

Design And Prototype Evaluation of a Sensor-Integrated Mobile Application for Inline Hockey Performance Monitoring

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ABSTRACT

This study presents a prototype mobile application for inline hockey performance monitoring that integrates wearable sensing, Bluetooth connectivity, performance analytics, shot history, training support, and configurable data preferences. Inline hockey is performed on a hard rink surface using inline skates, making skating mechanics, rapid acceleration and deceleration, changes of direction, balance, lower-limb range of motion, and technical puck-handling actions central to performance. Published inline-hockey research reports substantial injury exposure associated with skating, falls and player contact, while studies of elite and youth players demonstrate the importance of lower-limb flexibility, hip rotation, posture and skating technique. The supplied prototype screens were examined as a design artifact, with attention to settings architecture, device discovery, Bluetooth connectivity, shot-data management, and hardware compatibility. The methodology combines interface inspection, feature mapping, inline-hockey literature analysis, and descriptive prototype evaluation rather than a human-subject experiment. The connection screen contains three candidate devices with displayed RSSI values of -65, -78 and -55 dBm, while the settings screen contains navigation, preference, data-management and hardware sections. These observations demonstrate functional interface coverage but do not establish sensor accuracy, wireless reliability, or performance improvement. Inline-hockey-specific literature supports future inclusion of skating speed, acceleration, deceleration, change-of-direction events, lower-limb movement, shot events, workload and injury-risk indicators. The study concludes that the prototype provides a plausible mobile integration layer for inline hockey, but synchronized sensor validation, usability testing, cybersecurity assessment, and sport-specific field validation are required before performance claims can be made.

Keywords: Inline hockey; wearable sensors; inertial measurement unit; mobile application; skating analytics

1. Introduction

Inline hockey (IH) is a fast, intermittent team sport in which players move on inline skates while controlling and shooting a puck. Performance therefore depends on a combination of skating proficiency, rapid acceleration and deceleration, changes of direction, balance, lower-limb mobility, technical stick skills and repeated high-intensity efforts. Inline-hockey literature specifically describes the sport as technically and physically demanding, with skating identified as a fundamental skill and with frequent changes in speed and direction forming part of normal play [1–5]. These characteristics

create a distinct performance-monitoring problem: a useful digital system must capture skating and technical events rather than simply transfer concepts developed for running-based sports.

The injury literature also demonstrates why objective monitoring is relevant to inline hockey. Early work compared injury patterns in elite players using ice and inline skates, while later research examined professional roller-hockey injuries and amateur Spanish inline hockey populations [1–3]. Moreno-Alcaraz et al. reported 80 injuries among 154 Spanish inline hockey players, with games accounting for 67.5% of reported injuries and practice for 32.5%. The ankle was the most commonly injured body site, while fractures and sprains were the most common injury types. Non-contact skating, falls and player contact were prominent injury mechanisms [3]. These observations indicate that monitoring skating-related exposure and sudden movement events may have practical value for training and injury-prevention workflows, although an application cannot itself diagnose injury risk without validated clinical and longitudinal models.

Inline-hockey-specific studies also show that physical characteristics relevant to skating can be measured systematically. Cejudo et al. reported lower-extremity flexibility profiles in elite Spanish inline hockey players and identified limitations and bilateral asymmetries across hip, knee and ankle measures [4]. A separate study of 74 youth competitive inline hockey players found muscular tightness in at least one movement in every player except for hip abduction and identified asymmetry prevalence ranging from 5.4% to 17.6% depending on the movement tested [5]. These findings support the inclusion of lower-limb movement variables in a future performance dashboard, provided the sensor placement and algorithms are validated against appropriate reference measurements.

Spinal and hip function are also relevant. In 74 young inline hockey players, Sainz de Baranda et al. reported sport-specific sagittal spinal adaptations and emphasized the need for preventive or rehabilitative exercise programmes [6]. In elite Spanish inline hockey players, Cejudo et al. found associations between hip external/total rotation measures and low-back-pain status and proposed sport-specific ROM cut-points for further clinical investigation [7]. More recent prospective work in youth inline hockey reported that hamstring extensibility of 67° or less, measured through hip flexion with the knee extended, was a predictor of non-contact low back pain during the season [8]. These studies do not imply that a mobile application can diagnose low-back pain; instead, they demonstrate the types of athlete-level measurements that may be relevant to a broader monitoring system.

