

Strid Secure Project Proposal

By

Nick Schroeder

Harrison Wang

Janine Zhu

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TA: Aniket Chatterjee

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1. Introduction

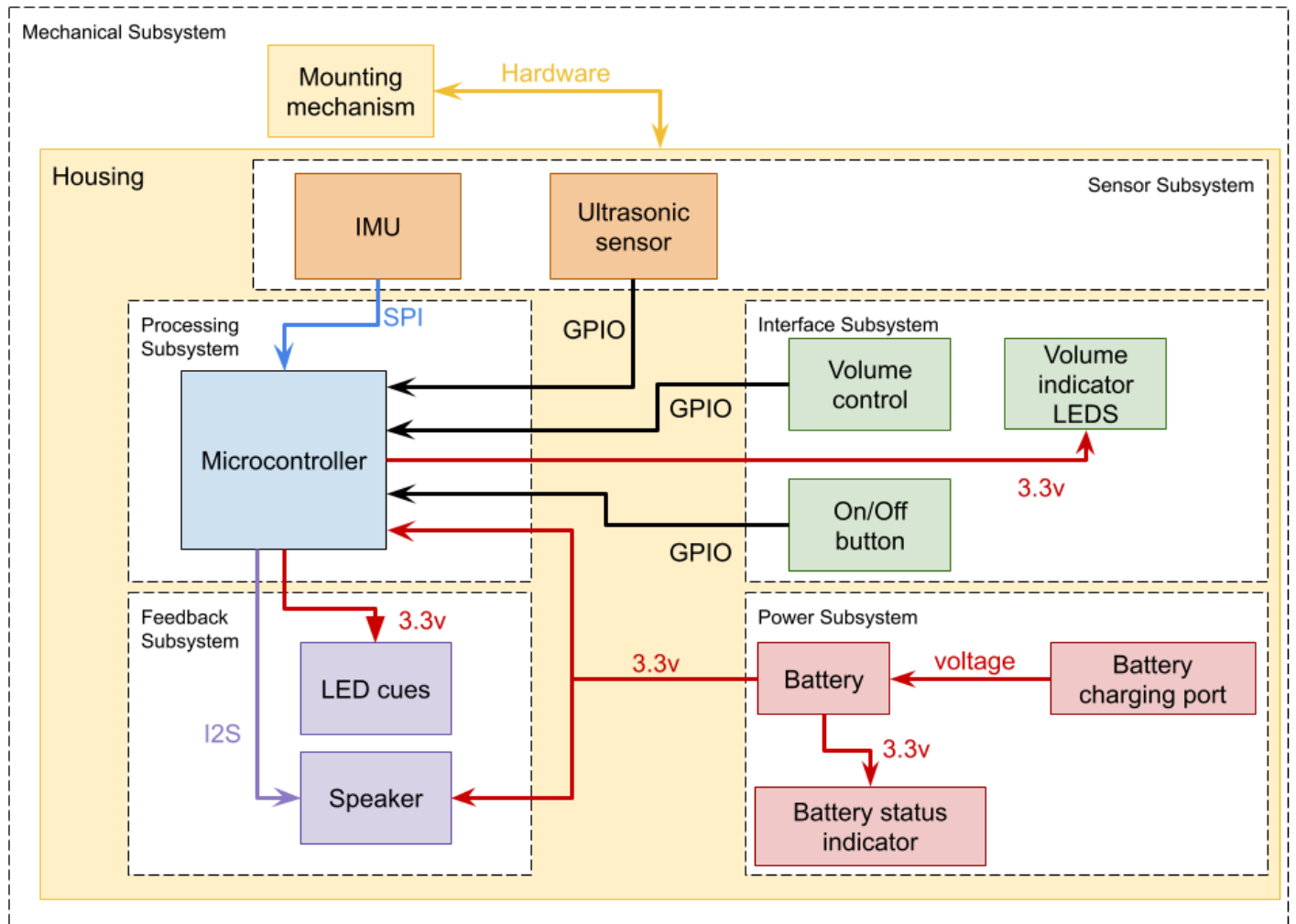
One of the most common injury risks with older adults are falls. More than 14 million adults in the US over 65 years old report a fall every year, which leads to 3 million trips to the emergency room and 1 million hospitalizations, almost 319,000 are for a hip fracture (Centers for Disease Control and Prevention [CDC], 2026a; CDC, 2026b). Data from 2019 indicates a problem of a similar magnitude, with 290,130 hip fracture hospitalizations in the target population, of which 88% are caused by falls (Moreland et al., 2023).

Most patients receive a wheeled walker to aid with their recovery, although many receive limited instruction before leaving the hospital for independent home recovery. Thomas et al. (2010) determined that 92% of these patients received a wheeled frame upon discharge, and that 32% of patients who changed aids were either using an inappropriate one or using it correctly. While healthcare professionals are able to guide patients in the proper use of these walkers, this professional observation inherently isn't possible in independent home environments, hence why an alternative method is needed. Customer discovery interviews conducted by the Stride Secure medical and business team with physical and occupational therapists further identified walker abandonment, poor walker positioning, unsafe turning, excessive gait speed, and low-light ambulation as common contributors to falls during the early recovery period.

