

# KhelSaarthi: An AI-Based Sports Talent Identification System Using Flutter and Firebase

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## Abstract

The KhelSaarthi mobile app is a sports assessment and training system that uses Artificial Intelligence (AI) technologies to enhance the performance of athletes by providing them with smart feedback about their movements. The proposed model combines technologies such as artificial intelligence, camera-based motion tracking and Firebase cloud services to assess the performance of the users in different sports activities. The app allows conducting automated fitness test assessments, recording the performance of the users and providing them with tips for improving their skills. The app uses the machine learning technology for analyzing the movements and providing performance scores. The app provides secure authentication and data storing with the help of Firebase integration. The proposed system is developed using Flutter technology to provide cross-platform functionality.

**Keywords:** KhelSaarthi, AI-Based Sports Assessment, Fitness Evaluation, Motion Detection, Machine Learning, Performance Analysis, Flutter Application, Firebase Integration, Sports Analytics.

## 1. Introduction

Sports talent identification and athletic performance assessment has increased through physical measurement, coach-based observation, and periodic assessment. Even though coach play a major role, the task of manually assessing the performance of an athlete becomes very

complex as the number of athletes increase or even if the athletes are dispersed. In addition, the absence of continuous digital records makes the detection of performance trends, comparison between periodic assessments and personalized feedback challenge. The emergence of advances in AI, computer vision, mobile computing and cloud computing technology have opened up new possibilities for transforming traditional sports assessment into a more data-driven process. Mobile camera on smartphones serve as a sensor to track the movements of athletes without the need for any motion capture equipment. Using computer vision techniques, various performance related attributes such as movements, repetitions and posture can be detected.

However, camera-based sports assessment alone does not make an entire intelligent sports assessment system. A technical system must specify what type of video is captured, pre-processed, analyzed, validated, converted into sports performance metrics, and finally stored. The other challenge is to prevent invalid or incomplete assessments from corrupting the athlete's performance record. In order to solve these problems, this research work introduces KhelSaarthi: an AI-powered mobile framework for sports assessment and performance monitoring of athletes. The solution combines camera-based activity assessment, performance evaluation, mobile interactions, cloud-based data management, and performance tracking. The implementation used Flutter as an application development and Firebase for the purpose of authentication and cloud-based data management. The initial implementation of the framework involves sports-related modules such as cricket, football, kabaddi, badminton, hockey, volleyball, basketball, boxing, and archery, along with the modules for assessment of athlete's fitness through activity such as height, weight, sit-and-reach, and standing vertical jump. The key point is not to develop a sports app, but to create an entire pipeline where athlete's activity will be transformed into performance information. This information can be stored as an athlete's longitudinal profile and further analyzed for performance comparison and personalized training purposes.

## **1.1 Problem Statement**

Existing sports assessment methods typically rely on human observation and physical testing. This approach may face issues of variability in assessment, lack of historical records, limited accessibility, and challenges in scaling to assess many athletes.

The research problem that this work attempts to solve is defined as follows:

How can the integration of camera-based athlete activity, automated performance assessment, mobile computing, and cloud-based data management solve the challenge of sports talent assessment and performance evaluation?

The suggested KhelSaarthi system solves the above problem by adopting a systematic pipeline consisting of activity capture, motion analysis, validation, performance scoring, data synchronization, and longitudinal analysis.

## 2. Related Works

The recent study has analyzed the application of artificial intelligence as a tool that would help the athletes to develop and scout talents, train, and make decisions. According to the reviewed literature, there is a trend toward the creation of an intelligent system that will combine information about the athletes, their performance, recommendations and decision-making instruments. Schimpf et al. [1] explored the use of LLM-based chatbots for effective goal setting. It is obvious that the potential of the intelligent conversation-based system that could transform users' personal goals into recommendations can be successfully applied in the area of sport, as well. In particular, in this case, the conversion of the results of the assessment into training recommendations is required. Furthermore, Chowdhury et al. [2] developed a student life assistant using a smartphone for talent hunting and preparation for careers. It is possible to integrate multiple features that will support the user in one mobile application.