Skating technique itself provides another reason to design the application around movement phases. Moreno-Alcaraz, Cejudo and Sainz de Baranda described forward inline-hockey skating as a cyclic movement with sliding, propulsion and recovery phases. They noted that skating performance depends on the interaction between the player, skating surface and skate characteristics [9]. The continuous combination of hip, knee and ankle movements during skating creates opportunities for inertial sensing to characterize movement timing, angular motion and acceleration patterns. However, any classification algorithm must be trained and validated on inline-hockey movements rather than being assumed to transfer automatically from unrelated sports.

The methodological literature on inline skating provides additional support for measuring sport-specific performance. Podnar et al. developed and evaluated an inline-skating skill test incorporating starts, acceleration, direction changes, push-off and slalom actions. The test demonstrated high inter-session correlations and low within-individual variation, indicating that skating performance can be quantified using reproducible movement tasks [10]. A 2026 study of a modified 30–15 Inline Roller Test, including roller-hockey athletes, reported moderate-to-good test–retest reliability and recorded heart rate, distance, skating speed and estimated VO₂peak during sport-specific testing [11]. These findings provide a stronger basis for an inline-hockey dashboard than field-running benchmarks because the measured tasks are performed on skates.

The supplied prototype addresses this need through a mobile interface containing a performance dashboard, shot history, prototype connection, speed-unit selection, automatic shot saving, data deletion and supported-hardware information. The connection screen presents candidate sensor

devices, Bluetooth identifiers, RSSI values and connection controls. The hardware list includes ESP32/Arduino Nano platforms, MPU6050/MPU9250 IMUs, HC-05/HC-06 Bluetooth modules, BLE 4.0+ modules and GPS NEO-6M hardware. This architecture is attractive for student and research prototyping because it can use low-cost components rather than requiring a proprietary wearable.

At the same time, inline hockey presents an important design constraint: the intended environment is a rink, so every sensing component must be tested under actual skating conditions. GPS availability and accuracy, Bluetooth stability, sensor orientation, sampling rate, mounting position and the influence of rapid skating manoeuvres must be evaluated experimentally. The application should therefore separate device connection from measurement validity. A connected IMU is not evidence that acceleration, speed, shot events or skating phases are being measured accurately.

The research problem addressed in this study is how to translate the heterogeneous sensing capabilities of a low-cost mobile prototype into an accessible inline-hockey performance-monitoring workflow. The objective is to evaluate the supplied interface, map its functions to inline-hockey performance requirements, quantify visible prototype features, and identify a research-grounded pathway for future implementation. The study deliberately does not treat the prototype as a validated athlete-monitoring system.

2. Methodology

This study used a prototype-oriented design evaluation of the supplied mobile application. No human participants were recruited and no physiological, skating or performance data were collected from athletes. The results therefore describe interface functionality and literature-grounded requirements rather than experimental effectiveness.

Stage 1 – Interface inspection. The settings interface was decomposed into navigation, preferences, data management and hardware information. The prototype-connection interface was evaluated for device discovery, device identification, RSSI display, connection controls and scanning.

Stage 2 – Inline-hockey requirements mapping. Visible functions were compared with inline-hockey evidence concerning skating technique, speed and acceleration, lower-limb movement, flexibility, injury mechanisms, low-back-pain risk, technical actions and sport-specific fitness testing [3–11]. The objective was to identify which variables could reasonably be represented by the proposed app and which would require additional validated sensing.

Stage 3 – Descriptive prototype quantification. The connection screen contains three listed devices and three RSSI values (–65, –78 and –55 dBm). The settings screen contains three navigation items, two preference controls, one data-management action and five explicitly listed hardware categories. These are interface counts and observations, not usability or wireless-performance scores.

Stage 4 – Literature benchmarking. Inline-hockey and inline-skating studies were used to identify scientifically meaningful performance variables and validation approaches. Reported values were not treated as measurements of the proposed application. In particular, the 2026 Inline Roller Test findings were used only to illustrate the feasibility of repeated sport-specific physiological/performance testing and not as validation of the present prototype [11].

