small size. Easy to handle and affordable vision technology, like that provided by the FoodPhone engineers, can take applications in industrial and consumer markets to the next level.

Please contact us if you have any additional questions about this technology or how best to implement in your use case. FRAMOS Imaging experts are available 24/7 to assist in your design and answer any questions you may have. Please contact your local representative or via email: info@framos.com



ABOUT FRAMOS | FRAMOS enables machines to see. Imaging and embedded vision technologies are their passion, they play a key role in automation, robotics and the IoT-connected factory and are key drivers in cognitive systems, the smart home, intelligent mobiles and autonomous vehicles. FRAMOS is a leading global supplier of imaging products, embedded vision technologies, custom solutions and OEM services. The vision experts have been assisting customers since 1981 as a technical consultant, development partner and external supplier selecting individual components, complex system compositions or customization options. They also provide individual technology, focusing on sensor modules and intellectual property, such as IP Cores, Imaging Algorithms and SoCs. From the sensor to the finished vision system, FRAMOS offers a powerful portfolio of imaging services and components with a range of capabilities to suit every budget. Strong brands combined with excellent technical support allow their customers to develop cutting-edge imaging and embedded vision systems and shorten their time-to-market. With a team of more than 100 employees working worldwide, they aim to find the fastest and most efficient imaging solutions for their customers.