Patil et al. [3] studied an application that utilizes AI technology to improve athletic performance. This research is very relevant to the goal of KhelSaarthi as it applies the AI technology to the area of sports in the digital world as opposed to considering athletic performance as a manual training program. But there is one very significant difference between this study and KhelSaarthi, which is in the utilization of camera assessment of activities along with performance data of athletes and mobile application protocol. Therefore, the issue here is not just about the display of training data but the establishment of a computational process from the activity of an athlete to his/her assessment data.

Machine learning is also used to solve the particular cases of player selection and analysis of performance. Santosh et al. [4] a machine learning framework that could select adequate cricket players based on the playing positions like offside, leg side, and defense performance. It

represents how sport-related variables of performance could be used as inputs of the machine learning model for the evaluation of players. Mănescu and Mănescu [6] predictive models that could identify high-performance athletes among team sports players. This research shows how predictive modeling for athlete selection problems. Nevertheless, all these works deal with the problem of prediction or analysis of athlete performance. In turn, KhelSaarthi is directed toward the mobile environment of performance evaluation, where the data on performance is gathered with the help of the application and is linked to a certain athlete's profile.

Furthermore, it can be concluded from the literature that modern intelligent sports systems should be more concerned with the overall management of sports persons and sport activities. In one example, Anju et al. [5] have designed a smart system for managing sports associations and providing live fixtures of the tournaments and notification to users. This example proves the need of real-time information management and interactive events in sports systems. But, here management of tournament and associations is related to the information management of organizations while the KhelSaarthi is based on computational analysis of sports person's performance.

Talent identification in sport has been explored from the perspectives of psychology and decision support systems. Sartor et al. [7] have analyzed the role of artificial intelligence in identifying and developing talent in the context of sport psychology and noted that AI can be used in the process of talent identification and development in sports. Further research on the same topic has been conducted by Morgulev and Azar [8], who explored the issues of using AI-driven decision-making tools for talent identification while paying attention to the challenges related to algorithmic bias, privacy concerns, and digital determinism in evaluating athletes. It can be seen from these studies that the issue of automated athlete evaluation cannot be reduced only to predicting performance; there are other important aspects like reliability, interpretability, privacy, and trustworthiness of the evaluation process. This is why it is necessary to note that for a mobile application like KhelSaarthi athlete evaluation data has to be stored in a secure way.

Research in the field of recommendation and selection of candidates systems is personalized recommendation and selection of candidates systems. Hamzah et al. [9] introduced a rule-based career finder system to filter university candidates based on certain criteria. Even though the context of use is different from the sports, the architecture of this

system shows how attributes of the user are analyzed according to certain criteria in order to generate recommendation. The same approach can be applied in the sports context where attributes of the athletes and assessment results are mapped to corresponding recommendations. As opposed to the candidate selection system that uses only rules to filter candidates, KhelSaarthi utilizes performance data gathered during the assessment activities.

The use of mobile coaching applications provides another instance for integration in digital interfaces with the training process oriented towards the athlete. Villellas [10] the running coach application, thus stressing the significance of mobile applications for the structuring of training in sports. Nevertheless, the coaching application and the automated framework for talent assessment are used in the different stages of the development of the athlete. The former is mostly used during the process of training, while the latter aims at building up an assessment-based feedback cycle.

The reviewed studies demonstrate that existing research has addressed several individual components of intelligent sports technology, including AI-assisted goal setting [1], mobile talent-support applications [2], AI-based athletic performance applications [3], sport-specific player analysis [4], sports management [5], predictive athlete selection [6], AI-supported talent development [7], ethical and policy considerations in AI-based talent identification [8], rule-based personalized selection [9], and mobile coaching [10]. However, these studies do not collectively establish the complete assessment pipeline targeted by KhelSaarthi. The specific research gap addressed by the proposed framework is therefore the integration of mobile athlete interaction, camera-based movement observation, automated performance assessment, quantitative scoring, historical performance storage, and personalized feedback within a unified application architecture.

