Automated Syringe Loading Device

Project for NREC-AMI
Student Design Competition

Client Contact: Dr. John D. Enderle
Biomedical Engineering, University of Connecticut
Email: jenderle@bme.uconn.edu
Phone: (860) 486-5521

Team 2
Daniel Littleton
Kathryn Tempe
Scott Relation
Introduction

**What is diabetes?**

- Disorder when the body doesn’t properly produce or use insulin
- Insulin: hormone required to convert mainly sugars and starches into energy required for daily life
- Affects 20.8 million children and adults in US alone
Clients

Disorders/Conditions faced by potential users:

- Arthritis
- Amputation
- Hemiplegia (side of body can become paralyzed)
- Parkinson’s disease (tremors, decreased range of motion)
- Wheelchair-bound & limited range of motion
- Neuropathy (numbness, pain)
- Loss-of-vision & -hearing
Purpose

To create a device that:

• Accurately dispenses insulin from any size bottle to any standard syringe
• Limited user requirements such as loading syringe, bottle and inputting dosage amounts
• Keeps time-stamped records of doses drawn
• Alerts user when bottle needs to be replaced
Previous Work Done by Others

**Insulin Pump**

- 3 Different insulin dosages: basal, bolus & correction/supplemental doses
- Delivers insulin through catheter-like system
- Pump sits outside the body
- Disadvantage: Costs over $5,000

http://www.diabetes.org/type-1-diabetes/insulin-pumps.jsp
Previous Work Done by Others

Senior Design 2005

UConn

University of Wyoming

Marquette University

http://www.bme.uconn.edu/sendes/Spring05/Team1/Index.htm
http://www.eng.mu.edu/wintersj/b18/index.htm
Using the Syringe Loading Device

To insert the syringe for loading, the user will first open the device’s hatch.

This hatch is designed with safety in mind. It will lock when the device is loading, and unlock when finished. LED’s and a voice output will inform the user when ready.
Methods of Operation

• Part 1:
  – The User will place the syringe in the holding tray, and attach the device’s grip to the plunger
Methods of Operation

• Part 2
  – The bidirectional motor and potentiometer will work together in a linear sliding gear mechanism
  – A motorized potentiometer is desired, but may not work if accuracy cannot be achieved
Methods of Operation

Safety

• Overfilling
  – The device will overfill the syringe when loading, then eject the extra insulin to push out any air bubbles

• Orientation Switch
  – Using a simple switch, the device will determine if proper orientation has been achieved
**Interaction With the Device**

- **Liquid Crystal Display**
  - An “LCD” will display all information that is important to the user

- **Voice Output**
  - Using a product called “DoubleTalk”, the device will communicate all actions and instructions to the user

- **Keypad**
  - A keypad consisting of numbers 0 thru 9, up/down arrows, Clear and Enter will be the users tool for giving the device instructions
How the Device Thinks

• **DoubleTalk**
  – Allows users to use text to speech outputs. This will allow the programming to “speak” directly to the user.

• **Microprocessor**
  – The microprocessor will be programmed to take the requested doses from the interface, and translate them into a distance for the motor to pull the plunger. This plunger distance will be calculated by the microprocessor as a function of resistance.

• **Rechargeable Batteries**
  – Rechargeable NiCad or Li-Ion batteries will be used to power the motor and computer functions. The device will alert the user when battery charge is low.
The Device has Finished Loading

- The Hatch Unlocks
  - the user may open the device and retrieve the syringe
  - A light and voice output will inform the user

- The Claw Remains in place
  - The claw that attaches to the plunger is placed on the plunger each use
Program Processing Flow

Main Menu
• Usage Log
• Prepare Dosage

User Navigation
• Make Selections
• Enter Amounts

Sensor Inputs

Memory Usage
**Budget**

**Major Components**
- Microprocessor
- LCD Display
- Keypad
- Sound Synthesizer / Speaker
- Motor / Potentiometer
- Pressure Sensors
- Rechargeable Batteries / Charger
Budget - Major Components

Microprocessor Concerns

• Data Storage: Program & Usage Data
• Real Time Clock & Calendar
• Analog/Digital Converters
• Multiple Input/Output Ports
• Data Transfer Options
• Power Consumption

Microchip  PIC24FJ128GA006
Budget - Major Components

**LCD Display Concerns**
- Type of Character Display
  - 7 Segment, 16 Segment, DOT Matrix
- Character Size
- Characters Per Line
- Lines to Display
- LCD Module vs. Direct Segment Driven

Data Vision LCD-122  16 Chars x 2 Lines
Keypad Concerns

- Key Size / Layout
- Number Keys, Enter / Cancel Keys
- Large Font, High Contrast Labels

All Electronics KP-24 8 Keys x 2 Rows

- Black/White, Large Font, Braille Labels

Special Needs Computers Solutions KBL-BB
Budget - Major Components

Audio Device Output Concerns
• Needs to store/play several menu prompts
• Must be able to output entered amounts
• Interface with the microcontroller
• Size and power considerations

RC Systems   DoubleTalk RC8660
• Has up to 33 min. of recording capability
• Unused memory can be used other storage
Motor / Potentiometer Concerns
• Accuracy – Motorized Potentiometer Issue
• Use separate DC motor and Potentiometer
• Size and power considerations

Hankscraft G4453
• 3V DC Motor with Gear

ETI Systems MW-22B
• 10 Turn Potentiometer
  Wirewound, 10k Ohms
## Budget - Current

### Major Components
- LCD Display $6.00
- Microprocessor $4.02
- Keypad $13.25
- DoubleTalk Chipset $50.00
- DC Motor $2.75
- 10 Turn Potentiometer $9.13
- Rechargeable Batteries / Charger $63.98

### Other Components
- Resistors, Capacitors, LED’s, etc. $11.00
- Circuit Boards, Wiring, etc. $5.00
- Gears, Plastic Box, Velcro Straps, etc. $12.00

### Total
- **$177.13**

### Other Costs
- Microprocessor Development Kit $99.00
- Sound Synthesizer Development Kit $139.00
Conclusion

This device:

• Is easy to use
• Allows users with disabilities to independently administer their medication, regardless of vision or hearing impairment
• Accurately dispenses insulin doses to within 1/1000th of a mL
• Is still less expensive than other equally convenient assistant devices
Resources

   Products. 2 Oct. 2007