Invention Disclosure Details

1. Please provide a suitable title for your invention.

"V-Belt".Wearable sensor belt with IoT system for prevention of falls in elderly people

2. Please elaborate the problem being solved by your invention. Please specify the actual problem in the existing product or process.

Disability is more common in elderly people, with falls being a major cause of disability. One-third of community-dwelling older adults experience a fall annually, leading to negative health outcomes and injury-related deaths [1], [2]. The psychological impact of falling can cause fear and limit physical activities, making individuals weaker and more susceptible to future falls. Many falls can be prevented, but fall prevention programs have faced barriers such as lack of resources, transportation issues, scheduling conflicts, and physical environmental factors [3], [4].

Our solution addresses this social issue by enhancing facilities by preventing injuries and increase in raising advance level of functionalities and technologies that helps to prevent fall in elderly people. One of the most notable advancement in this belt is that utilization of lightweight materials used in manufacture, emergency alert system via a GSM-module and designed to reduce body pain in people.

3. Please detailed the solution being provided by the invention to overcome the problem. Please provide schematics diagram and its description if required.

The Waist belt wearable sensors with IoT systems may help elderly people in preventing falls by giving feedback to users regarding risks of falling. This software developed with sensors that could able to sense whenever there is risk of Line of Gravity (LOG) goes outside the Base of Support (BOS) during day-to-day activities for elderly people as this is the commonest reason for elderly people.

These technologies will help elderly people to prevent falling by which Disability may be prevented. This digital delivery of a fall prevention may be feasible.

4. Please provide us the already available solution of the problem? Please provide us any information with you on the same.

The WaistonBelt X and similar wearable devices promoting healthier lifestyles and supporting rehabilitation through accurate monitoring of activity recognition, and posture correction[3], [4]. However, some potential issues arises in the areas of

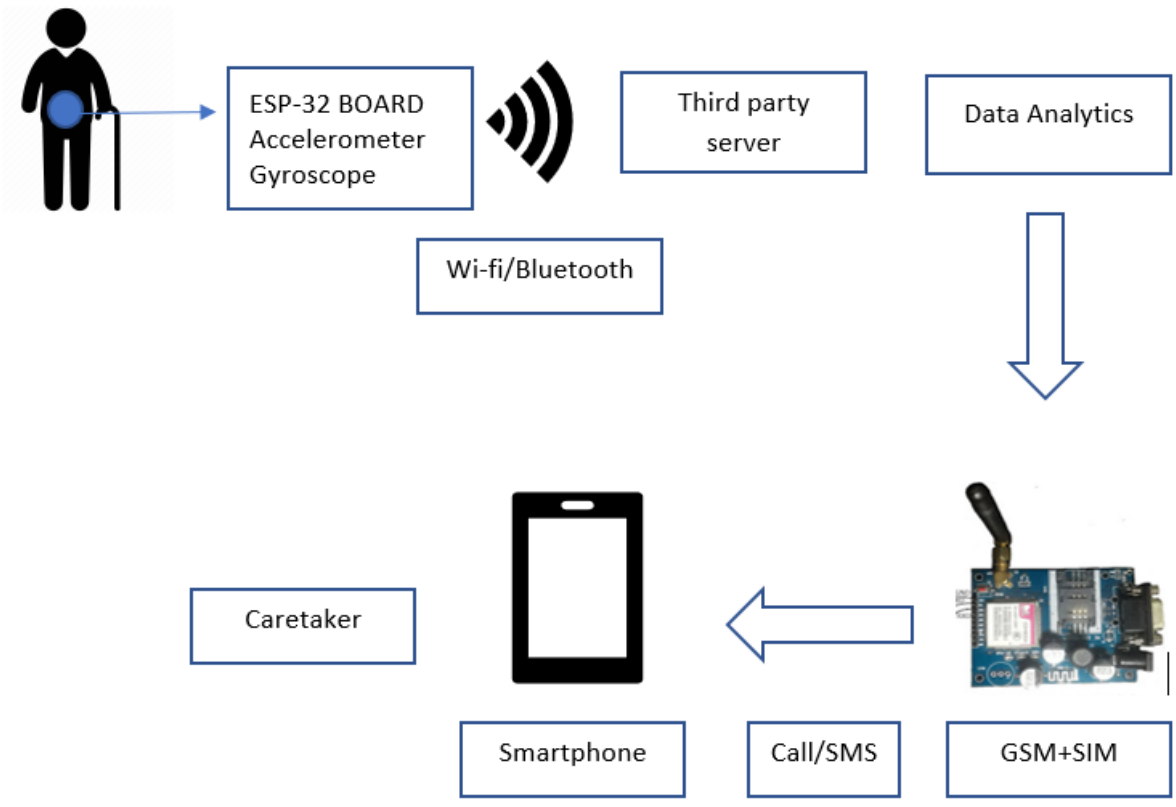
1. Privacy concerns: No continuous monitoring of an individual's activities and health data[5]
2. Comfort and wearability: It's not easy to incorporate into daily routines is crucial for long-term user[3]
3. Reliability and accuracy: While high accuracy rates are reported for waist measurement and activity recognition, real-world conditions may introduce variability[6],[17].

