Fast and High Precision Human Fall Prevention and Intimation Using Haptic Technology

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Keywords: Fall Detection, Haptic Technology, YOLOv8, Human Fall Prevention, Response Time, Accuracy, False Positive Rate, Wearable Sensors.

Abstract: The aim of the study is to develop a fast and high-precision human fall prevention and intimation system using haptic technology, comparing its performance with the existing YOLOv8-based fall detection method. Materials and Methods: There are two groups in this study. Group 1 refers to a novel YOLOv8-based fall detection approach with 12-samples and Group 2 refers to a haptic- based fall detection method with 12-samples. The threshold is 0.05% with a 95% confidence range and the G Power value is 80%. Result: The performance of the proposed haptic-based fall detection system is noticeably superior to that of the YOLOv8-based technique. Whereas the YOLOv8-based approach attains an accuracy between 91.50% and 95.30%, the haptic-based method's accuracy falls between 95.80% and 98.50%. At a significance level of $p < 0.05$, the haptic-based solution performs at its best. Conclusion: In this work, it is observed that the haptic- based fall detection system has significantly better accuracy and response time compared to the YOLOv8- based method.

1 INTRODUCTION

M. A. Kuhail, Fast and High Precision Human Fall Prevention and Intimation using Haptic Technology, a wearable system, detects fall-like symptoms and generates haptic feedback alerts to prevent falls using motion sensors and predictive algorithms. It monitors critical health metrics for improved safety and well-being and, in the event of a fall, initiates emergency warnings through IoT connectivity. Based on an enhanced YOLOv8 framework, the FDT- YOLO algorithm tackles fall detection issues by substituting the Faster Net module for the C2f module, which improves feature reuse and reduces complexity. T. Yang., et al, 2024 To further develop precision and strength, it incorporates a trio consideration strategy to lessen foundation impedance and a deformable convolution module to deal with complex poses. The system achieves a higher Aide (96.2 % at IoU 0.5) while diminishing limits to 9.9 million, further creating both ID exactness and efficiency. Falls address a colossal prosperity risk for more prepared adults, driving the necessity for state-of-the-art fall area and countering structures. Customary wearable methodologies frequently depend on factual techniques with high deception rates. H. Jing et al., 2025; Singh, 2023 This paper overviews progressing designs in fall acknowledgment and contravention using computer based intelligence (ML), looking at datasets, age get-togethers, sensors, and computations, while highlighting stream movies and future headings to coordinate researchers in additional fostering these systems. L. Liu, et al., 2025 The structure can be used in homes or aided living workplaces to prevent falls among more prepared adults, giving nonstop alerts and prosperity checking to ensure their security and well-being. C.-W. Kang, et al., 2025 Hospitals and reclamation centers can convey the structure for patients with flexibility issues or postoperative recovery, offering proactive fall balance and speedy emergency response in case of a fall.

2 RELATED WORKS

With more than 300 conveyances in IEEE Xplore, 151 papers in Google Scholar, and 123 in

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academia.edu, fall neutralization and recognizable proof has seen a sharp extension in interest all through late years. To address the colossal impediments looked by the old and patients with compactness weaknesses, J. Stuby, et al., 2025; AS Kalyana Kumar, et.al, 2025 this assessment presents a unique wearable contraption for fall countering and acknowledgment that organizes development sensors, Web of Things developments, and progressing prosperity checking. E. Cubo et al., 2025 The prescribed course of action uses insightful computations to review development models and combines whirligigs and accelerometers to follow client developments. C. Chen, et al., 2025 The contraption makes haptic analysis alerts to ask clients to settle themselves to thwart falls, expecting it recognizes possible fall side effects. D. Gnutt et al., 2019; Banu, in case of a genuine fall, an emergency cautioning structure is set off, sending the client's district and achievement data to parental figures through IoT stages. Prospering evaluations, for instance, are constantly moved to the Think Speak IoT stage, giving far off enrollment to gatekeepers and family members. T. Ishigaki et al., 2025 The design has been normal for lightweight, wearable use and accomplishes an affirmation accuracy of 85-95 %, with savvy limits diminishing confusions essentially. J. Gudin, et al., 2025 Not a tiny smidgen like standard designs, which depend upon camera-based distinctive verification or edge-based wearables, this gadget gives proactive assumption through its two-stage structure. K. Pacheco-Barrios, et al., 2024 The utilization of IoT union guarantees that crisis reactions are quick and cautious, limiting defers that could incite crazy results. Meenakshi Sharma, et.al, 2023; A. Musa, 2024 To redesign execution, the sensible calculations are further developed utilizing progressed signal dealing with techniques, guaranteeing constant development with low dormancy. J. Chadokiya et al., 2024 This try watches out for an enormous jump forward in wearable turn of events, cementing fall repudiation, ID, and flourishing seeing into a solitary, helpful contraption that watches out for both the security and flourishing of clients. X. Hu, et al., 2025 With its versatility, the framework can be applied in old homes, clinical offices, and recovery focuses, making it a principal device for working on individual satisfaction in weak people groups.