Stage 5 – Future validation framework. A full experimental study should include sensor calibration, criterion-device comparison, test–retest reliability, Bluetooth packet-loss and latency testing, task-completion measures, usability scoring, data completeness, cybersecurity, and agreement between app-derived and reference measurements. Testing should be conducted on the intended inline-hockey rink and with the same skate, sensor-mounting and communication conditions used during real training.

3. Results and Discussion

3.1 Prototype information architecture

The supplied settings screen presents four functional groups: Navigation, Preferences, Data and About. Navigation contains Performance Dashboard, Shot History and Prototype Connection. Preferences contains Speed Unit and Auto-Save Shots, while Data provides Clear Shot History. The interface therefore supports a complete high-level workflow from sensor connection to performance visualization and historical event management.

Figure 1 is retained from the supplied prototype and is interpreted here specifically as an inline-hockey application interface. The Performance Dashboard can serve as the main destination for skating and physiological summaries; Shot History can store puck/shot events; and Prototype Connection can manage the wearable sensor layer. The interface itself does not prove that shot detection, skating classification or speed estimation is currently implemented.

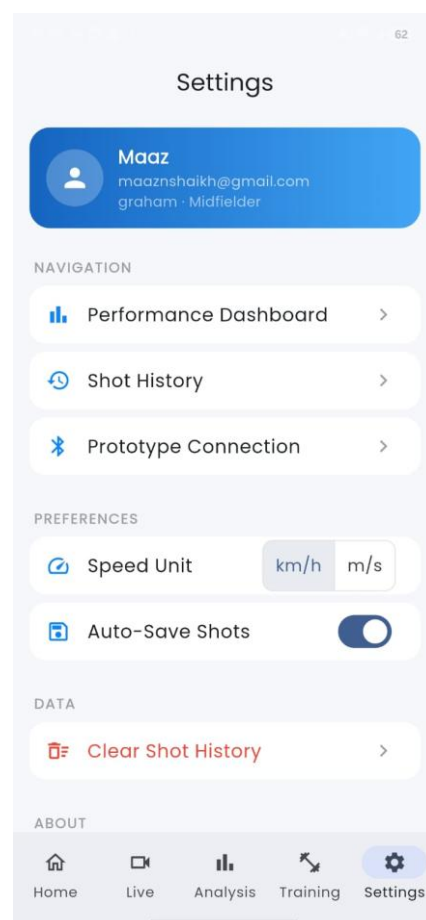


Figure 1. Supplied settings interface interpreted as the configuration layer of the proposed inline-hockey performance application.

3.2 Inline-hockey sensor-discovery workflow

Figure 2 shows three discovered devices: Hockey Sensor Unit A, Hockey Sensor Unit B and IMU Ball Sensor. Their displayed RSSI values are -65 dBm, -78 dBm and -55 dBm, respectively. The strongest displayed signal in this single screenshot is therefore associated with the IMU Ball Sensor, while Unit B has the weakest displayed signal.

These values must not be interpreted as evidence that one device has superior range or reliability. RSSI is affected by device position, antenna orientation, obstacles, body position and the wireless environment. A research-grade inline-hockey implementation should record connection state, packet

loss, latency, reconnection time and data gaps during skating. This is particularly important because inline hockey includes rapid movement, turns and body-to-body interactions that can change sensor orientation.

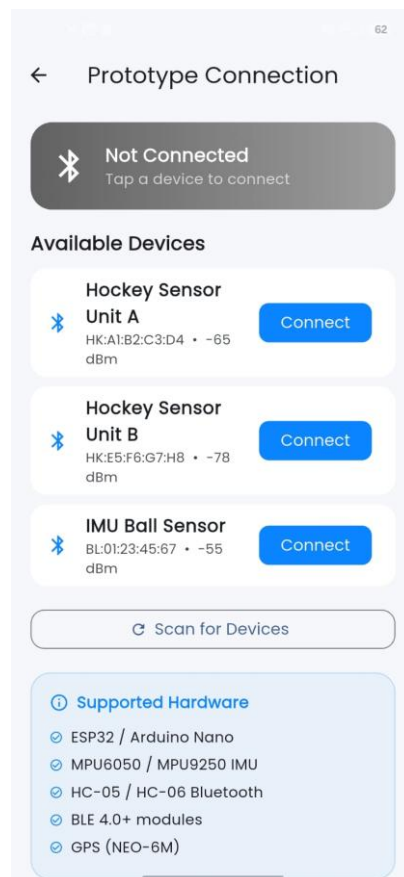


Figure 2. Supplied prototype connection interface showing discovered sensor nodes, RSSI values and connection controls.