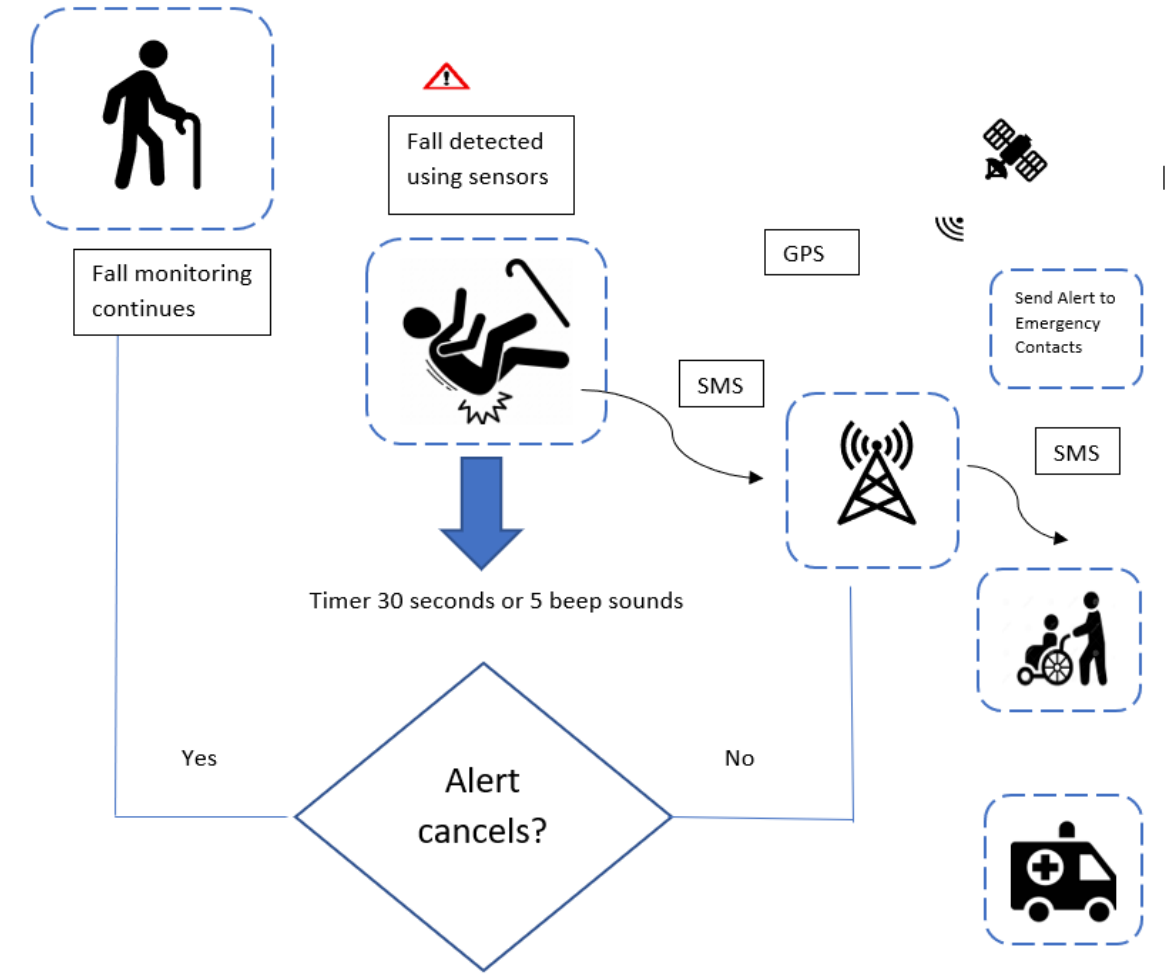
4. Integration with healthcare systems: No comprehensive health management and facilitate communication between users and their care teams[7].
5. Battery life and charging: Ensuring adequate battery life and convenient charging methods is important but it's getting interrupted in monitoring leads to user inconvenience[7].
6. Durability and water resistance: No proper designing in the devices to withstand daily wear, including exposure to water and sweat[3], [8].