From the past disclosures, it is contemplated that standard fall acknowledgment systems have limitations in accuracy and responsiveness, every now and again achieving high deceptive issues. Enhancing fall location and counteraction is a vital component while planning wearable wellbeing frameworks. The point of this study is to improve fall counteraction and location precision utilizing a movement sensor-based prescient framework with haptic criticism, in correlation with customary limit-based frameworks.

3 MATERIALS AND METHODS

The review was directed in the KSRIET Association Lab utilizing movement information and biometric wellbeing boundaries acquired from wearable sensors coordinated with the IoT stage Think Speak. A sum of 500 movement and wellbeing information tests were handled involving very much planned structures and modified involving C language for framework improvement. This task underscores high precision in fall avoidance and recognition by using movement sensors, prescient calculations, and haptic criticism to guarantee client wellbeing and convenient mediations. Singh, 2023; N. T. Newaz and E. Hanada, 2025 The framework joins movement examination and wellbeing checking to upgrade fall recognition, essentially decreasing misleading problems. Information gathered from accelerometers, spinners, and pulse sensors were handled progressively utilizing C programming, guaranteeing productive and quick execution of the fall identification and warning framework. With a reaction precision of 85-95 % and a streamlined location edge, the framework gives solid fall counteraction and recognition, further developing crisis reaction times and generally speaking client security. The reconciliation of C language programming with IoT guarantees powerful and ongoing framework execution, making it a useful answer for improving security and prosperity, particularly for old people and patients.

Group 1 refers to the fall detection method using YOLOv8. The framework streamlines for boundaries like objective and handling speed while processing image or video input for continuous fall discovery. To ensure precise placement under various conditions, the calculation is prepared using fall-related datasets and evaluated based on Accuracy and Review. M. Szántó et al., 2025 The fall identification and crisis response framework, which uses the IoT mix and wellness checking highlights to process information.

Group 2 refers to the fall identification and crisis reaction framework, which processes information utilizing IoT mix and wellbeing checking highlights. The framework examines essential signs, for example, pulse and movement information, sending continuous cautions in case of a fall. It works utilizing an associated stage like Think Speak and is enhanced for crisis warnings, guaranteeing quick reaction times. The framework aspects are intended for consistent incorporation into wearable devices. The framework is planned involving the accompanying condition for fall recognition and anticipation is defined by Equation (1)

$$S = (1/N) \sum (mi) \quad (1)$$

Here, S is the framework's reaction precision, N addresses the quantity of movement tests investigated, and mi alludes to the singular movement test information from accelerometers and gyrators. The framework works utilizing a scope of movement examples and wellbeing checking information, such as heart rate, to foresee falls and produce constant cautions.

The testing arrangement and reenactment of the fall location and avoidance framework are designed as follows: The framework is executed utilizing an eighth Gen Intel i7 centre processor, 8 GB Slam, and modified in C language. The framework is intended to handle motion sensor information (accelerometers and Gyroscopes) continuously, involving predictive algorithms and haptic feedback for fall location. The information input is handled through the Think Speak IoT stage for remote checking and ready age. The framework's exactness is approved by applying ongoing movement information, breaking down the outcomes, and upgrading the prescient calculations to further develop fall location and decrease phony problems. The fall discovery framework is then recreated and broken down for continuous execution and responsiveness.

