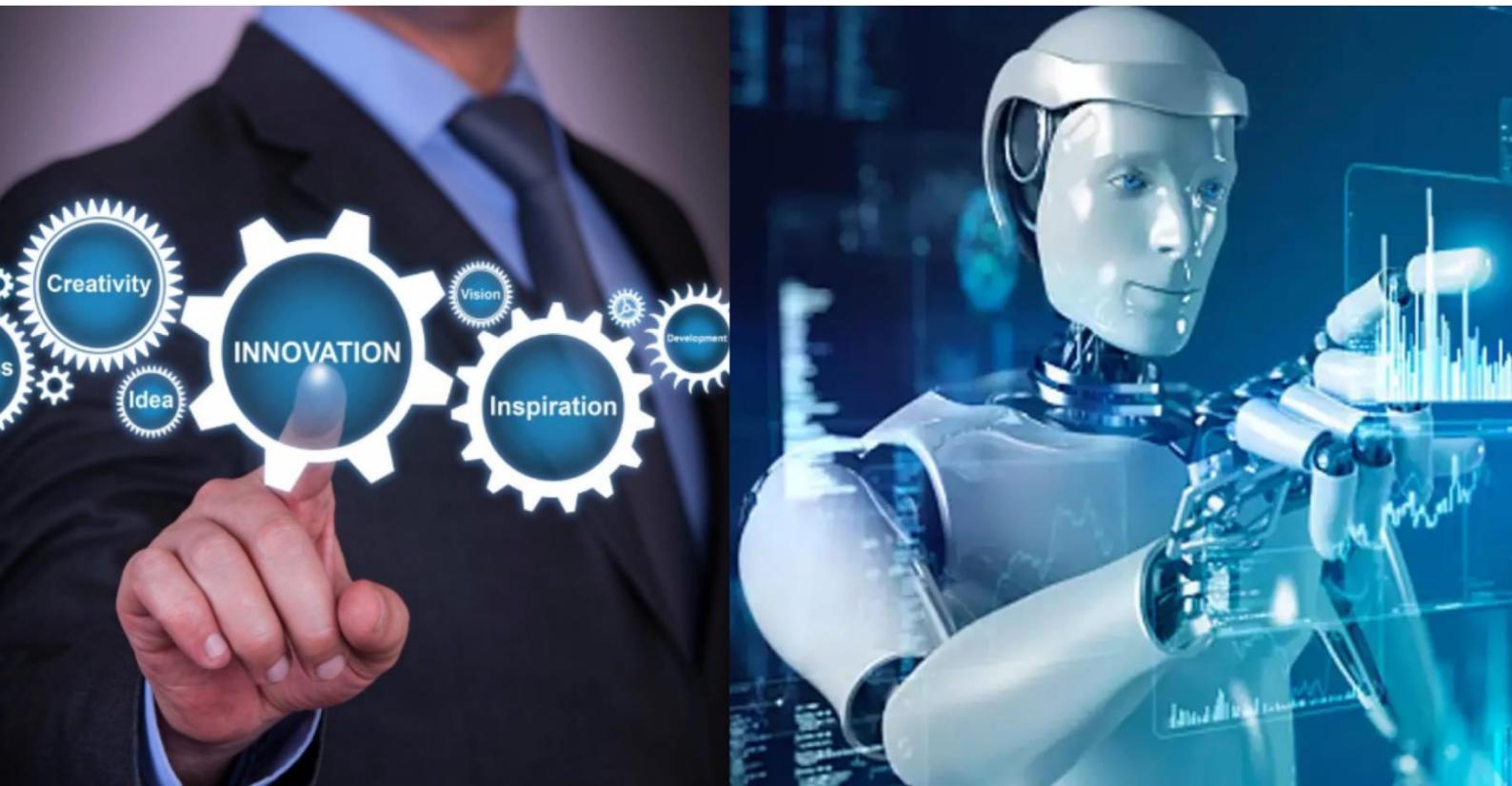




International Journal of Innovative Research in Science Engineering and Technology (IJIRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.699