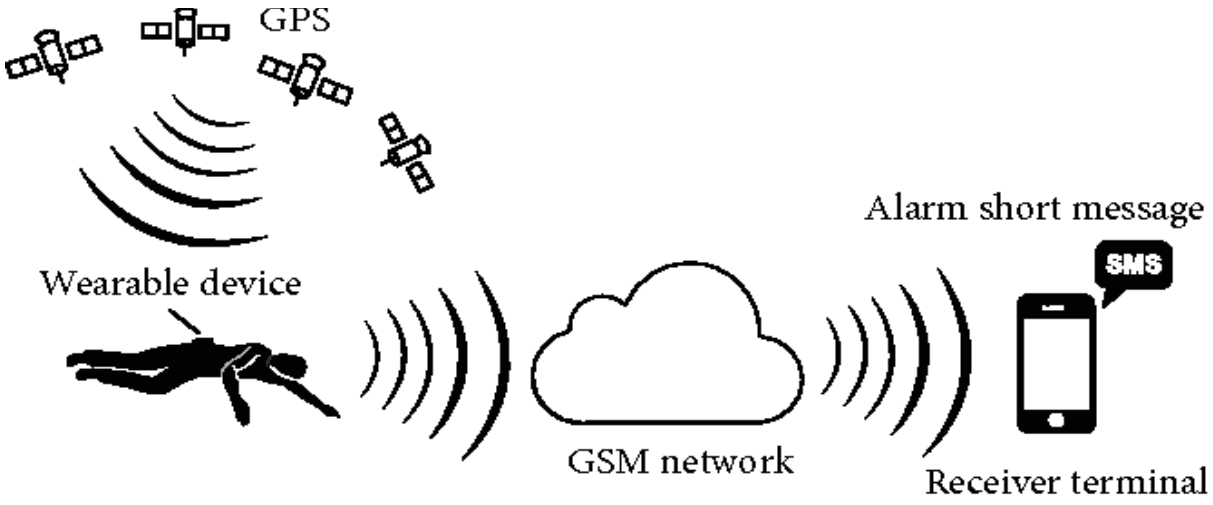
5. Please provide you how your solution is unique and different as compared with other available/known solutions to the same/similar problems?