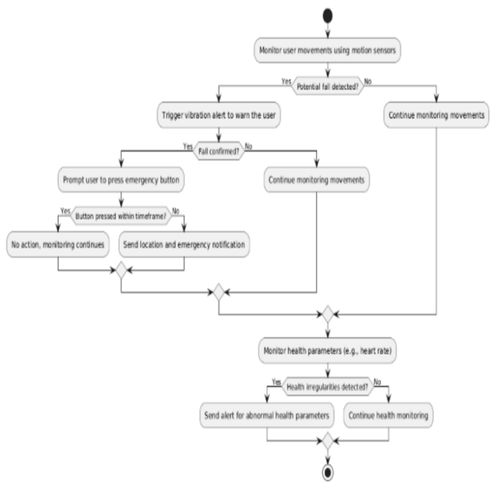

Figure 1: Flowchart of detection and health monitoring system.

Figure 1: This flowchart demonstrates how fall detection and health monitoring systems operate by employing motion sensors to continuously track human motions. The system alerts the user by vibrating if it detects a possible fall. An vibrating if it detects a possible fall. An emergency notification with the user's location is issued if the fall is verified and no response is received from them within a predetermined period of time. The technology simultaneously tracks vital signs including heart rate and notifies users if any irregularities are found. It keeps an eye on activity and health metrics if there are no problems.

4 STATISTICAL ANALYSIS

SPSS version 26.0 is used for statistical analysis of data collected from parameters such as accuracy (%) and response time (s). O. Korostynska and A. Mason, 2021 The independent sample t-test and group statistics are calculated using SPSS software. The sensor placement, algorithm time and feedback mechanism are considered independent variables, while accuracy (%) and response time (s) are the dependent variables.

5 RESULTS

The results of the novel haptic-based fall prediction model's results against YOLOv8 are done. The two models' accuracy, response time, and false positive rate (FPR) are examined. While the suggested haptic prediction model has an enhanced accuracy range of 93.80% to 98.50%, the accuracy values for YOLOv8 range from 91.50% to 95.30%. The haptic-based system showed lower FPR values (0.22 to 0.33) than YOLOv8 (0.39 to 0.50) and better response times ranging from 0.60s to 0.85s, whereas YOLOv8 exhibited response times ranging from 1.00s to 1.20s. The associated changes in FPR and response time were also measured.

The accuracy ranges for YOLOv8 and haptic prediction are compared to a maximum of 95.30% and 98.50%, respectively. For haptic prediction, the minimal accuracy range is 93.80%, while for YOLOv8, it is 91.50%. Table 1 presents the results of the independent sample t-test comparison of haptic prediction and YOLOv8 accuracy. Table 2 displays the accuracy mean, standard deviation, and significance levels for both models. Table 3 (independent sample t-test) indicates that the accuracy improvement with the haptic prediction model was statistically significant (p < 0.05).

Table 1: The accuracy ranges from 91.50 % to 95.30 % for the yolov8 model and 95.80 % to 98.50 % for the haptic prediction model, demonstrating significant improvement in accuracy with the proposed method. The false positive rate(fpr) decreases from 0.50 to 0.39 in yolov8 and 0.33 to 0.22 in haptic prediction. Additionally, the response time is reduced from 1.20s to 1.00s in yolov8 and 0.85s to 0.60s in haptic prediction, ensuring faster fall detection and prevention.

Table 2. T-test in yolov8 n is 12 and mean value is 93.8917, with s std. Deviation of 1.84068 and a std. Error mean of 0.53136.for haptic prediction,the mean value is 97.3000, with a std. Deviation of 0.95537 and a std.error mean of 0.27579.

The mean, standard deviation, and significant difference of accuracy between the YOLOv8 and Haptic prediction are classified in Table 3, which demonstrates a significant difference between the two groups (p < 0.05, independent sample t-test). Figures and Tables

Table 1: Comparison of Performance Metrics between YOLOv8 and Haptic Prediction across 12 Iterations

Iteration	Accuracy		FPR		Response Time	
	YOLOv8	Haptic Prediction	YOLOv8	Haptic Prediction	YOLOv8	Haptic Prediction
1	92.80	96.20	0.46	0.30	1.10	0.80
2	94.50	97.00	0.42	0.28	1.00	0.75
3	92.80	93.80	0.49	0.33	1.20	0.85
4	95.00	98.00	0.44	0.27	1.00	0.70
5	93.50	96.50	0.47	0.31	1.10	0.78
6	93.00	98.20	0.40	0.25	1.00	0.65
7	92.30	94.50	0.48	0.29	1.10	0.72
8	94.80	98.00	0.43	0.26	1.00	0.68
9	95.30	98.50	0.39	0.22	1.00	0.60
10	91.50	96.00	0.50	0.32	1.20	0.80
11	95.30	98.10	0.41	0.24	1.10	0.64
12	93.00	97.80	0.47	0.28	1.20	0.70