Volume 14, Issue 12, December 2025

Design and Fabrication of Sensor Enabled Walking Stick for Elderly People

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ABSTRACT: A smart walking stick is an assistive device designed to enhance the safety and independence of elderly and visually impaired individuals. The main objective of this project is to develop a walking stick equipped with modern sensors and technology to help users navigate their surroundings with ease. The stick incorporates ultrasonic sensors to detect obstacles in the user's path and provides vibration or buzzer alerts to warn them of potential hazards. Additional features such as GPS tracking, emergency alert systems, and fall detection can also be integrated to ensure user safety and allow caregivers to monitor their location in real time. The proposed smart walking stick is affordable, lightweight, and easy to use, making it a practical solution to improve mobility and reduce the risk of accidents among elderly and differently-abled persons. This smart walking stick is an innovative and multifunctional mobility aid designed primarily for elderly individuals and people with mobility challenges. It functions both as a walking stick and a portable folding chair, allowing users to switch between walking and resting with ease. The main objective of this project is to design a lightweight, strong, and user-friendly that provides comfort, stability, and safety. The chair is made using durable materials such as aluminum or high-density plastic to ensure strength while keeping the weight low. Its folding mechanism is designed for quick and effortless conversion between stick and chair modes. This product helps reduce fatigue during long walks and promotes independence among elderly users, making it a practical and reliable aid for daily activities.

KEYWORDS: ultrasonic sensors, GPS tracking, multifunctional mobility, fall detection System.

I. INTRODUCTION

Elderly people and individuals with mobility challenges often experience difficulty maintaining balance and stability while walking, especially on uneven surfaces or for long durations. With age, muscle strength, coordination, and endurance tend to decrease, making normal walking a tiring and sometimes unsafe activity[2]. Traditional walking sticks provide only limited physical support and do not address additional needs such as rest, navigation assistance, or fall prevention[4]. Moreover, most conventional designs lack ergonomic comfort, adjustability, and multipurpose functionality suitable for modern users. Therefore, there is a need to design and develop an improved walking stick that enhances user safety[3], comfort, and independence possibly by integrating modern features like adjustable height, lightweight materials, anti-slip grips[5], and even smart technologies (such as obstacle detection, lighting, or emergency alerts). Many elderly individuals suffer from conditions such as arthritis, joint pain, muscle weakness, or balance disorders that make walking unsafe without support[8]. The lack of suitable walking aids often leads to fear of falling, dependency on others, and physical inactivity. Conventional walking devices are frequently uncomfortable,

poorly designed, or not adapted to individual needs, leading to further discouragement from regular walking.

II. RELATED WORK

The concept of a combined walking and seating aid is not a recent innovation. A review of historical patents and trade catalogs reveals a long-standing recognition of this need as those found in the United States Patent and Trademark Office (USPTO) database[1], show patents for combination walking sticks and seats dating back to the late 19th and early 20th centuries. These early designs were often mechanically complex, made of wood and metal, and functioned as novelties or for specific professional use rather than as mainstream medical devices. The late 20th and early 21st centuries saw a significant increase in patent filings and commercial models[12]. Modern designs benefit from advanced materials like lightweight aluminum alloys and carbon fiber, making them more practical for daily use. The literature reveals several distinct design typologies, each with unique engineering challenges and trade-offs between stability, weight, and ease of use. The cane itself forms one leg of a stool that deploys, with two or three additional legs folding out from a central hub. Studies in Ergonomics and Human Factors journals highlight the critical balance between the stool's base of support for stability when seated and the device's weight and bulk when folded. A key challenge is ensuring the locking mechanisms for the legs are intuitive and fail-safe for users with reduced hand strength. Another popular design incorporates a small, fabric seat that unfolds from the cane, supported by an Square-frame mechanism similar to a miniature camping stool. Research in Rehabilitation Engineering points out that while this design can offer a more comfortable seat[15], it often has a larger packed size and may be less stable on uneven ground than a tripod design. A significant finding of this survey is the relative lack of high-quality, peer-reviewed clinical evidence specifically for this device category compared to standard walking aids. While user testimonials and commercial websites are replete with positive reports, there is a scarcity of randomized controlled trials (RCTs) comparing the hybrid device to a conventional cane or rollator. Most evidence resides in the realm of Occupational Therapy practice models, which emphasize client-centered choice and task analysis. Some clinical guidance documents, such as those from the American Physical Therapy Association, caution that these devices may have a different "feel" and weight distribution than a standard cane. If not properly fitted and the user not adequately trained, this could potentially increase the risk of a trip or fall while walking, especially if the leg mechanism is bulky. The act of deploying and sitting down also requires a certain level of balance and coordination. The biomechanical literature on standard canes is extensive, establishing their role in offloading weight and improving stability. It remains unclear how the added mass and altered center of gravity of a seat-cane influence gait patterns, energy expenditure, or upper limb forces. This represents a clear gap for future research.

