Automated Syringe Loading Device

Project for RERC-AMI Student Design Competition

Client Contact: Dr. John D. Enderle
Biomedical Engineering, University of Connecticut
Email: jenderle@bme.uconn.edu

Team 2
Daniel Littleton
Scott Relation
Kathryn Tempe
Introduction

Affects 20 million children and adults in US alone

What is diabetes?
- Disorder in which the body is unable to properly produce or use insulin
- Insulin: hormone required to convert sugars and starches into energy
Clients

Conditions/Disorders 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 interactions
- Alerts user
- Keeps time-stamped record
Previous Work Done by Others

- Insulin Pump
- Insul-Cap
- Load-Matic
- Count-a-Dose
- Syringe Support
- Senior Design 2005
Patents

- #4357971: Syringe apparatus for low vision/hearing patients; uses audible sound or tactile stimulus
- #4778454: Syringe loading fixture for low or no vision patients; uses gauge for measurements
- #7025757: Syringe loading device; uses a drive member to impart motion

(http://www.freepatentsonline.com)
Subunits: 1

**PIC24 microprocessor**

- Least expensive of all the processors being considered
- Uses both serial and parallel port communication
- Capable of performing analog-to-digital conversion, voltage comparison, and date/time tracking
DoubleTalk chip by RC Systems

- Text-to-speech processor that translates pain English into speech in real time
- Audio output would be in analog format
- For simple instructions and questions for the user of the device to answer by keypad
Insulin Bottle Holder

- Accommodates a wide variety of bottle sizes and shapes; from 12 mm to 40 mm in diameter, and between 40 mm and 70 mm in height.
Subunits: 3.2

Moving the insulin bottle
- Will be moved using a servo
- Movement will follow tracks in the device’s case
- Distance moved will be determined by size of the syringe
Subunits: 4.1

The syringe cartridge
The syringe cartridge

- One bay on each side of the cartridge
- Two sensors in each bay
- Clip holds syringe in place
- Two prongs also help hold the syringe
Subunits: 5.1

Syringe Loading

- Motor
- Potentiometer
- Gear
- Point of Contact Between Gears
- Bracket
- Nut
- Leadscrew
- Collar (joins motor shaft to the screw)
- Motor
- Spacer
- Plunger Claw
- Nut
Subunits: 5.2

Moving the Motor to the Syringe

The wires will push the motor assembly to the syringe, then pull it away when filling is complete.
Subunits: 6

The Orientation Sensor
Ensures the device is standing upright

Device will not work if sensor does not report proper orientation
The Case

Subunits: 7.1

Display

Keyboard

Insulin Bottle Movement

Cartridge

Motor Case Movement

Plunger Motion
Subunits: 7.2

Enter dosage amount in ___ units
## Budget

### Major Components
- LCD Display: $224.95
- Microprocessor: $4.02
- Analog Tilt Sensor: $229.00
- DoubleTalk Chipset: $42.00
- Nema Step Motors: $130.00
- Futaba Digital Servos: $159.98
- Digital Potentiometer: $3.83
- Rechargeable Batteries / Charger: $84.55

### Other Components
- Resistors, Capacitors, LED’s, etc.: $30.00
- Circuit Boards, Wiring, Gears, Case, etc.: $70.00

### Other Costs
- Microprocessor Development Kit: $224.99
- Sound Synthesizer Development Kit: $139.00

---

**Total** $978.33
Problems and Concerns

- Prevention / Elimination of Air Bubbles in the Syringe
- Battery Life – Hours use per Charge
- Size / Weight of the Device
- Support for Multiple Languages
- Cost of the Device
Possible Improvements/Future Research

- Incorporate Voice Input
- Computer Connectivity
- Expanded Syringe Cartridge
- Integrate Glucose Monitoring Equipment into Device
- Insulin Infusion Pump Design
Conclusion

The Automated Syringe Loading Device:

- 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 easy to load and use

- Is still less expensive than other equally convenient assistant devices
Acknowledgements

✦ Dr. John Enderle of the University of Connecticut

✦ Dave Price of the University of Connecticut

✦ Rehabilitation Engineering Research Center

✦ Dr. Edward Etkind – a diabetologist from the Connecticut Medical Group

✦ Lee VanHennik – a diabetes patient
References


Questions?