(ID-50)

LiDARCalorieCam: Mobile Food Calorie Estimation Using Smartphone LiDAR Sensor

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Overview

Background

Conventional calorie estimation relies on RGB images, which lack 3D depth information and often lead to inaccurate volume estimation.

Contribution

Using iPhone LiDAR, we achieve real-time 3D volume and calorie estimation without reference objects.

Result

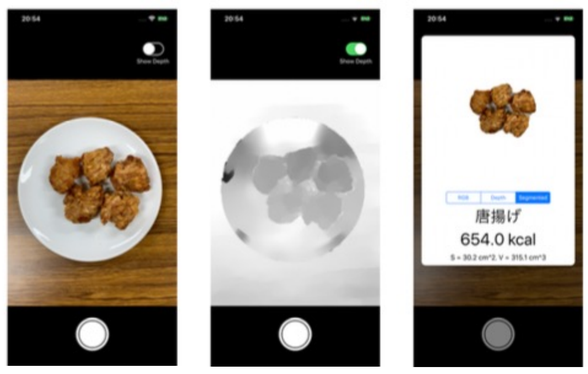
84% improvement in MAE vs. DepthCalorieCam [1].

Related Research

RGB-based and stereo-camera methods such as CalorieCam [2] and AR DeepCalorieCam V2 [3] required reference objects or fixed angles. DepthCalorieCam [1] estimating calories from volume using dual camera depth value.

DepthCalorieCam [1]

- No reference objects are required.
- The shooting angle is restricted to directly overhead.
- The meal category is limited to three types.