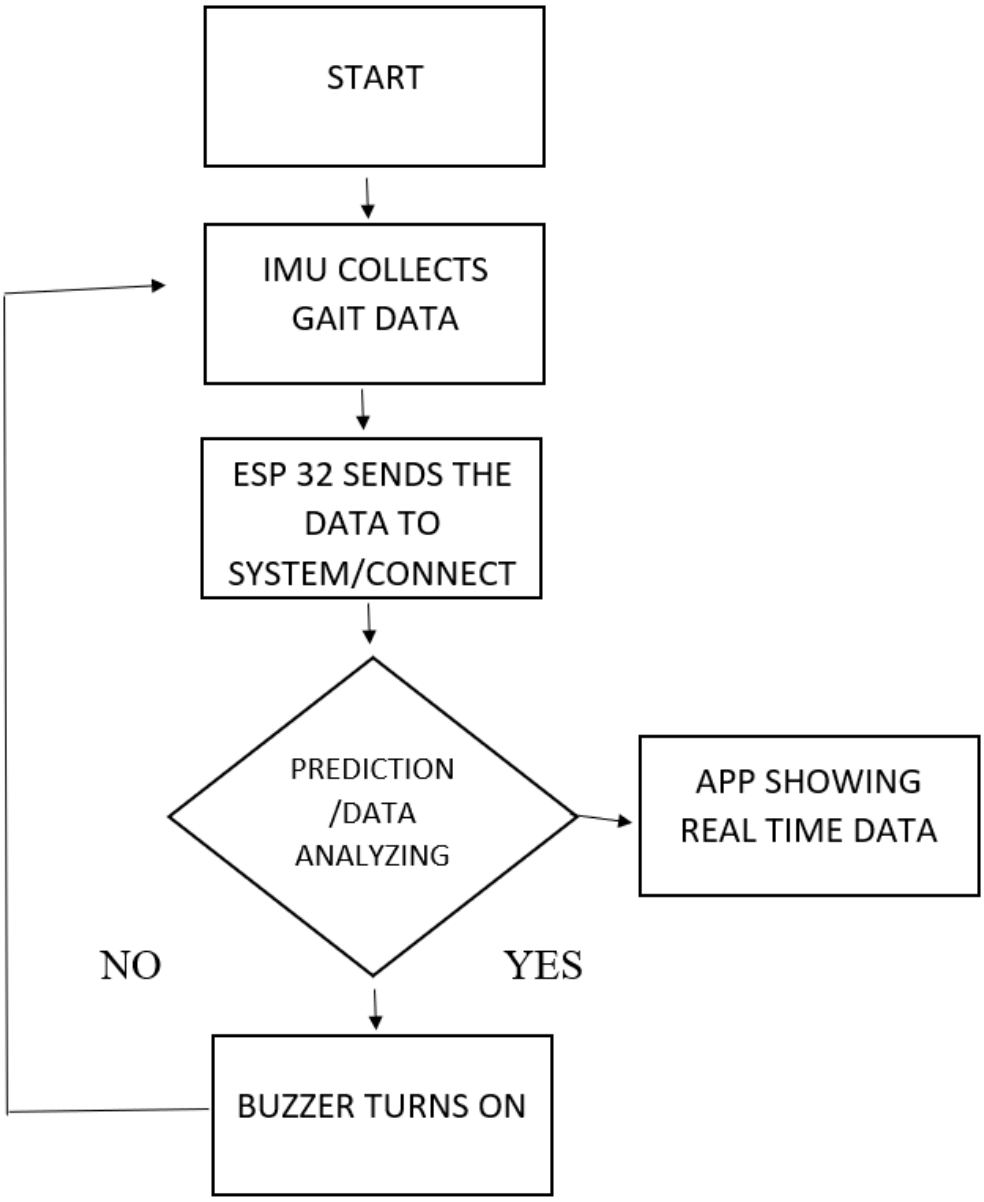
The belt can be worn around the waist, it's close to the body's center of mass, which is ideal for capturing overall motion, including falls, shifts in posture, or sudden movements. A belt is minimally invasive, easy to wear , and doesn't interfere with everyday activities like walking. Since it's not subject to constant foot impact (like a shoe), sensor accuracy remains high without the need for impact-proof designs. Protective Padding in belt includes layers of high-density foam or materials like D3O (a smart material that stays soft but hardens on impact). This adds constant protection, particularly to the hips or lower back, areas most vulnerable to injury during a fall. While this method offers less dynamic protection compared to airbags, it's easier to implement and can still significantly reduce the risk of fractures or bruising.