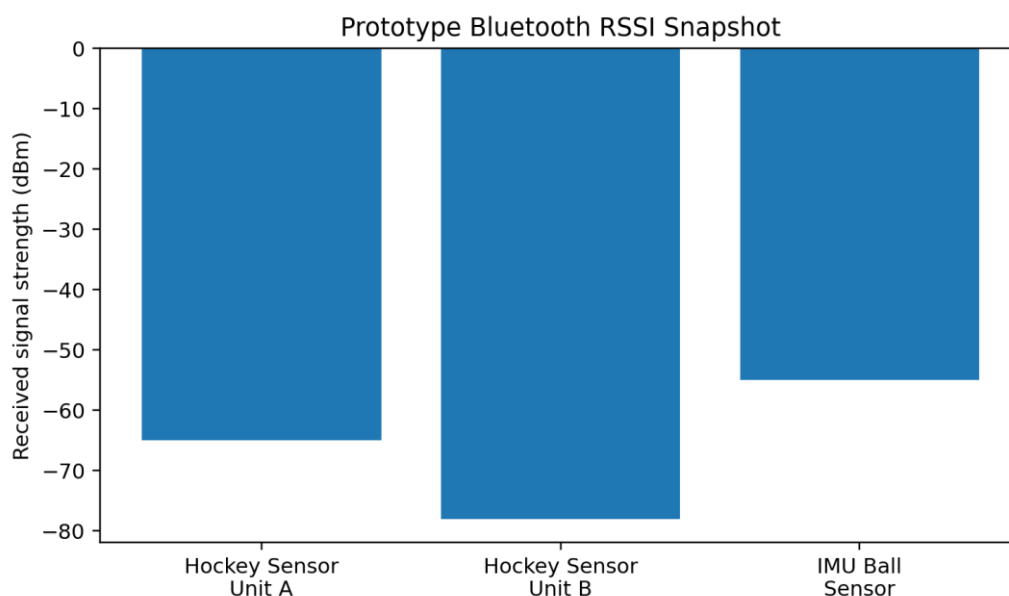


Figure 3. RSSI snapshot from the supplied prototype. Values are interface observations and not a wireless-performance experiment.

3.3 Feature and hardware coverage

Table 1 summarizes the visible prototype inventory. The modular hardware approach is suitable for experimental development, but each component requires inline-hockey-specific validation before its measurements can be used as research outcomes.

Category	Visible prototype elements	Inline-hockey application
Navigation	Performance Dashboard; Shot History; Prototype Connection	Skating workload, technical events, sensor management
Preferences	Speed Unit; Auto-Save Shots	Skating-speed display and automatic event storage
Data	Clear Shot History	Session/shot record management
Hardware	ESP32/Arduino Nano; MPU6050/MPU9250; HC-05/HC-06; BLE 4.0+; GPS NEO-6M	Low-cost sensor node, IMU, wireless communication and optional positioning

Table 1. Prototype feature inventory reinterpreted for inline hockey.

3.4 Alignment with inline-hockey performance requirements

Inline-hockey research indicates that skating should be treated as a primary performance variable. Forward skating consists of sliding, propulsion and recovery phases, and its quality is influenced by the athlete, rink surface and skate characteristics [9]. Accordingly, a future Performance Dashboard should include skating speed, acceleration, deceleration, change-of-direction events, stride frequency or cycle timing, and session duration where these can be measured reliably.

Lower-limb mobility is another relevant dimension. Elite inline-hockey players have demonstrated measurable hip, knee and ankle ROM characteristics and asymmetries [4], while youth players show frequent tightness across lower-limb movements [5]. These findings support storing periodic screening results alongside performance records, but such assessments should remain separate from automatic sensor-derived metrics unless validated.

Injury-related monitoring should focus on exposure and movement context rather than automated diagnosis. Spanish inline-hockey data identified non-contact skating, falls and player contact among common injury mechanisms [3]. Figure 4 converts the reported injury-mechanism values into a visual benchmark. Because the published sample was amateur Spanish inline hockey, the values should not be generalized to all leagues, age groups or countries.