Current smart mobility devices generally address isolated aspects of mobility, such as gait initiation or weight distribution, and often require specialized equipment. Stride Secure instead augments an existing walker with real-time behavioral feedback that targets multiple modifiable fall-risk factors identified through both published literature and stakeholder interviews.

Our goal for this project is to design and implement a working prototype of Stride Secure as a lightweight, reusable clip-on device that transforms a standard walker into an intelligent rehabilitation support system. Using motion sensing and proximity sensing, the prototype provides configurable visual and auditory cues to encourage proper walker positioning, remind patients to use their walker, promote safer walking speed, and reinforce safe mobility behaviors during the first 2–6 weeks following discharge.

1.1 Block Diagram:



- Due to its need to carry out full days of work, the system must be able to run on a single battery charge under clinically expected operation for 12 hours
- The sensor array must be able to take in proper data to recognize prominent user error with 90% accuracy for our prototype, providing a strong baseline to build upon in future iterations of the project.
- The processing system must be able to take in all data from the sensing system and properly determine whether a hazardous state exists with 90% accuracy

2. Design

2.1 Subsystem Overview:

2.1.1 Mechanical Subsystem

This subsystem is the mounting mechanism for the device as well as the housing for all electronics parts such as sensors, microphones, and the microcontroller. The mounting mechanism should be adjustable for a variety of walker models. The housing should be a COTS product such as the 75065K51 enclosure, for example, and will need to account for sensor placement and feedback system optimization.

Mechanical requirements:

- securely attach to standard front-wheeled walkers without permanent modification.
- be lightweight and not interfere with normal walker operation or stability.
- Maintain attachment during routine walking, turning, and sit-to-stand transitions.
- Simple installation and removal
- withstand routine cleaning and repeated daily use

2.1.2 Sensor Subsystem

This system must be able to detect the walker's motion and orientation and the user's proximity to the walker. An IMU (MPU6050) would be used to detect falls or excessive leaning of the walker. Integrating the collected acceleration data from the IMU can be used to determine walker speed. This system will have an ultrasonic sensor (HC-SR04) to determine the user's location relative to the walker, allowing it to detect if the user drifts too far in or out of the walker. We're also considering a lidar camera either to replace the sensor or in tandem with it to provide a broader set of data. The determination of whether to or not to use lidar is in consideration pending further analysis by the team.

Sensor requirements:

- detect continuous walker motion, orientation, and user proximity relative to the walker.
- reliably distinguish between normal use and unsafe behaviors
 - e.g., walker abandonment, excessive distance from walker, rapid gait changes
- operate consistently with different walker models and user heights/physical profiles.
 - Allow for calibration with different walkers to ensure reliable data collection

2.1.3 Processing/Control Subsystem

This subsystem processes sensor data to make real-time cues for the user. The subsystem will have a microcontroller (STM32U0) to intake data collected by the sensors and provide real-time instructions to the feedback system. It can use its flash memory to store data as needed, and as the most power-efficient current model in STM's lineup, it will support the need for efficient power consumption. The cues and instructions will be issued depending on predetermined/inputted mobility states to delineate what are safe and unsafe use patterns. The inputs from the interface subsystems, such as volume and brightness controls, will be processed to be reflected in the feedback subsystem as well.

Processing requirements:

- continuously process sensor inputs in real time during device operation.

- Identify safe vs unsafe movements
- generate feedback decisions with minimal delay to support real-time correction.
- operate using low-power embedded computation suitable for portable use.
- support personalized thresholds/alerts based on patient needs

2.1.4 Feedback Subsystem

This subsystem provides the user with reminders based on information and data processed from the sensor subsystem and instructions determined by the processing/control subsystem. The instructions and cues are sent audio cues through a microphone. Visual cues, such as reminders to use the walker at night, would be small flashing LEDs for users who are hard of hearing or deaf. The LEDs would also be different colors for different warnings, which colors such as Red, Yellow, and Blue for users who may be red-green colorblind. Brighter LEDs will be used to improve nighttime visibility.

Feedback requirements:

- provide immediate and understandable cues for unsafe walker use.
 - e.g. bumpy/slippery
- allow users to mute or adjust alert intensity when appropriate.

2.1.5 Power Subsystem

This subsystem powers the device and all the electronic components. This subsystem will consist of a rechargeable battery and battery status display at its core. We will design it to be charged by USB, thus allowing us to use standard AC-DC wall power blocks and avoiding the need for an onboard rectifier. The system as a whole will be designed to minimize power consumption in order to prolong battery life throughout the day. This will be achieved by selecting components specifically for power efficiency, regulating voltage to convert to the most efficient operating voltage of those devices when the energy expense of this conversion is less than the efficiency boost, and allowing the system to entirely cut off conduction to elements which aren't in use if determined that the system for cutting off these current paths will burn less power than the elements would without cutoffs. The cutoffs will be determined by software and achieved by switching power MOSFETs (IRF11310N) on or off. The voltage regulation can be achieved using either a switching regulator (TPS62A01DRLR) or an LDO (MIC5156YM) depending on how noise-sensitive the device being powered is.