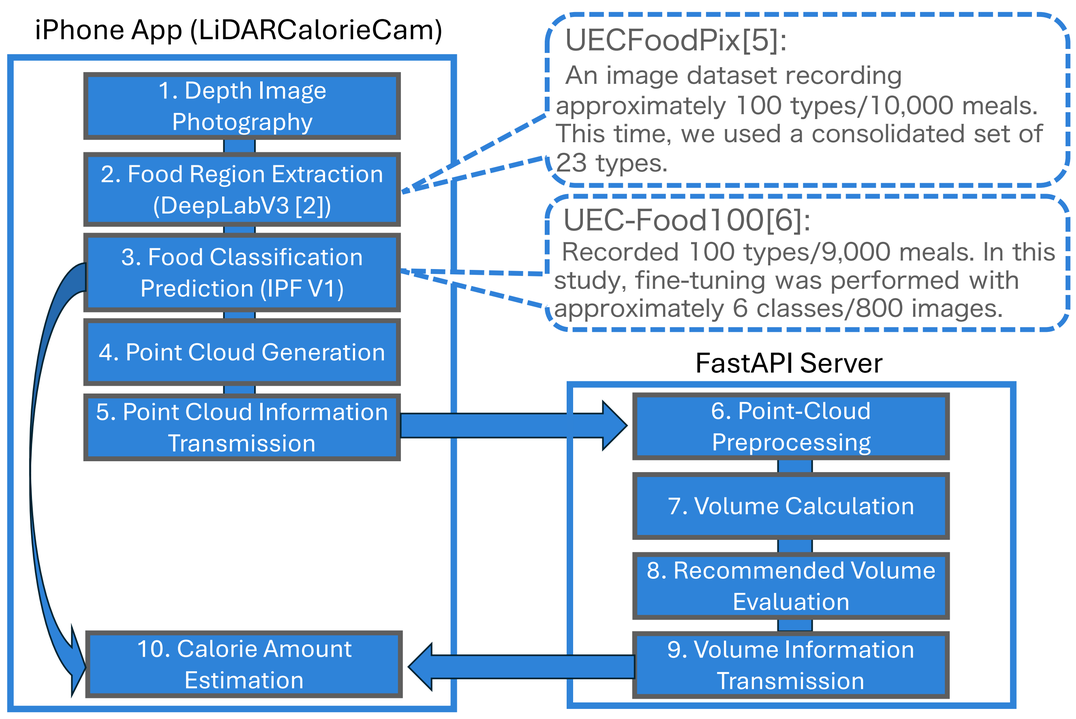


RGB camera view | Depth camera view | Result view

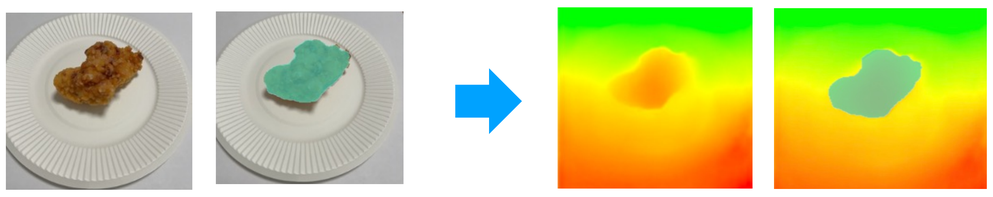
Method

Process Flow

The proposed system integrates RGB and LiDAR depth information captured by the iPhone to estimate food volume and calorie content in real time.

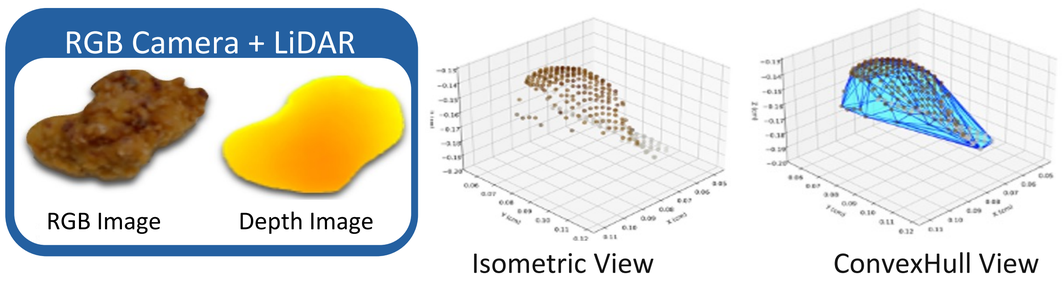


2. Food Region Extraction



After applying to the RGB image, apply to the same area in the Depth-Map.

7. Volume Calculation



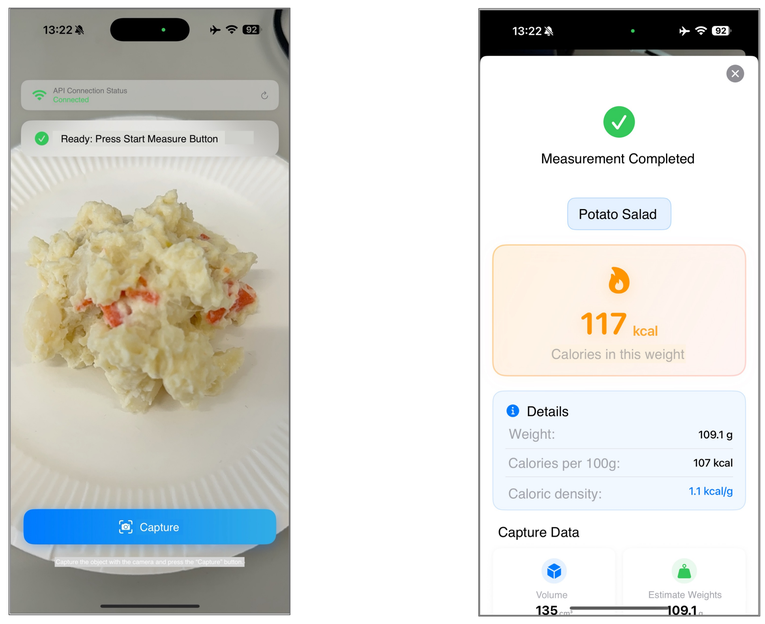
Isometric View | ConvexHull View

We convert RGB + Depth data to real-world coordinates (X, Y, Z).
Estimating the volume of the eating area from real-world coordinates.
Then, estimate the actual weight from the volume and calculate the calories.

