Acceptance and Delivery Review May 25, 2022

Adaptable Device Which Reminds User to Take Medications

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Team 08

Timeline















Adaptable Device Which Reminds the User to Take Medications

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Problem Statement

Elderly people with health issues often have numerous daily prescribed medications, and as age increases, it becomes more difficult to remember what and when to take the medication

Objective

The project objective was to create a device which assist users in remembering to take the correct prescribed medication at the correct time of the day.

Level I Requirements

- The device will have a visible light function that serves to remind the client to take the prescribed pills
- The device will stop the alert (visual) to take pills once the pills have been taken.
- After a specified time, if pills have not been taken, the device will stop the alert (visual)
- The device will allow for a reminder to take medicine at least three times a day
- The device will come with a Manual and Instructions
- The pills will be easily accessible for an elderly person
- The device will hold one week's worth of pills

Construction Process

- 1. Cardboard Proof of Concept
- 2. Computer Aided Design (CAD) Model
- 3. 3D Printing
- 4. Arduino-Controlled Electrical System
 - Stepper Motor
 - Light Alert
 - Off Button



Figure 1: Cardboard Proof of Concept



Figure 3: Arduino Setup



Figure 4: Final Prototype

Design Studies

- 1. Time it takes to refill the final prototype versus in a standard pillbox (See Figure 5)
- 2. Time it takes to remove medication from one time slot in the final prototype versus in a standard pillbox (See Figure 6)





Conclusion

- Our final prototype pushes out compartments filled with medication based on what time it is in the week
- 2. It also emits a visual alert for the user to know that it is time for them to take their medication
- The data shows that our prototype is both quicker to refill <u>and also</u> quicker to remove medication from.

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Figure 2: CAD Proof of F

Statement of the Problem: Elderly people with health issues often have numerous daily prescribed medications, and as age increases, it becomes more difficult to remember the amount and type of medication.

Engineering Objective:

The project objective was to create a device which assist users in remembering to take the correct prescribed medication at the correct time of the day.

Project Background

Target Audience:

The elderly who have many prescribed medications and who may struggle with decreased memory capabilities.

- Medication Nonadherence due to forgetfulness is a serious yet preventable issue
 - 125,000 deaths per year due to medication nonadherence (Benjamin, 2012)
 - 70% of nonadherence cases can be attributed to simple forgetfulness or procrastination (Kirzinger et. al., 2019)
- Forgetfulness is present in the elderly population to a greater extent than the younger population
 - Higher risk of medication nonadherence for the elderly
 - The elderly also need to take the medication more frequently

Design Requirements





Level I Level II Level III

Level I Requirements

- Visible light function to remind client to take prescribed pills
- Alert to take pills will stop once the pills have been taken.
- If pills are not taken in time, access will be revoked
- Device will allow for a reminder at least three times a day
- Device will come with a Manual and Instructions for use
- Pills will be easy for elderly to take from compartment
- Device will hold one week's worth of pills



Level II Requirements

- Pills will be unavailable to the client until specified times
- Device will have an optional/adjustable sound reminding function
- The device will be connected to an electrical outlet
- The device will cost no more than \$80

Level III Requirements

- Device will have user interface for the caretaker to specify correct dates and times
- Caretaker will be able to prefill the container to allow for non-weekly visits
- The device will notify caretaker if pills are not taken at the correct time
- The device will not be larger than 2ft x 2ft x 2ft and will be aesthetically pleasing

PDR Designs



Design I Design II Design III



- Commercially available pill box slides into device, LED lights underneath line up with pill compartments
- LEDs turn on depending on the time/date corresponding with the compartment above
- Lights will turn off once the pills are taken
- The device will also have a master light that illuminates each time pills should be taken
- The device has an optional speaker for an auditory reminder to take medication
- Arduino board will serve as the controller for LEDs