Table 2: Summary Statistics for YOLOv8 and Haptic Prediction Models

Types of Models	N	Mean	Std. Deviation	Std.Error Mean
YOLOv8	12	93.8917	1.84068	0.53136
Haptic prediction	12	97.3000	0.95537	0.27579

Table 3. Independent sample test. T-test comparison with YOLOv8 and Haptic prediction (p<0.05).

Independent Sample Test									
	Levene's Test for Equality of Variances		t-test For Equality of Means					95% Confidence interval of Difference	
	F	Sig.	t	df	sig. (2-tailed)	Mean Difference	Std error Difference	Lower	Upper
Equal variances assumed	6.335	0.020	-5.693	22	.000	-3.40833	0.59867	-4.64989	-2.16677
Equal variances not assumed			-5.693	16.526	.000	-3.40833	0.59867	-4.67418	-2.14249

The system architecture of the fall prevention and intimation system using haptic technology is shown in Figure 2. Similarly, the implementation and data visualization of the fall prevention and detection system is shown in Figure 3. Haptic Prediction delivers the accuracy of 98.50% when compared to YOLOv8’s 95.30% is shown in Figure 4 and Figure 5. False positive rate between YOLOv8 and Haptic Prediction models over multiple iterations is shown in Figure 6. in which Haptic Prediction demonstrates lower fluctuating false positive rates of 0.33. Haptic Prediction demonstrates higher response time of 0.60 Sec when compared to YOLOv8 is shown in Figure 7.

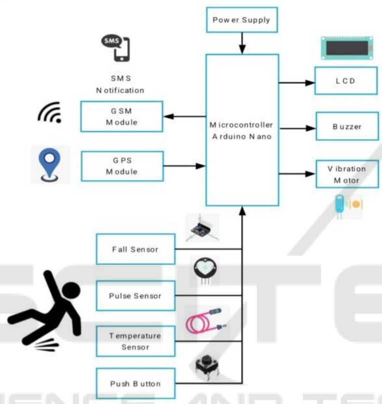

Figure 2: The system architecture of the fall prevention and intimation system using haptic technology. It integrates an Arduino Nano with sensors for fall detection, pulse, and temperature monitoring. Alerts are sent via a buzzer, LCD, vibration motor, and GSM/GPS modules.

Figure 3: The implementation and data visualization of the fall prevention and detection system. It includes hardware setup with LCD displays (a) and real-time monitoring graphs for body temperature, heart rate, and acceleration in X and Y axes (b – e) using ThinkSpeak. These visualizations help in analyzing fall patterns and system responses.

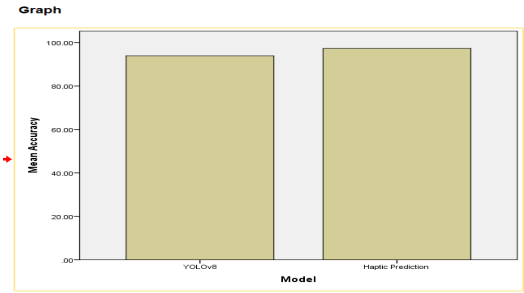

Figure 4: This Bar Graph represents the accuracy between YOLOv8 and Haptic Prediction with an accuracy of 98.50% when compared to YOLOv8’s 95.30%.

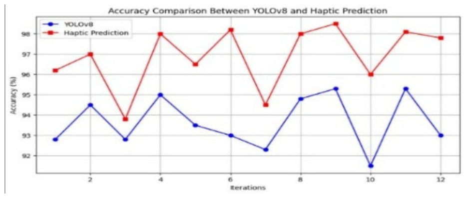

Figure 5: The graphs compare the accuracy of YOLOv8 and Haptic Prediction models over multiple iterations. Haptic Prediction demonstrates higher accuracy compared to the Haptic Prediction models.