III. PRODUCT ARCHITECTURE

It must function both as a walking stick/cane and as a chair. The transition from cane to seated mode should be fast and easy. When in walking-stick mode it should be compact and easy to carry; when in chair mode it should provide stable seating. Stability and safety when in seated mode able to support a specified maximum load without collapse. Ergonomic user experience: Comfortable handle in walking mode, comfortable seat height and area in sitting mode. Insert the handle onto the upper aluminum shaft[12]. Fix it using screws, rivets, or industrial adhesive. Add the internal locking rod. Attach hinges to the three aluminum legs. Install rubber feet at the bottom. Connect legs to the central pivot block or mounting hub. Link the three seat panels using hinges (tri-fold arrangement)[16]. Attach seat lock latch underneath. Add connecting linkages that synchronize: This ensures when the user spreads the legs, the seat automatically unfolds. Connect the seat assembly to the leg assembly via: Test folding and unfolding motion to ensure smooth movement. Adjust hinge tension for stability. Attach main shaft to the leg-seat assembly. Install safety lock that prevents accidental closing. Fit cosmetic caps or covers over fasteners if used[18]. Check alignment and folding angles. The walking stick with a portable chair is a pragmatic and innovative response to the real-world mobility challenges faced by a growing segment of the population. The literature confirms its value is primarily psychosocial and functional, empowering users by extending their safe and comfortable range of mobility. However, its adoption is currently driven more by consumer demand and clever design than by robust clinical evidence. Future work should focus on rigorous biomechanical and clinical outcome studies to establish clear guidelines for prescription, fitting, and training. As the design continues to evolve with lighter, stronger materials and potentially smart features, this hybrid device is poised to play an increasingly important role in promoting independence and quality of life for individuals with mobility limitations.

Table 1: Key Specification of Design Components

Parameter	Specification
User heights supported	150-195 cm
Seat height	50 cm above ground
Load capacity	136 kg (300 lbs)
Product weight	0.9-1.0 kg
Material	Aluminium alloy + stainless steel rim
Footing / stability	Large anti-slip rubber feet, spiral pattern
Conversion time	Ideally 1 second fold/unfold
Modes	Walking cane mode + Chair mode
Safety features	Seat lock, safety buckle, reinforced structure



