Semi-Automatic Self Feeding Device

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Introduction: While there are many commercially available robotic arms, they mainly focus on grabbing objects, and are permanently fixed onto wheelchairs because of their size and weight. We designed a portable semi-automatic self-feeding device that can be attached onto a wheel chair, for wheel chair users who have limited functionality of their arms or hands. We primarily concentrated on facilitating the transfer of food using spoons.

Materials and Methods: Our system is made of a robotic arm and a controller with user operated switches and buttons. We used the commercially available M100RAK robotic arm that supports up to 500 grams of weight. Onto this, we integrated an infrared distance sensor, positioned at a fixed location above the spoon in order to detect food on the plate. Inside the second part of our system is a custom designed printed circuit board. The board is 2.5 cm by 5 cm and therefore easily packaged and mounted into a project box on the side of the arm. An 8-bit, 32 pin AVR microcontroller (ATmega168) controls the robotic arm by accepting user and system inputs (button presses and ADC data values from the sensor, respectively). The ATmega168 also outputs PWM signals to the appropriate servomotors. Both the arm and I/O panel are mounted on top of a wheel chair tray, and the arm is held in place using neodymium magnets. The results discussed here refer to the use of a distance sensor (IR Sensor - Sharp GP2Y0A21YK) to detect food on any standard sized plate. The distance sensor is positioned above the spoon, with its beam directed to the region of food immediately in front of the spoon. Initially two sensors were used to establish an accurate threshold value in the calibration phase of design, but as the aim was to reduce weight, power, and robot reaction time, only one is utilized in the final implementation.

Results and Discussion: The IR Sharp sensor (Figure C) returns an analog signal that is digitized into 8 bits. The longer the distance of the first object in front of the sensor, the smaller the signal. After much experimentation, we were able to determine that a digitized threshold of 238 was where our cutoff should be, as shown in Figure A. If the distance between the food and sensor is greater than 238, the arm will scoop up a spoonful of food. Otherwise, the arm will continue to scan the plate in increments of 2 cm until food is detected. Accuracy of this food detection method was established by running 40 trials. In 20 of the trials, one layer of cheerios was evenly spread on the plate. In the other 20 trials, no food was shown on the plate. Figure B shows that the arm was able to identify the presence of food 85% of the time food was present, and to detect its absence 95% of time when there was no food. The amount of time it took the user to consume a spoonful was experimentally found to be 22.1 seconds. This time is defined as the time it took the user to transfer the spoon from the plate to his mouth, and then return the spoon to the plate (excluding chewing time). Using our feeder and food detection method allowed the user to reduce this time to 17.2 seconds, a 22.2 % decrease.

Figure A: System Calibration

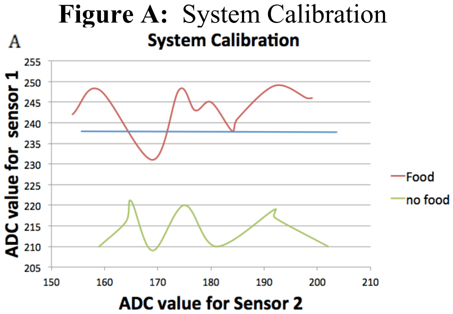

Figure B: Food Detection Accuracy

	Food	No Food
Food Detected	85%	5%
Food Not Detected	20%	95%

Figure C: System Overview

IR Distance Sensor

I/O Panel

Figur

distance sensors, a threshold value of 238 was chosen (blue line). Note that the peak at 231 was ignored as an outlier.

Figure B: Summary of experimental results

Figure C: M100RAK mounted onto wheel chair

Conclusion: We have met the initial requirements of building a portable feeder that weighs less than 2.5 kg and easily clamps onto a wheel chair. We chose to use large buttons as the main input methods for this system, as shown in Figure C. However, because the user has limited functionality of his hands, we intend to add voice control as an option to manipulate the device in the future. Additionally, we hope to extend the functionality of this self-feeding device by adding the usage of a fork.

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