### **3. System Architecture**

The proposed KhelSaarthi architecture is a data flow architecture based on components that convert the physical movements of an athlete into a digital performance profile. This architecture includes the Flutter mobile application, activity acquisition using the camera, motion analysis using AI, performance evaluation, Firebase services, performance analytics in the past, and feedback generation. Unlike the design where each of these systems operates as a standalone system, the architecture ensures that there is a flow from one component to the other

such that when the user initiates the test, it can be turned into a validated performance and then analyzed over time. This architecture aligns well with the intended purpose of incorporating all these features into one software package.

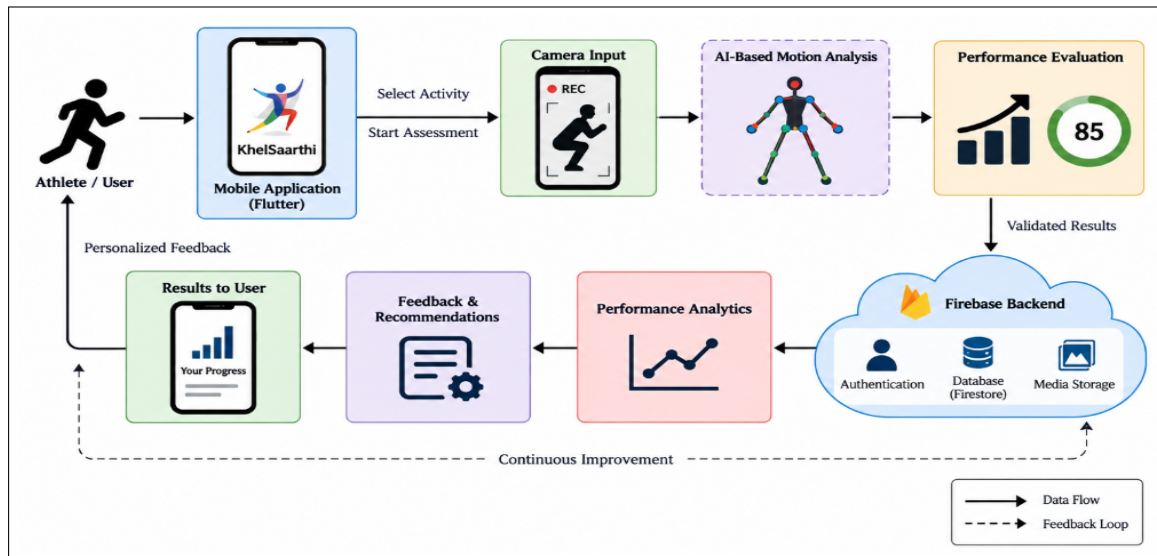


**Figure 1.** Proposed architecture of KhelSaarthi

As shown in Figure 1, the interaction begins at the athlete-facing Flutter application. The interface provided by the application to register themselves, authenticate their credentials, choose a sports or fitness activity, start the assessment process, and view the performance information. The existing application design incorporates various modules that include cricket, football, kabaddi, badminton, hockey, volleyball, basketball, boxing, and archery, in addition to fitness tests that are height, weight, sit-and-reach, and vertical jump. Therefore, the mobile application acts not only as a presentation tool but also as the controller for starting and controlling the assessment process.

The process of activity selection, after the camera input module captures the activity performed by the athlete in the form of the time series of image observations. It translates the athletic activity of the person into machine-readable visual data. Time dependency in the input plays a critical role in that several attributes of assessment, including movement displacement, number of repetitions, duration of execution, and consistency of the movement, rely on the difference between sequential images and do not consider an individual picture. The captured time series of images serve as the input to the AI-assisted motion analysis module for the extraction of information regarding the movements. Although the paper indicates AI-assisted

motion analysis and camera motion detection as the algorithmic core of the assessment tool, the provided implementation does not indicate a particular architecture or training of the model.