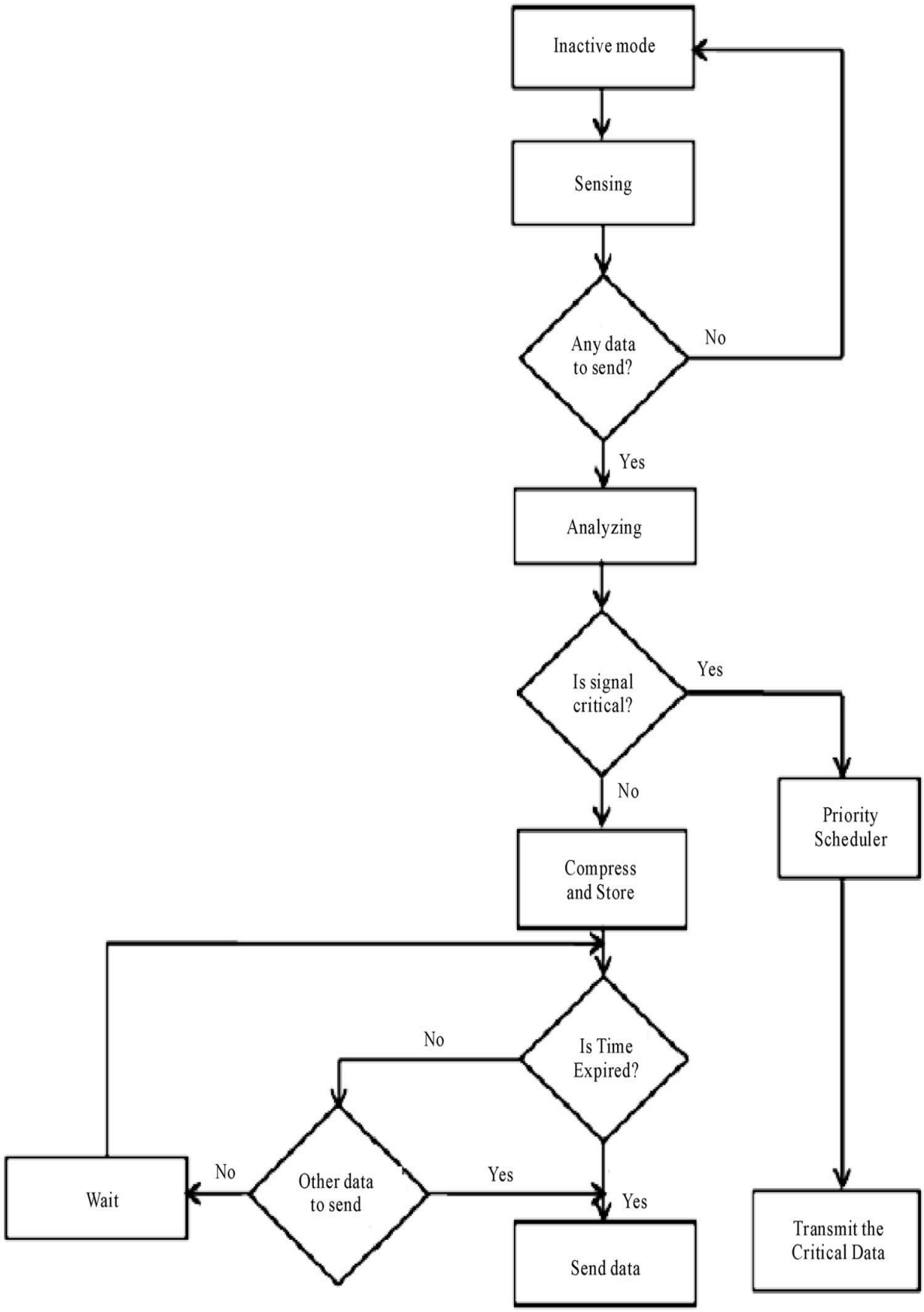
Fall Detection System




Fall monitoring continues
Fall detected using sensors
GPS
Send Alert to Emergency Contacts
SMS
SMS
Timer 30 seconds or 5 beep sounds
Yes
Alert cancels?
No


GPS
Wearable device
Alarm short message
SMS
GSM network
Receiver terminal


START
IMU COLLECTS GAIT DATA
ESP 32 SENDS THE DATA TO SYSTEM/CONNECT
PREDICTION /DATA ANALYZING
APP SHOWING REAL TIME DATA
NO
YES
BUZZER TURNS ON