Power requirements:

- operate for at least one full day (~12 hours) of typical use without recharging.
- be rechargeable using a standard USB connection
- Clear battery indicator
- maintain safe operation without overheating during continuous use.
- be safely enclosed to prevent user exposure to electrical components

2.1.6 User Interface Subsystem

This subsystem is for users to input volume and brightness settings as well as initialize/define basic mobility states for safe and unsafe use patterns. Any user inputs for instruction volume or alert intensity can be adjusted with larger buttons for mobility accessibility. Interface requirements:

- provide a simple on/off mechanism suitable for older adult users.
- allow basic adjustment of alert settings (e.g., volume or sensitivity).
- be operable with minimal fine motor control.
- include clear indicators for device status (active, low battery, muted).
- be designed for intuitive use without requiring training

2.2 Tolerance Analysis (Design Risks):

One of the primary technical risks is accurately detecting unsafe walker use. Stride Secure will use motion and proximity sensors to identify behaviors such as improper walker positioning, walker abandonment, excessive walking speed, and unsafe turning. However, natural differences in users' gait patterns, everyday movements, and walker designs may result in false positive or false negative detections. Excessive false alerts could cause users to unnecessarily alter their walking pattern and can cause users to disregard notifications. False positives could create a false sense of security that would be counterproductive for patients. To mitigate this risk, detection algorithms will be developed and refined through iterative testing with clinicians and end users. Clinical trials and developing a refined detection algorithm are outside the scope of our project. Our final product will be a proof-of-concept prototype that would allow for data collection and can give appropriate alerts, but will not be trained with real patient data to develop a refined algorithm.

Another technical challenge is determining the user's position relative to the walker. Differences in the user's physical profile, including their height, walking style, and recovery stage, make it difficult to establish universal thresholds for safe positioning. The project will therefore evaluate combinations of inertial measurement units (IMUs), proximity sensors, and rule-based algorithms to improve detection reliability across a range of users while minimizing unnecessary alerts. The prototype should be tested amongst users of different heights and will not falsely flag regular walking movements simply due to height differences.

Battery life is an additional design consideration. Continuous sensor monitoring, audio feedback, and nighttime illumination can increase power consumption and therefore limit operating time. The decision will prioritize low-power components, efficient software, and a rechargeable battery capable of supporting a full day of use. The design will also incorporate battery indicators and notifications to reduce the risk of device failure. The battery life can be tested by being left to continuously monitor sensors throughout the length of a full day.

The device must also remain securely attached to the walker during normal use. Repeated loading, vibration, accidental impacts, and cleaning could loosen or damage the mounting mechanism over time. Mechanical testing will evaluate the durability of the attachment system over repeated installation and removal cycles, while ensuring that the device remains secure and does not interfere with normal walker operation.

3. Ethics

Stride Secure is designed to supplement clinical rehabilitation rather than replace physical therapy or professional clinical judgment. Ethical considerations will be incorporated throughout the design process by clearly communicating the device's capabilities and limitations. Users will be informed that Stride Secure provides behavioral guidance and safety alerts, but cannot fully eliminate the risk of falling or replace professional medical care. User privacy will also be considered when implementing alerts. Configurable alert settings will allow users and clinicians to adjust notification volume based on individual needs and to avoid overly intrusive alerts in public settings.

The project will also consider accessibility and equitable use. Stride Secure is designed to attach to walkers that patients already receive during rehabilitation, allowing users to simply purchase an optional add-on rather than requiring them to purchase a specialized smart walker. This approach reduces additional equipment requirements and costs, allowing the technology to be used with a wider range of patients with any walker, rather than limiting it to only those who can afford a specialized smart walker. Design decisions will account for differences in user height, gait patterns, mobility limitations, and recovery stages to maximize the breadth of Stride Secure's potential application.

Safety is a primary consideration since the device is intended for use on a mobility aid. The attachment mechanism must remain secure during normal walking, turning, impacts, and repeated use without interfering with the walker's stability or operation. The enclosure will use lightweight construction and rounded edges to reduce the risk of injury. The product enclosure will ensure electrical safety through the appropriate isolation and protection of electrical components. Battery indicators will help prevent unexpected loss of functionality. Nighttime lighting will be incorporated to improve the user's visibility. Thorough testing will be conducted to evaluate the mechanical and electrical safety, sensor reliability, and alert behavior and adjustability before user testing.

Stride Secure will also be developed with applicable engineering and medical device standards in mind. Relevant FDA requirements for medical devices, including quality system, labeling, registration, and device-listing requirements, will be considered during development. Applicable electrical, battery, electromagnetic compatibility, and mechanical safety standards will be reviewed as the hardware and enclosure are finalized. Engineering decisions will prioritize user safety, reliability, accessibility, and responsible communication of the device's capabilities and limitations.

4. References

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Centers for Disease Control and Prevention. (2026b). Facts about falls.

<https://www.cdc.gov/falls/data-research/facts-stats/index.html>

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