Low-back and postural variables may also be relevant to longitudinal monitoring. Inline-hockey studies have documented sport-specific spinal adaptations in young players [6], associations between hip rotation and low-back-pain status in elite players [7], and a prospective relationship between limited hamstring extensibility and low-back pain in youth players [8]. A mobile system could therefore provide a secure record of screening measurements, training exposure and symptom reports, while clinical interpretation remains the responsibility of qualified professionals.

Sport-specific fitness can be represented through repeated testing. The 2026 Inline Roller Test study included roller-hockey athletes and measured peak/submaximal heart rate, total distance, maximum skating speed and estimated $\text{VO}_{2\text{peak}}$, reporting ICC values of 0.68–0.82 and low variability for heart-rate/performance measures [11]. These findings illustrate the feasibility of collecting repeatable skating-related metrics, although they do not validate the current application's sensors.

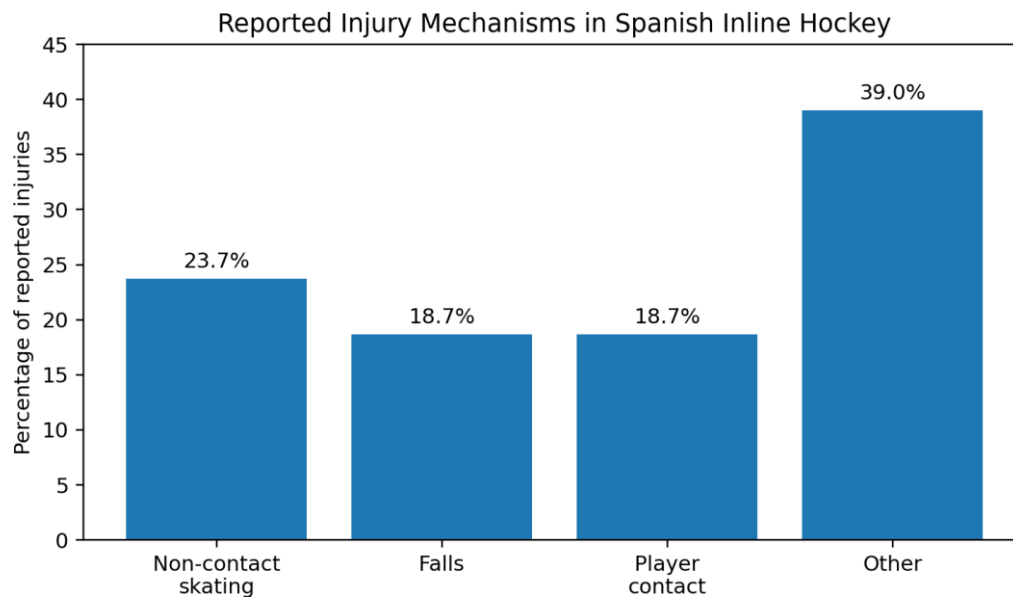
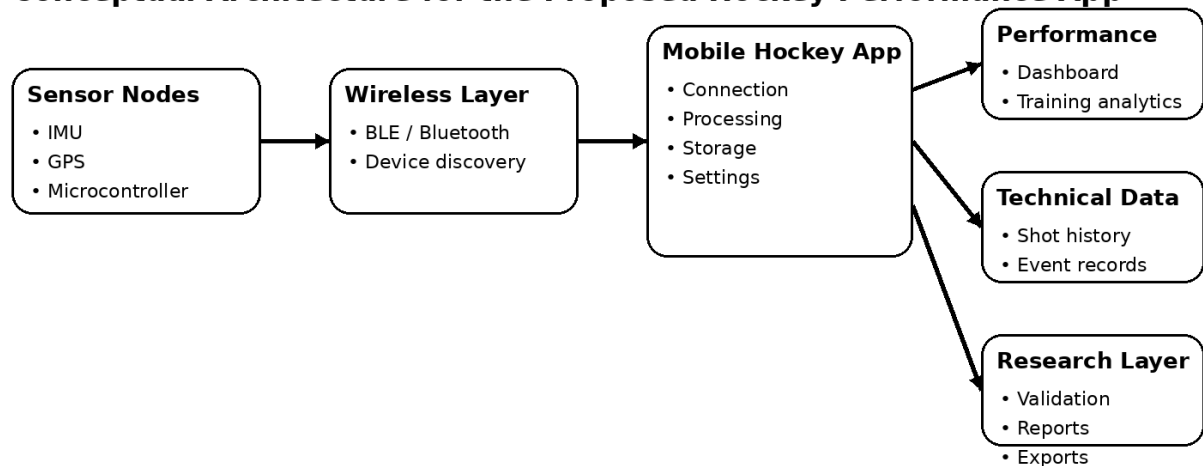