Figure 1: Final Assembly

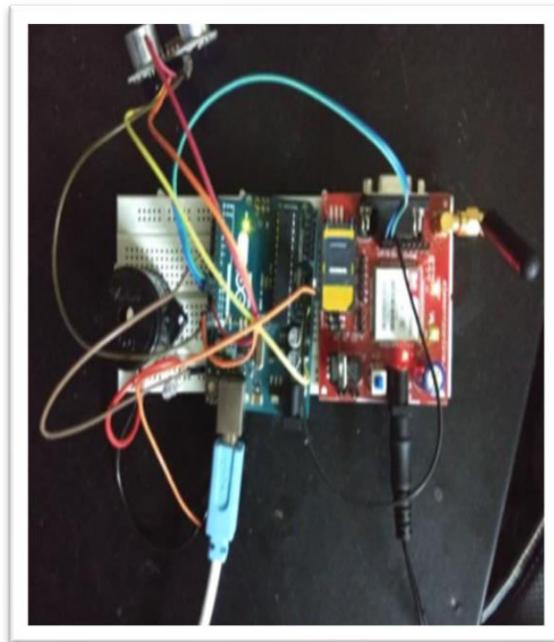


Figure 2: Object Detection Circuit

IV. SIMULATION

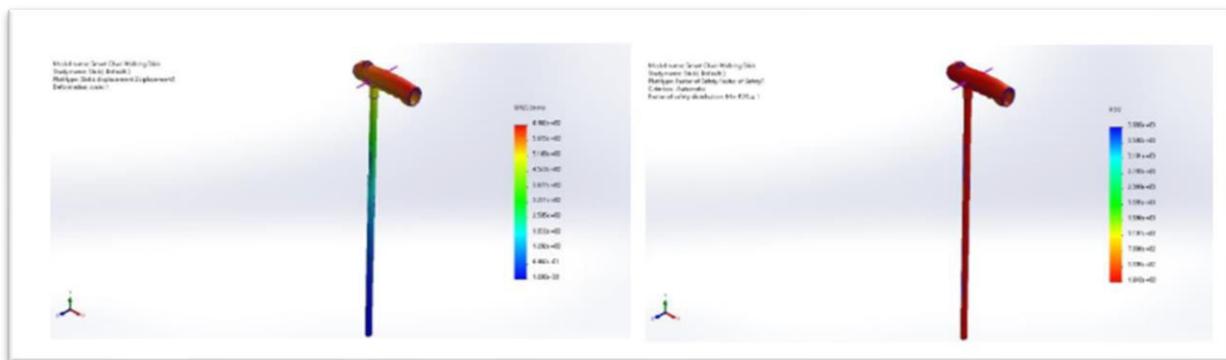


Figure 3: Static stress and strain in stick .

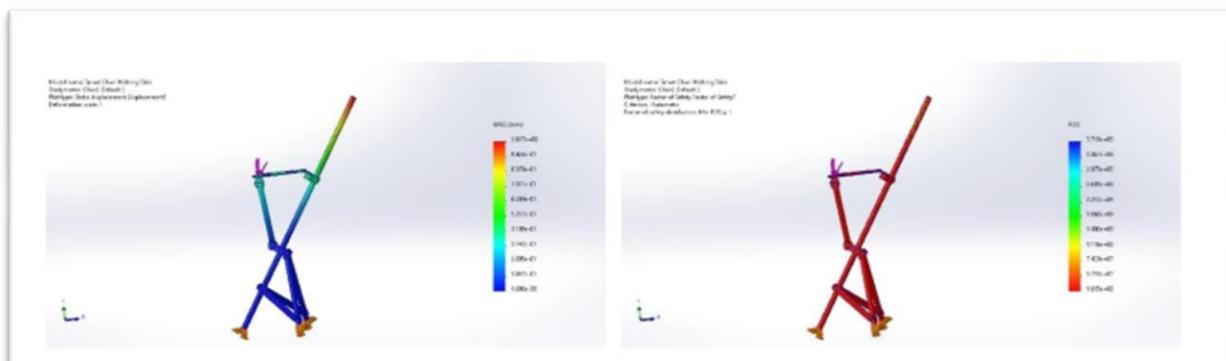


Figure 4:Static displacement in chair mode

Figure 5: Factor of safety in chair mode .

In SolidWorks, a comprehensive Finite Element Analysis (FEA) was conducted on the Smart Chair Walking Stick design in both stick and chair modes. For the stick mode analysis, loads were applied, and stress and displacement were examined along the stick. The results revealed that when a force equivalent to 70kg is applied to the handle, the factor of safety is calculated as 1. This signifies that the device is capable of safely managing loads up to 70kg in stick mode. Similarly, for the chair mode analysis, loads were applied, and stress and displacement were assessed along the chair. The FEA results indicated that when a load of 55kg is applied to the seat, the factor of safety is 1. This suggests that the Smart Chair Walking Stick is designed to safely accommodate individuals weighing up to 55kg in chair mode. These simulation results form the basis for determining the load-bearing capacity and safety limits for both the stick and chair configurations, ensuring that the device is robust and reliable under specific conditions.