Inactive mode
Sensing
Any data to send?
No
Yes
Analyzing
Is signal critical?
Yes
No
Priority Scheduler
Compress and Store
Is Time Expired?
No
Other data to send
No
Yes
Wait
Yes
Send data
Transmit the Critical Data

6. Please provide us the advantages of your solution? Please Compare the advantages in view of the existing/conventional or solutions uncovered during the search under point 5. You may make a table or figures. Further you can provide us the economic potential or commercial applications for the technology.

Features	Existing Technologies	References I	References I I	Proposed Technologies
Fall Detection using wearable device	Pendants, Watches, Or Belts[3], [9]	• Integrated Smartphone application • Intervention via belt vibration for high accuracy	• Smart Insole integrated with mobile application • Smart-cane device to detect fall • Sensor gives feedback and alert users	Waist Belt
Fall Positions	Coming to rest on the floor, or other lower level, excluding the change in position to rest[5]	• Wireless smart shoe to detect fall using multi-sensors • Sensors passes to Machine learning • Posture detection		Coming to rest on the ground, floor, or lower level, including the position to rest
Power source	Batteries, Triboelectricity, Piezoelectricity, Solar batteries and supercapacitors[2]	• Recharging the divice using triboelecticity		Batteries
Hardware materials	Polymers, Nylon, Carbon Nanotubes, Polyester and Metal Foils[4], [10]	• Using ML algorithm • To adjust with sensors like barometric, and to absorb shock		Viscoelastic, soft density foam or materials like D3O or gel-based padding

		polymer are used		integrated into the belt
Detection method	AI, ML, IoT, Inertial Measurement Units (IMU), Deep learning, Insole-based, Matrix-based, threshold based, Robotic analysis, and Camera-based[9], [10]	• Camera based and 3D detection systems	• 2D RGB camera is used to detect fall	IMU / IoT sensors integrated with ML
Monitoring and control	Limited to basic controls, some systems may include basic sensors[7]	• Systematic review of sensor detection system to prevent fall in that less usage of gait analysis and false triggers due to poor tools used.		Arduino-based control for stepper motors; real-time monitoring via sensors
Portability	Varies; some systems are portable, while others are fixed			Adjustable
Alert Systems	Yes, but mostly false triggers and min 100 ms[7]	• False trigger or false alarm rate of 25 alarm per 59 hours of active		Yes, using buzzers and SMS to caretakers, 99% accuracy
Alert Trigger	Once the fall is confirmed, an alert is sent via: 1.Bluetooth + Mobile App (if using a smartphone)	• Send message through telegram bots with triggered medical details		Bluetooth/ GSM Module

	2.GSM Module (direct SMS) 3.Wi-Fi Module + Cloud [5], [11]	• Sensor feedback to prevent hazards		
Protection	Its based on the wearable on body parts but particularly only saves from minor injury not focusing on comfort[7]	• low-power field-programmable gate arrays to implement a fixed neural network function • Using 3D accelerometer • combined with an ultra-low-power Lattice iCE40UP FPGA		Protect the lower back and hips from injury upon impact
Integrated with IoT	Limited with Arduino technologies[17]	• wearable-based fall-related recognition system (WFRS) which is limited to pressure and temperature detection		ESP -32 and Multi-Sensors
Sensors	Accelerometers, Gyroscopes, Pressure, Radar, Barometric and Triboelectric sensors[4]	• All various kinds of sensors are reviewed and how all these are detecting is mentioned		Accelerometers, Gyroscopes and Gait analysis
Pain relief	No [2], [3]	• An energy efficient wearable device like high sensing	• Require knowledge to hanadle it	Reduce lower back pain, muscle strain by promoting comfort and mobility

		parameters but heavy weight		
Lightweight and Flexible Materials	Lightweight design that does not compromise flexibility or comfort[6]	• A wearable device which detetcts daily activities with less number of sensors leads to lightweight		High-speed deployment while remaining soft against the skin, reducing abrasion risks.
Fixed Position	Limited coverage[17]	• Smart-cane, Smart-Insole device to detect fall covers only particular parts of the body not the head or other parts of body.		Escapes with minor injury
Use	Reusable[3]	• Waistonbelt x: rechargeable using triboelectricity		Reusable

7. Please intimate if can think of any alternative way/solution of achieving the same result as your invention? Please note that the alternative way/solution that you are thinking may or may not have same advantages as offered by the invention.

