SnapDiet: Smart Diet Monitoring for Polycystic Kidney Disease Research

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Introduction: Polycystic Kidney Disease (PKD) is an inherited disease in which cysts develop in the kidneys, causing a loss of kidney function over time. Research shows that maintaining a healthy diet may slow the progression of the disease [1]. The proposed SnapDiet system has been created to help monitor the diets of patients with PKD. A variety of table-top scales are available for home food preparation, but there are few options for smart systems that can link a patient and their eating habits directly to their clinician. (Mattfeld et al) proposed a table-embedded scale called a universal eating monitor (UEM), that measures grams of food and beverage consumed over the course of a meal [2]. However, it only measures the mass of food consumed, but not the types of food and composition of the meal. SnapDiet is a combination of a food scale and camera that is linked to the SnapDiet App. This enables patients with PKD to monitor their diet by providing weight of the food and an image.

Methods: The SnapDiet system consists of three components (1) a scale, (2) a camera, and (3) a companion app for visualizing the scale and camera data. This system is presented in Figure 1. The SnapDiet scale records the weight of the food with the press of a button, which is connected to the load cell sensors placed below the bowls. This weight data is uploaded to Google cloud (Google Drive) using the Bluetooth communication protocol. Each of the three bowls are dedicated to a different type of food group namely protein, carbohydrates, and fruits/vegetables. Each load cell is bracketed to the underside of the base with the use of 3D printed brackets, on which the removable and washable food bowls are rested as shown in Figure 1A. The mass recorded by each load cell is recorded in grams, sent to an Arduino, then wirelessly transmitted via Bluetooth to the Android device. The load cell tare function is automatic and occurs when the SnapDiet scale is switched on. The calibration factor of the load cells can be adjusted to ensure accurate food mass measurements. To determine if the mass used to set the calibration factor made a difference in load cell accuracy, the load cells were re-calibrated with a 40g weight and an 800g weight. A variety of weights from 40g - 800g was tested after the calibration changes, the known mass compared to each load cell measurement to determine accuracy.

Figure 1: (A) Overview of the SnapDiet system consisting of camera and load cells. (B) SnapDiet companion Android app.

The camera allows for an image to be captured of the food that has been placed on the scale. The SnapDiet camera (Arducam, 5 Mega pixel), connects to the Arduino and image data is sent to a laptop via USB connection. The image is uploaded to a Google Drive folder. A sample image from the camera is included in Figure 2.

The SnapDiet companion Android app consists of four main screens. The first screen is the home screen, which displays the patient's login page. The second screen, shown in Figure 1B, is used to obtain Bluetooth weight measurements from the SnapDiet scale. The third screen displays the images from the Google Drive folder that contains the meal images obtained by the SnapDiet scale.

Results: In order to evaluate the proposed SnapDiet system we conducted calibration experiments using calibration weight (pre-weighted sandbags). We evaluated the accuracy of load cells using 40g, 300g, and 800g sandbags. The load cells weight was compared against a food scale provided by the BME lab. The average percent error after using the 40g calibration weight was 1.08%. After calibration with the 800g weight the percent error was 0.65%. To conclude, the load cells on average trend toward more accurate readings when the calibration factor was set with a heavier mass. The load cells will now be calibrated with the 800g weight to ensure accuracy during normal use. The images generated by (2) the camera is clear enough to show the components of a meal as seen in Figure 2. (3) The app interface is shown in Figure 1. The different screens can be easily navigated using the menu at the bottom of the screen.

Figure 2 : Image from Arducam.

Conclusions: Patients using the SnapDiet system to monitor their meals will be able to use the app functions to meet their health goals, while allowing for seamless communication and monitoring from a clinician. Future improvements to the SnapDiet system include a smoother app interface and extra features for the patient such as a recipe guide and a social forum to connect with others facing the same challenges. Sending images directly from the scale to the app is a future goal, along with connecting a body weight scale to the SnapDiet to collect patient weight data and keep everything in one place.

References:

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2. Mattfeld, RS. Et al. IEEE J Biomed. Health Info.; Vol. 21, no. 6, pp. 1711-1718.

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