Result

Supports classification into 10 categories :
Fried chicken, croquettes, hot dogs, grilled chicken skewers, toast, potato salad, stir-fried vegetables, rice balls, rolled omelet, yakisoba

Application Preview Screen



Camera view | Result view

Volume Estimation Error for Each Food Item

Food	MAE [kcal]	MAPE [%]	Average measured volume[cm^3]
Fried chicken	32.5	64.5	53.2
Croquette	58.0	31.0	163.1
Hot dog	28.5	8.8	347.4
Grilled chicken skewers	37.4	39.5	83.5
Toast	61.3	13.9	354.4

Estimated Calorie Intake Error

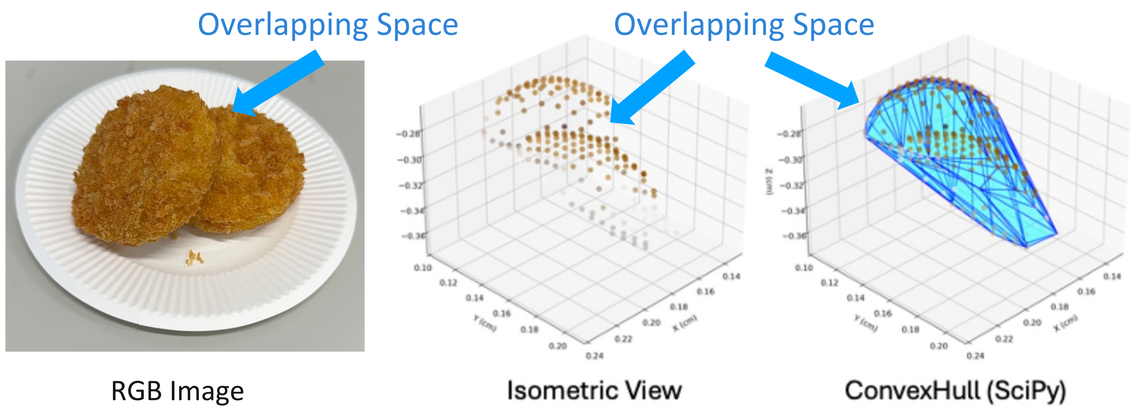
Food	DepthCalorieCam[1]		LiDARCalorieCam	
	MAE [kcal]	MAPE [%]	MAE [kcal]	MAPE [%]
Fried chicken	101.29	52.84	15.88	7.87
Croquette	43.09	20.11	12.83	6.10
Hot dog	—	—	25.68	11.50
Grilled chicken skewers	—	—	12.03	5.59
Toast	—	—	23.95	8.64

Key Advantages of LiDARCalorieCam

- Performs real-time calorie estimation on mobile devices.
- Requires no reference objects or fixed shooting angles.
- Achieves accurate 3D volume estimation using LiDAR.
- Supports 10 major Japanese food categories.

Considerations and Future Challenges

Overall, the point-cloud density was low, and insufficient point-cloud data were captured in overlapping regions between food items. Additionally, inaccurate convex-hull approximations of these overlapping regions led to overestimation of volume.



RGB Image | Isometric View | ConvexHull (SciPy)

- Changes to volume estimation are required to enable processing completion within the mobile device.
- Handling unknown categories and complex shooting environments.
- Addition of a bulk-estimation function for the entire meal.

[1] Yoshikazu Ando et al. Depthcaloriecam: A mobile application for volume-based food calorie estimation using depth cameras. In Proc. of ACMMM Workshop on Multimedia Assisted Dietary Management (MADIMA), 2019.
[2] Okamoto, K., Yanai, K.: An automatic calorie estimation system of food images on a smartphone. In: Proc. of ACM MM Workshop on Multimedia Assisted Dietary Management (MADiMa) (2016)
[3] Tanno, R., Ege, T., Yanai, K.: Ar deepcaloriecam v2: Food calorie estimation with cnn and ar-based actual size estimation. In: Proc. of the 24th ACM Symposium on Virtual Reality Software and Technology (2018)
[4] Liang-Chieh Chen, George Papandreou, Iasonas Kokkinos, Kevin Murphy, and Alan L. Yuille. Rethinking atrous convolution for semantic image segmentation. arXiv preprint arXiv:1706.05587, 2017.
[5] Kaimu Okamoto and Keiji Yanai. UEC-FoodPIX Complete: A large-scale food image segmentation dataset. In Proc.of ICPR Workshop on Multimedia Assisted Dietary Management(MADiMa), p. 647–659, 2021.
[6] Y. Matsuda, H. Hoashi, and K. Yanai. Recognition of multiple-food images by detecting candidate regions. In Proc. of IEEE International Conference on Multimedia and Expo (ICME), 2012.