Smart Shoes or Insoles

- **Smart Insoles:** Embedded with sensors, these insoles can monitor pressure points, gait, and balance to predict fall risk. They can send alerts to the user or their caregivers if irregular movements or pressure shifts are detected[12].
- **Wearable Haptic Shoes:** Similar to belts, shoes with built-in haptic feedback mechanisms can guide users on adjusting their gait or posture when an imbalance is detected[13].

Smart Walking Aids (Canes, Walkers)

- **Smart Canes:** Equipped with sensors, smart canes can monitor the user's stability and balance. Some smart canes can detect uneven terrain and provide feedback to the user to avoid trips or falls. They can also send fall alerts if a sudden impact is detected[14].

- **Intelligent Walkers:** Advanced walkers with built-in sensors and AI can monitor the user's gait and walking speed, offering support or stopping in place when instability is detected.

AI-Enhanced Wearables

- **Camera-Based Fall Detection:** AI-powered cameras can be installed in homes to monitor the movements of elderly individuals. These systems analyze posture, gait, and other indicators of fall risk. When they detect signs of a potential fall, they can trigger alerts or preventive interventions[15], [16].
- **AI-Driven Gait Analysis:** AI techniques can identify patterns that indicate a higher risk of falling. This can be used for long-term fall risk assessment[9].

8. What are the novel aspects of your invention that need protection? Describe technical difference between the conventional and available product/process and your solution.

Features	Conventional model	Waist-belt or Novel model
Deployment Speed	No detection to alert	High speeds (within milliseconds)
Lightweight and Flexible Materials	Lightweight design that does not compromise flexibility or comfort	High-speed deployment while remaining soft against the skin, reducing abrasion risks.
Fixed Position	Limited coverage	Escapes with minor injury
Use	Single use	Reusable
Smart sensors	Yes	Yes
Material	Nylon	Padding using viscoelastic
Battery	2000 mA (45 hrs)	
Mass	1.2 – 1.5 kg	Weightless
Alert/ Triggering	100 ms (false triggers or no alert system)	Yes
Pain relief	No	Reduce lower back pain, muscle strain by promoting comfort and mobility
Adjustable or flexible	No	Yes

9. Any environmental issues confronted while developing or implementing the invention?

A) No.

10. Please enlist all innovative feature of your invention which you think are making the invention more sophisticated.

1. Sensor Placement: The belt can comfortably house multiple sensors (accelerometer, gyroscope, etc.) without causing discomfort.

2. Wearable Microcontroller: Lightweight like Arduino Nano/ESP32 for the sensor and processing unit.
3. Battery: Lightweight, rechargeable Li-Po battery to power the device.
4. Alert Trigger: Once the fall is confirmed, an alert is sent via: GSM module
5. Caregiver Notifications: If the belt continuously detects instability over a period of time, it can also notify caregivers via a mobile app or SMS, warning them that the elderly person is at increased risk of falling.
6. Protective Padding Design: Since the padding is always integrated into the belt, it will provide constant protection even during light slips or sudden jerks that might not trigger the sensor-based systems.

11. What are the utilities/applications of the invention? Enlist them.

1. Prevention of falls in elderly and specially-abled people
2. Real-time alert system
3. Proactive monitoring of movement patterns using sensors
4. Integration with smart home technologies
5. Rehabilitation support

12. Is the invention already been implemented in any product or process?

A) No.

13. Has the invention been published or disclosed/discussed to anyone outside of your organization or any third party including abroad also (such as marketing meetings, conferences, tradeshows, trade fairs, websites, social media, news papers etc)?

A) No.

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