The result of the motion analysis step is used as input for the performance feature and evaluation step, in which the obtained movement information is translated into performance assessment parameters. According to the type of exercise, such parameters can include repetitions, exercise time, movements, and other exercise-related features. The intermediary representation is needed as an interface between raw visual information and the resulting performance score. This necessary scoring should be performed using validated activity-level measurements rather than directly from individual camera frames.

Before the result is updated to the athlete's profile, a validation process for the assessment information is performed to verify its completeness and consistency. The process of data processing defined in the manuscript involves eliminating incomplete entries, cleaning up corrupt motion information, normalizing performance variables, and authenticating user identity, assessment type, and timestamp. It is only after the validation process that the assessment can be used to score and update the profile of the athlete. This validation process is especially crucial because any faulty observation on the athlete's movement or incomplete session might contaminate his/her history of performance.

The validated measurements are then processed by the performance-scoring component, that converts the activity-specific parameters into an assessment result. For a general assessment containing multiple normalized performance variables, the scoring mechanism can be represented as,

$$S = \sum_{j=1}^m w_j x_j^*, \quad \sum_{j=1}^m w_j = 1$$

where  $x_j^*$  represents the normalized value of the  $j$ -th performance parameter and  $w_j$  represents its corresponding contribution to the overall score. The specific weights and scoring criteria are dependent on the implemented assessment protocol and should therefore be defined separately for each assessment rather than assumed from the architecture.

The validation of the assessment record is then followed by synchronizing the record with the Firebase backend. The Firebase Authentication ensures that user identity is maintained,

whereas Cloud Firestore stores structured records of the athlete, their assessments, scores, and performance records. Firebase Storage stores multimedia data associated with the assessment process. Therefore, the backend creates the association between the athlete, assessment, and their past performance records.

The records used by the performance analytics component to generate longitudinal data from subsequent evaluations. Instead of assessing each evaluation session separately, the system is able to compare subsequent scores of valid assessments to measure changes in performance. With two consecutive valid assessments, the change can be depicted

$$\Delta S_t = S_t - S_{t-1}$$

and the corresponding relative improvement can be expressed as

$$I_t = \frac{S_t - S_{t-1}}{S_{t-1}} \times 100$$

Such an approach enables the construction of the athlete's performance profile and thus allows the use of the system to showcase the athlete's progress in the past instead of displaying the results of the latest evaluation alone. The paper specifically refers to the historical performance tracking and individual recommendations as the system's features.

## 4. Methodology

The methodology of KhelSaarthi identifies the computational method through which the assessment activity of an athlete is transformed into a performance of record. This methodology involves the gathering of data on the athlete and the assessment activity, preparation of gathered data, motion analysis, extraction of performance factors, validation of the assessment, scoring of the performance, and analysis of the obtained performance record relative to previous assessments. It ensures that there is a consistent link among the athlete, chosen activity, performed activity, and its corresponding assessment outcome. The original method has an additional feature of historical performance tracking so that assessment activities are not treated individually but in sequence.

### 4.1 Assessment Data Acquisition and Representation

The first step consists in obtaining information that is necessary for recognizing the athlete and describing an assessment session. An assessment session description includes

information about the user, the chosen activity, the session itself, data on the performed activity, performance parameters, and an assessment result. A general view of the assessment session can be presented as

$$D_s = \{U_s, A_s, V_s, T_s, R_s, P_s\}$$

where  $U_s$  represents the athlete identifier,  $A_s$  denotes the selected assessment activity,  $V_s$  represents the acquired visual or activity data,  $T_s$  denotes the session timestamp,  $R_s$  represents activity-related measurements, and  $P_s$  denotes the resulting performance information.