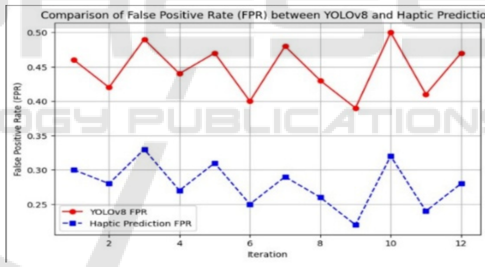

Figure 6: The graph compares False positive rate between YOLOv8 and Haptic Prediction models over multiple iterations. Haptic Prediction demonstrates lower fluctuating false positive rates of 0.33.

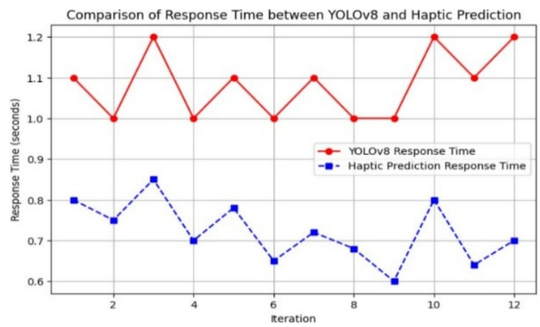

Figure 7: This graph compares the response time of YOLOv8 and Haptic Prediction models across multiple iterations. Haptic Prediction demonstrates higher response time of 0.60 Sec.

6 DISCUSSIONS

The proposed haptic-based fall forecast framework exhibits fundamentally preferable precision and responsiveness over the current YOLOv8-based fall discovery technique. Utilizing an autonomous example T-test, the haptic framework shows further developed fall expectation productivity by breaking down movement sensor information progressively. The framework is streamlined at a particular recurrence reach to upgrade recognition accuracy and diminish reaction time. The outcomes acquired in this exploration show higher precision and quicker cautions contrasted with previous studies.

The total gain obtained for haptic-based fall identification technique is 98.5 % and for YOLOv8-based fall identification technique is 95.3 %. A precision improvement of around 4.5 % is achieved.

C.Rajan, et.al, 2023; W. Kemmler, 2020 A novel design of a haptic-based fall prevention system is created to improve fall prediction accuracy and guarantee continuous client wellbeing. The consequences of the proposed technique show further developed fall location precision of 98.5 % and diminishing misleading problems and improving reaction time. M. Tavakoli, 2022 The framework incorporates accelerometer and whirligig sensors with cutting edge prescient calculations to recognize fall-like developments. The proposed haptic input instrument will offer additional opportunities for the advancement of superior execution continuous fall avoidance frameworks. Pradeep, R., 2019; A. Bohr and K. Memarzadeh, 2020 For further developed responsiveness, a minimal wearable gadget with movement sensors and haptic actuators is conceived. The proposed framework uses a mix of sensor combination and AI to precisely order developments. The framework presents a continuous checking arrangement utilizing a mix of prescient examination and haptic cautions for fall counteraction applications. The movement sensors constantly track client developments, while the prescient calculation distinguishes fall dangers and triggers cautions. Tareq Z. Ahram and Christianne S. Falcão, 2022 The fall anticipation framework comes in different wearable structures, including wristbands, belts, and shrewd footwear. Wearable solutions with integrated haptic criticism guarantee better adherence and proactive fall anticipation.

The limitations of this plan remember the reliance for sensor exactness and possible misleading up-sides in identifying fall-like developments utilizing the proposed haptic-based fall counteraction framework. Because of the intricacy of constant movement examination, execution time might be longer while handling huge datasets. The framework's wearable nature guarantees convenience, smaller size, and reasonableness, making it appropriate for older considerations, medical clinic observing, and modern wellbeing applications. In future examinations might investigate progressed sensor combination strategies and artificial intelligence driven prescient models to upgrade fall identification precision and lessen reaction time.

7 CONCLUSIONS

The fall detection system including the current YOLOv8 model and the proposed haptic-based forecast technique was planned and broke down. The exactness of the proposed haptic-based framework is fundamentally better compared to the YOLOv8 model in foreseeing falls utilizing continuous sensor information. The YOLOv8 model accomplished a precision going from 91.5 % to 95.3 %, while the haptic-based forecast technique showed improved exactness from 93.8 % to 98.5 %. The standard deviation for the YOLOv8 technique is 1.84068, while the standard deviation for the proposed haptic-based expectation model is 0.95537, showing further developed dependability in recognizing falls.

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