Figure 4. Reported injury mechanisms in the 2020 Spanish inline-hockey study. The values are external literature data, not measurements from the present application [3].

3.5 Conceptual architecture for inline hockey

The supplied architecture is retained conceptually but is interpreted specifically for inline hockey. Sensor nodes can be mounted on the player, skate, stick or puck depending on the measurement objective. The wireless layer transfers sensor data to the mobile application, where data can be synchronized, stored and converted into performance metrics. The output layer should distinguish raw sensor information, derived metrics and validated research indicators.

Conceptual Architecture for the Proposed Hockey Performance App



Conceptual design derived from the supplied prototype hardware and interface screens; not experimentally validated.

Figure 5. Conceptual sensor-to-app architecture for inline-hockey performance monitoring. The model is a design proposal and is not a validated implementation.

3.6 Quantitative prototype observations and inline-hockey benchmarks

The prototype contains three RSSI observations: -65 , -78 and -55 dBm. The three values demonstrate that the interface can display device-specific signal information, but a single screenshot cannot establish communication quality. Wireless testing should therefore be conducted over repeated skating sessions and multiple sensor positions.

The 2026 Inline Roller Test provides a more sport-specific external benchmark for validation planning than the field-hockey values in the original paper. The study reported moderate-to-good test-retest reliability ($ICC = 0.68-0.82$), coefficient of variation of $1.20-2.80\%$ for heart-rate/performance measures, and $7.03-16.46\%$ for blood-lactate responses [11]. These values are not targets for the present application; they demonstrate the type of reliability evidence that should be generated for inline-hockey testing.

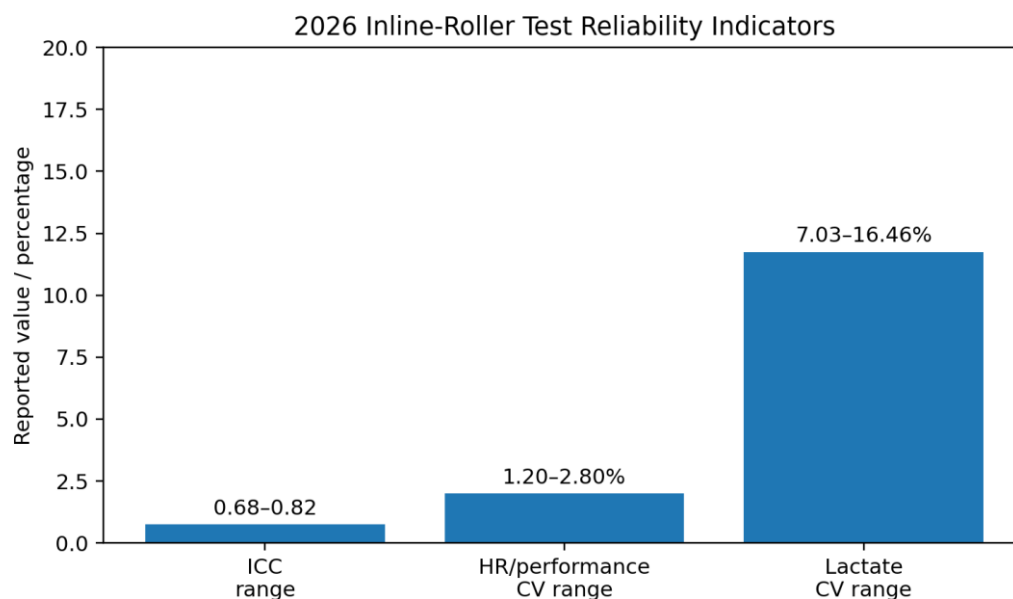


Figure 6. External reliability indicators reported for a 2026 Inline Roller Test including roller-hockey athletes [11]. Values are not measurements of the proposed application.