Design Concept #2 Vibrating tunction

- Mobile device which can be used on trips
- Small 7-compartment box
- Similar to the previous design in the use of LEDs as reminders
- Vibrating reminder system
- Easily replaceable pill containers for planning purposes
- Arduino serves as controller for the LEDs



- Larger monthly device with 31 separate "drawers", each containing pills for the corresponding day of the month
- Similar LED functions as the previous designs
- Arduino to implement controls of the LEDs
- Each drawer can have multiple sub containers
 - Morning, Afternoon, Evening

PDR Decision Matrix

#	Criteria Weight	Requirement Type	Requirement Statement	Design 1 Pill-Box Attachable	Design 2 Travel Container	Design 3 Calendar
1	9	Functional	The device will have a visible light function that serves to remind the client to take the prescribed pills	9	9	9
2	7	Functional	The device will stop the alert (visual) to take pills once the pills have been taken.	7	6	7
3	8	Functional	After a specified time, if pills have not been taken, the device will stop the alert (visual)	6	5	7
4	10	Functional	The device will allow for a reminder to take medicine at least three times a day	10	0	10
5	9	Documentation	The Device will come with a Manual and Instructions	5	5	5
6	9	Ease of use	The pills will be easily accessible for an elderly person	5	3	2
7	10	Functional	The device will hold one week's worth of pills	10	7	10
			Total out of 62:	52	35	50

CDR Design





Focused Design

Rolling Floor Design

- 7 columns for each weekday
- 3 rows with one motor each (morning, noon, evening)
- The motor rotates a gear which rolls up the floor
- When the floor moves, it drops the medication out
- Based on the order, for example Tuesday morning medication will ALWAYS be dropped after Monday morning
- Medication (if not taken) will be dropped into a "waste" section

PROS

- Only 3 motors used, relatively inexpensive
- Medication is blocked if the user is late
- Large compartments are easy to fill up

CONS

- Floor doesn't unroll well
- The pills in the "waste" section will be unsorted
- Requires good hand coordination to remove the medication

Build Process





From CDR to TRR

Roulette Design Brainstorm





- Wanted only 1 motor to power with a single arduino
- Wanted compartments to be "lockable"
 - User should only be able to take the compartment that they need to at the moment, and not have access to previous or future medication
- Needed 21 large compartments
 - Impacted size constraints

PROS	CONS
Only 1 motor, relatively	- Difficult to keep the diameter
inexpensive	< 2 feet while also organizing
Medication is blocked if the	the compartments in a way
user is late	that makes sense
Simple to fill up	that makes sense

Roulette Design Brainstorm



- Kept the circular layout from the previous design
 - Only requires 1 motor
- Wanted the user to be able to fully remove the compartments
 - Makes it easy to get the medication out of compartments
- Allows for smaller size compartments
 - Reduces the diameter
- Use a "push" rod to propel the correct compartment outwards
- User removes the pushed compartment and takes the medication
- Used gravity to have the compartment fall back into place

PROS

- Only 1 motor
- Medication is "locked"
- Easy to access medication
- Simple to refill
- Small; The diameter is 9 inches

CONS

- Position of rod must be precise
- Must follow correct procedure for obtaining pills



Full prototype in Solidworks



Bottom view with all componentry

Roulette Design Process

- Moved from cardboard designing phase into the CAD phase
 - Multiple iterations designed in Solidworks
 - Arduino components imported or modeled



"Rest" state



"Active" state

Scan QR code to view and download .stl files:



Roulette Design Brainstorm





Arduino Coding

- Stepper Motor
- Stepper Motor Driver
- LED Bulb
- Button
- Breadboard

Help From: Mr. Loven, Dr. C and Classmates (Thank you to the Paper Cranes)