V. RESULTS AND DISCUSSIONS

It Allows users (especially elderly or mobility-limited people) to walk longer distances. Provides immediate access to seating anywhere. Allows users (especially elderly or mobility-limited people) to walk longer distances. Provides immediate access to seating anywhere. Reduces fatigue since users don't need to search for benches or resting areas. Chair transforms instantly about 1 second. Users can sit safely during long queues, outdoor events, walking trips, or travel. Offers a stable rest point to reduce risk of dizziness or falls due to overexertion. Tripod structure provides stable seating. Anti-slip rubber feet reduce risk of sliding. Seat-lock mechanism prevents accidental collapse. Supports high weight relative to its own low mass. A walking portable seat in one device. Reduces the need to carry extra items (folding stool, cane, etc.). Easy to store, carry, hang, or place in vehicles. Seat height is optimized for effortless sitting and standing (usually ~50 cm). Three-piece seat design provides balanced weight distribution. Reduces strain on knees, hips, and back compared to low or unstable foldable stools. Made with aerospace aluminum and reinforced

components. Withstands daily wear, outdoor use, and varied weather conditions. Provides long-term value with minimal maintenance required. Users feel more confident leaving the house knowing they can sit anytime. Encourages more outdoor activities, exercise, and independence. Helps people participate in events that require standing for long periods. Prevents falls or strain caused by fatigue. Useful for people with heart, lung, or joint conditions who need frequent rest. Supports safer rehabilitation and physical therapy routines. Effective indoors, outdoors, in parks, malls, public transport, and travel. Helps in crowded situations (queues, stations, airports). Adaptable for a wide range of user heights and mobility levels.

Table 2: Applications of Magic Walking Stick in various fields.

Category	Applications
Mobility	Elderly walking support, patients with reduced stamina
Medical	Rehabilitation, chronic disease support
Public spaces	Long queues, public service centers
Outdoor	Hiking, fishing, picnicking, sightseeing
Travel	Airports, stations, long walks
Events	Concerts, festivals, markets
Home	Chores, short resting moments
Work	Security, guiding, field work
Emergency	Backup seating, portable rest

VI. CONCLUSION

The magic walking Chair offers a practical and innovative solution by combining a walking cane with a lightweight, portable seat, providing users—especially the elderly or those with mobility challenges—greater confidence and independence. Its quick one-second transformation, stable tripod design, and anti-slip feet ensure safety and ease of use in both indoor and outdoor environments. Made from durable, lightweight materials, it offers ergonomic comfort, long-lasting reliability, and the convenience of resting anywhere, whether in queues, parks, airports, or during everyday activities. Overall, this chair enhances mobility, reduces fatigue, and supports an active, socially engaged lifestyle. Works as both a walking cane and a portable chair. Reduces the need to carry extra items such as a separate stool or mobility aid. Saves space, money, and physical effort. Usually weighs less than 1 kg. Easy to carry for elderly users or people with limited strength. Can be used indoors, outdoors, during travel, or stored easily in a car. Converts from cane to chair in 1 second. Uses simple hinge and locking mechanisms that require no strength or complex actions. Highly convenient during sudden fatigue, dizziness, or long queues. Tripod base provides excellent stability on uneven surfaces. Anti-slip rubber tips prevent sliding. Locking mechanisms secure the seat and legs in place. Designed to support high weight (often up to 120–136 kg). Seat height is optimized to reduce strain on knees when sitting and standing. The curved multi-panel seat distributes weight comfortably. Cane handle often features ergonomic grip designs. Encourages elderly users or recovering patients to walk more confidently. Reduces fear of fatigue or falling due to lack of nearby seating. Supports rehabilitation and daily mobility routines. Useful in parks, malls, airports, stations, events, outdoor markets, and hiking. Perfect for long-standing tasks like ticket lines, ceremonies, or festivals. Suitable for both medical and recreational use. Made from strong yet lightweight materials like aircraft-grade aluminum. Resistant to corrosion, pressure, and outdoor wear. Minimal maintenance required. Helps prevent exhaustion, dizziness, or leg pain. Beneficial for people with. Users are more likely to join outings, social events, and outdoor activities. Provides reassurance that they can sit whenever needed.

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