3.7 Shot history and technical-event monitoring

The Shot History function is particularly relevant to inline hockey because performance is not limited to locomotor load. Passing, receiving, driving and shooting are core technical actions described in inline-hockey research [5,9]. A future shot record could contain timestamp, session identifier, sensor identifier, estimated puck/shot speed, movement signature, player position and contextual information. However, the current screenshot only demonstrates the existence of a Shot History interface and Auto-Save control; it does not demonstrate validated automatic shot detection.

The distinction between a user-entered event and a sensor-derived event should be explicit. For example, a coach may manually label a shot while an IMU algorithm independently detects an acceleration or impact pattern. The application should retain both the raw signal and the derived label so that algorithmic errors can be audited. This design would also facilitate future machine-learning studies using labelled inline-hockey actions.

3.8 Usability, data management and limitations

The Clear Shot History control should include a confirmation step, export/backup functionality and clear identification of the records being deleted. Each session should retain a timestamp, device identifier, calibration status, firmware version, sensor placement and data-quality flag. These fields would support longitudinal analysis and troubleshooting.

Usability testing should be performed with inline-hockey players and coaches. A representative task sequence could include scanning for a sensor, connecting the device, confirming signal strength, selecting speed units, enabling Auto-Save, viewing a skating session, retrieving a shot event and exporting a report. Outcomes should include task completion time, user errors, connection failures, perceived usability and successful retrieval of required information.

The main limitation is that the present study evaluates a prototype rather than athlete performance. The RSSI values are single-state interface observations, and the hardware list indicates compatibility targets rather than validated integration. The literature base for inline-hockey-specific digital sensor systems is also considerably smaller than the literature for some other team sports. Consequently, the present study does not claim measurement validity, diagnostic capability or performance improvement.

Another limitation is that some inline-hockey literature focuses on Spanish national or youth populations. Their findings provide relevant sport-specific evidence but should not be treated as universal benchmarks for all ages, sexes, playing standards or competition systems. Future studies should recruit the intended target population and report sample characteristics clearly.

3.9 Proposed validation pathway

Validation stage	Measurement	Reference/criterion	Primary outcome
Sensor calibration	IMU acceleration/gyroscope	Laboratory calibration procedure	Bias and repeatability
Skating validation	Speed, acceleration, direction change	Validated timing/video/reference system	Agreement and error
Wireless testing	RSSI, packet loss, latency	Repeated rink trials	Reliability of data transmission
Technical-event validation	Shot/impact detection	Coach-labelled video events	Sensitivity, specificity, F1
Usability	App tasks	Players/coaches	Task time, errors, SUS
Longitudinal study	Training exposure and performance	Repeated sessions	Within-player trends and test–retest reliability

Table 2. Proposed validation framework for the inline-hockey application.

4. Conclusion

This study reinterprets the supplied sensor-integrated mobile application specifically for inline hockey. The framework is based on inline-hockey evidence concerning skating technique, lower-limb flexibility, spinal posture, low-back-pain risk, injury mechanisms and sport-specific fitness testing. The supplied interface provides the main components required for a prototype workflow: performance dashboard, shot history, sensor discovery, speed-unit preferences, automatic event saving and data management.

The prototype observations show that three sensor nodes can be displayed with identifiers and RSSI values and that a low-cost ESP32/Arduino, IMU, Bluetooth/BLE and optional GPS architecture can serve as a development platform. Nevertheless, the present work does not establish sensor accuracy, wireless reliability, automatic shot detection or improvement in athlete performance.

The next stage should therefore be empirical inline-hockey validation. Testing should occur on the intended rink and should evaluate skating speed, acceleration, deceleration, direction changes, technical-event detection, data transmission, sensor repeatability and usability. Where GPS is used, its performance under actual rink conditions must be tested rather than assumed. The final system should

preserve raw sensor data, derived metrics and validation metadata so that performance claims remain scientifically traceable.

Overall, the paper establishes an inline-hockey-specific research pathway for transforming a low-cost sensor/mobile prototype into a validated performance-monitoring platform. Its value will depend on rigorous sport-specific calibration, repeatability testing, usability assessment and independent comparison with criterion measurements.

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