Final Prototype









Roulette Design



Demonstration



Requirements Fulfilled

Level I Requirements

#	Requirement Type	Requirement Statement	Roulette Wheel
1	Functional	The device will have a visible light function that serves to remind the client to take the prescribed pills	Yes
2	Functional	The device will stop the alert (visual) to take pills once the pills have been taken.	Yes
3	Functional	After a specified time, if pills have not been taken, the device will stop the alert (visual)	Yes
4	Functional	The device will allow for a reminder to take medicine at least three times a day	Yes
5	Documentation	The device will come with a Manual and Instructions	Yes
6	Ease of use	The pills will be easily accessible for an elderly person	Yes
7	Functional	The device will hold one week's worth of pills	Yes

Level II Requirements

#	Requirement Type	Requirement Statement	Roulette Wheel
8	Functional	The pills will be inaccessible to the client until specified times (It will lock)	Yes
9	Functional	The device will have an optional/adjustable sound function to aid in reminding the client to take their pills	No
10	Functional	The device will have a power source supplied by an electrical outlet	Yes
11	Cost	The cost of the materials of the device will cost no more than \$80	Yes

Level III Requirements

#	Requirement Type	Requirement Statement	Roulette Wheel
12	Functional	The device will have a user interface for the caretaker to specify the days and times when the device will remind the client to take their pills	No
13	Functional	The device will be supplied with a personalized pill box that allows for the caretaker to fill it up with pills quickly and move it back into place for the clients use	No
14	Functional	The device will notify caretaker if pills are not taken at the correct time	No
15	Physical	The device will not be larger than 2ft x 2ft x 2ft and will be aesthetically pleasing	Yes





Refilling Taking

Testing

VS.



Roulette design

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Original box

Testing Results (Refilling)

Participant	Roulette Design (s)	Standard Pillbox (s)
1	125.56	138.44
2	138.85	147.59
3	85.96	122.75
4	77.52	109.26
Average	106.84	129.51

Testing Results (Removing)

Participant	Roulette Design (s)	Standard Pillbox (s)
1	4.11	8.67
2	3.44	12.08
3	3.21	6.83
4	3.43	11.47
Average	3.55	9.76

Future Extensions





Future Extensions

- Incorporate RTC (Real Time Clock) for more efficient programming and to accurately run the device for longer time spans
- Create system to check whether pills were removed from containers
 - Mobile app to alert caretaker when medication is not taken
- Mobile reminder device which uses vibration to alert user at necessary times
- Add individual lights for each container, to help with identifying which medication to take
- More securely fix lid to box, only removable by the caretaker for refilling purposes

References

Benjamin R. M. (2012). Medication adherence: helping patients take their medicines as directed. *Public health reports (Washington, D.C. : 1974), 127*(1), 2–3. https://doi.org/10.1177/003335491212700102

de Boyles, D. R. (2015, May 5). Pill Reminder Wheel

Dickie, R. G., & Prokopchuk, W. (2017, August 1). Electronic pill box prefill system including a blister pack with a capacitive sensor.

Henderson, R., & President, V. (2019, September 19). Study: Proactive efforts improve adherence. Study: Proactive Efforts Improve Adherence. Retrieved March

20, 2022, from

https://www.express-scripts.com/corporate/articles/study-proactive-efforts-improve-adherence

Kirzinger, A., Neuman, T., Cubanski, J., & Brodie, M. (2019, August 9). Data Note: Prescription Drugs and Older Adults. Health Reform. Retrieved March 20, 2022, from

https://www.kff.org/health-reform/issue-brief/data-note-prescription-drugs-and-older-adults/

Lai, J. (2006, July 25). Automatic pill reminder bottles

U.S. Department of Health and Human Services. (2018, January 24). *Do memory problems always mean alzheimer's disease*? National Institute on Aging. Retrieved March 20, 2022, from https://www.nia.nih.gov/health/do-memory-problems-always-mean-alzheimers-disease

Thank You for Listening Please ask any Questions

Thank You to all who assisted us in making this idea into a reality:

Family, Peers, Teachers, Dr. C, Mr. Loven