

Team 43: Chewing Sounds- Product Design Specification

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1. Background Information

Close to one-third of all Americans are obese.

(<http://win.niddk.nih.gov/statistics/index.htm#whydodiffer>) Many researchers are developing ways to prevent this alarming number from growing. Monitoring caloric input and output are the main goals; analyzing habitual dietary and exercise data will help predict trends in obesity. Monitoring caloric output has been explored extensively. The pedometer, for instance, is a common tool that aids in measuring expended calories. Monitoring food intake has been a daunting task; many people rely on their memories to describe what they ate. To portray a better image of themselves, they may even lie about some of the foods they have eaten.

2. Function

In order to obtain more accurate data, our team is exploring the possibility of recording and analyzing chewing sounds. We will need to find an effective microphone that is capable of recording different chewing sounds at differing frequencies. After recording the data, we will need a way of filtering the data so that it is distinguishable from background noise (speech etc.). After the filtration, we should be able to relate certain intensities/frequencies of chewing sounds to the consumption of foods possessing different textures. In concert with other devices, we hope that the microphone will be a tool in monitoring dietary intake, paving the way for a healthy lifestyle.

3. Client Requirements

- Create a tool that accurately records what people eat, when they eat it, and where they eat it.
- To record the chewing sounds, either utilize a microphone that is placed inside the ear or some other location, such as near the mouth.
- The device should be able to distinguish between when a subject is chewing and when he/she is swallowing.
- The ability to record chewing sounds should be able to be performed numerous times.
- The chewing and swallowing sounds should also be able to be differentiated from other background noises.

If and when we have accomplished these requirements, Dr. Schoeller has some additional requests. They are:

- That the device is able to distinguish between what types of food are consumed, such as crunchy and soft foods.

- The device is able to identify the food and the number of calories that the subject consumes.

4. Physical and Operational Characteristics

- Performance Requirements:** The device used to detect chewing sounds will have use in the laboratory setting, but it has the potential to become a portable device after much initial testing. Using this device, we will record sounds and store this data until transmission to a computer source. Given the preliminary status of this experiment, the design will be used only in the laboratory and should experience minimal wear. The microphone will be placed into the ear by the user and will remain there for the period of testing, possibly as long as an hour.
- Safety:** In order to correlate foods to their sound patterns, we must test the device extensively using human subjects. Other than this, there should be no safety concerns with the device, especially if it consists of portions of other apparatuses (such as hearing aids) that are considered safe.
- Accuracy & Reliability:** Previous studies (Amft, *et al.* 2005) have achieved 80-100% accuracy in food determination, and we hope to replicate and improve upon these results.
- Life in Service:** Since this field has not received a great deal of attention, the device will have to perform for hours at a time in order to obtain enough analyzable data. The sound detector will have to perform for many hours in the laboratory and for many weeks (and months if this study continues).
- Shelf Life:** Shelf life is not a concern in this stage of the project since our goal is to obtain, analyze and report data. This will become a concern once the design of a prototype has commenced.
- Operating environment:** The device must operate effectively in a lab environment. This environment may include noise sources including external sounds and subject movement and speech that should not hinder the device from operating effectively.

In the field, the device must operate effectively in a reasonable temperature, pressure, and humidity range that the subject could be exposed to in their everyday life. External noise or other influences such as speech, ambient sounds and subject movement should not hinder detection of chewing audio.

Battery life at a minimum must last the length of an average waking day, or roughly 16 hours.

- g. Ergonomics:** In the eventual development of a prototype, the microphone and recorder should not impede with the normal daily activities of the wearer.
- h. Size and Weight:** The device must be of portable size, shape, and weight. Carrying the device throughout the day should not place undue burden on the subject.
- i. Materials:** The three components of our analysis are: the microphone, recorder and an analyzer (computer).
- j. Aesthetics, Appearance, and Finish:** Ideally, the device would be small and relatively unnoticeable to both the subject and others so it could be carried inconspicuously throughout the day.

5. Production Characteristics

The goal of this project is to record and analyze data more so than to develop and market a prototype. This preliminary work is necessary so that in the future, a prototype may be developed.

6. Miscellaneous

- a.** No information found about national/international standards and specifications.
- b.** As this project involves human subject testing, we will need to get approval from the IRB (Institutional Review Board Services), even though we will only be testing amongst our own team. One of our clients, Dr. Schoeller, has offered to obtain this approval.
- c.** As the microphone will be placed in the ear canal, it may need to be sterilized after testing each subject.
- d.** Monitoring dietary intake is a novel idea. Although studies of chewing data have been published, a product with the client's specifications has not been marketed. No competition is anticipated.

References

Amft, O, Stager M, Lukowicz, P, Troster, G. "Analysis of Chewing Sounds for Dietary Monitoring. Springer-Verlag Berlin Heidelberg, 2005. pp. 56 – 72.

National Institute of Health Statistics.

<<http://win.niddk.nih.gov/statistics/index.htm#whydodiffer>>