RERC: Accessible Pill Cutter/Dispenser

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Problem Statement

The goal of our project is to create a combined pill dispenser and cutter that is capable of administering set dosages of pills and half pills on a preprogrammed schedule. Our device must also alert the patient when a pill has been dispensed and off-site medical personnel if dosages have been missed.

Motivation

- Errors in medication administration & compliance (1)
  - Average compliance rates of 43%-78%
- Poly-pharmacy is common for elderly and disabled population (3)
- Prescriptions are becoming increasingly expensive
  - 100mg pill costs same as 50mg pill
- No current pill dispenser has the ability to cut pills in half

Background

RERC- Accessibility:
- Must adhere to ADA specifications (2)
- Should be operable by persons with multiple , varying disabilities (sensory-motor, physical, & cognitive)
- Should eliminate disability-associated barriers

Current Pill Dispensers:
- Either expensive or inadequate
- No pill dispensers cut
- Not all monitor ingestion or alert caregiver when dose is missed

Current Pill Cutters:
- Small, hand held device
- Uniform cutting not guaranteed
- Work only for certain pill shapes, sizes, and compositions
- Cost-effective

References

1. Osterberg, Lars, and Terrence Blaschke. "Adherence to Medication" *Drug Therapy353: 487-497 (1995): 18-22.*
2. "Americans with Disabilities Act Homepage". <http://www.ada.gov/>. Oct 2, 2007.
3. Salzman, C. "Medication Compliance in the Elderly." *J Clin Psychiatry56*

Abstract

Currently, errors in medication administration and compliance are persistent problems in home medication. The goal of our project is to create a combined pill dispenser and cutter that is capable of administering set dosages of pills and half pills on a preprogrammed schedule. Over the course of a year, we designed and built one module of our pill dispenser which will be used as a template for a complex multiple module system.

Design Constraints

- Accurately Dispense Multiple Medications
- Moderately Priced
- Dispense Varying Doses
- Functional for Home or Clinic
- Medication Alarm Systems
- Record Medication History
- Accessible Device
- Precisely Cut Pills in Half

Final Design

Electrical Components

Basic Stamp II
- Microcontroller w/ EEPROM
- PBASIC language
- 16 I/O pins

Servo Motor
- Standard and continuous
  - Standard: 180° motion-control
    - Pill drum rotation, half pill release
  - Continuous: 360° open-loop
    - Pill mixing

Pill Sensors
- IR emitter and detector
- Sense pills in drum and half pill holder
- I/O pin voltage threshold
  - Pill Sensed → Output = 0
  - No Pill → Output = 1

Lights/Alarm
- Push Button Activation
- Bright, visual alert
- Two-tone piezoelectric speaker
- Loud, audible signal

Interface Program
- User-friendly programmable interface
- Able to set regimen of pills daily and weekly
- Capable of being coupled with LCD screen
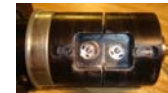
Physical Components

Mixing Funnel
- Shape orientates pills to pill inserts
- Servo mixer attached to lid
  - Sweeps pills into inserts
  - Prevents build-up of pills

Pill Drum/Pill Inserts
- Low friction
- Ball-bearing design
- Dry lubricated delrin
- Embedded sensor
- Accurate servo-controlled motion
- Snap fastening for interchangeability

Solenoid/Cutting
- 12VDC, 7A = 84 Watts of power
- Detachable razorblade
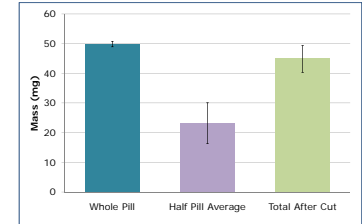- Spring return
- Runs on a track

Pill Drum Casing
- Half and whole pill exits
- Stable mount
- Low friction

Half Pill Holder
- Embedded Sensor
- Servo controlled trap door release

Testing

Pill Loss After Cutting
Average mass of 50 mg Vitamin C full pill before cutting, average half pill mass, and total mass after cut for n = 10 trials (SE = +/- 1 SD).

Validation Testing
Times pills were dispensed out of a possible 6 full or 12 half pills. Type 1 errors occur when pills aren't caught. Type 2 errors occur when pills stick in the pill drum.
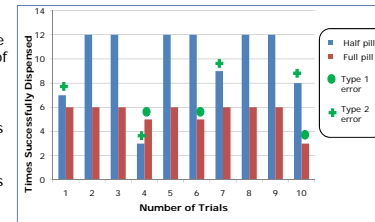
Cost Projections

Item	Company	Quantity	Unit Price	Cost
IR Sensors and Detectors	RadioShack	2	$3.49	$6.98
Piezo Buzzer	RadioShack	1	$11.49	$11.49
110 Watt AC-DC Power Adapter	Ituner Network Corp	1	$35.95	$35.95
5 Volt REED Relay	RadioShack	5	$2.99	$14.95
Wood	Home Depot	2	$10.49	$20.98
Microcontroller Startup Kit	Parallax	1	$99.95	$99.95
Razor Blade Set	Ace Hardware	1	$20.49	$20.49
Standard Servo Motor	Parallax	2	$12.95	$25.90
Plastic Scraps	Laird Plastics	1	$50.00	$50.00
Solenoid	Electromechanic	1	$105.49	$105.49
Misc Electrical Materials	RadioShack	1	$30.00	$30.00
Misc Hardware	Ace Hardware	1	$20.00	$20.00
			TOTAL	$442.18

Future Work

- Interface input and microcontroller
- Create user manual
- Further testing
- Reduce size
- Incorporate multiple modules

Acknowledgements