For camera-based assessments, the visual input is acquired as a temporal sequence rather than as an isolated image. The captured sequence can be represented as

$$V = \{I_1, I_2, \dots, I_N\}$$

where  $I_t$  represents the observation captured at time  $t$ , and  $N$  is the number of observations available for the assessment session. This representation allows movement-related information to be derived from changes between consecutive observations. The methodology therefore treats the assessment as a temporal activity sequence rather than a static image-classification problem.

In addition to data collected by the camera, the system collects activity-based metrics like number of repetitions performed, the duration of the exercise, and other performance metrics when necessary. The original system also keeps track of users' profiles, their assessment scores, and history of training to relate the result of a single session to the athlete's history.

The motion-analysis results are converted into a representation of a performance feature. Depending on the choice of the evaluation method, the resulting information can consist of repetition number, time of execution, motion metrics, and activity-specific metrics. For motion analysis with coordinates  $(x_t, y_t)$ , the motion shift can be defined as

$$d_t = \sqrt{(x_t - x_{t-1})^2 + (y_t - y_{t-1})^2}$$

The resulting temporal information that is going to determine if the athlete has performed the requisite task and will be used to calculate the parameters used in evaluating the performance.

It is crucial that there is a distinction made between the raw camera observation and the score calculation as the former should be evaluated before generating the score.

The extracted features are then passes to the assessment and scoring module. Before doing the scoring, the system ensures that the assessment data is complete and consistent. As per the original approach, incomplete data should be removed, corrupt motion data should be filtered, scoring, time and repetitions should be standardized, and user identity, test details and timestamp should be verified. Only valid completed assessments should go for final scoring and profile update.

For an assessment containing  $m$  performance parameters, the normalized value of parameter  $x_j$  can be represented as

$$x_j^* = \frac{x_j - x_{j,min}}{x_{j,max} - x_{j,min}}$$

The validated assessment record will be uploaded to Firebase back-end, which is the persistent backend of the system. The Firebase Authentication is used for athlete identification, Cloud Firestore will contain structured data such as athletes' profiles, assessment results, and performance logs while Firebase Storage contains media files regarding the assessment. The backend is responsible for the connection between an assessment session and an athlete's performance profile.

The architecture includes a performance analysis component that works on the assessment history. Let  $S_t$  represent the current valid assessment score and  $S_{t-1}$  the previous valid score; the change in performance measurement is given by

$$\Delta S_t = S_t - S_{t-1}$$

The corresponding percentage can be expressed as

$$P_t = \frac{S_t - S_{t-1}}{S_{t-1}} \times 100$$

These ensure that the application can show progress of an athlete from one assessment to another, and not regard the assessments as independent entities. This is because the system has been designed in such a way that the historical performance of an athlete and his recommendations will be part of its functionality. The last phase of the architecture is the

feedback and recommendation phase. The analysis results are fed back to the flutter application, where the athlete gets the assessment results and feedback.

## 5. Implementation

**Table 1.** Hardware and software components used for implementation

| Category | Component                   | Usage in the Proposed System                                                 |
|----------|-----------------------------|------------------------------------------------------------------------------|
| Hardware | Development Computer/Laptop | Application development, configuration, and testing                          |
|          | Smartphone                  | Execution and testing of the mobile application                              |
|          | Smartphone Camera           | Acquisition of athlete activity and movement data                            |
|          | Internet Connectivity       | Communication with cloud-based Firebase services                             |
| Software | Flutter                     | Cross-platform mobile application development                                |
|          | Dart                        | Application programming and interface implementation                         |
|          | Firebase Authentication     | User registration and secure login                                           |
|          | Cloud Firestore             | Storage of athlete profiles, assessment results, and performance records     |
|          | Firebase Storage            | Storage of assessment-related multimedia data                                |
|          | AI Motion Analysis          | Analysis of camera-based movement observations                               |
|          | Performance Scoring Module  | Processing validated assessment parameters and generating performance scores |
|          | Performance Analytics       | Analysis of historical assessment records and performance progression        |

The prototype of the KhelSaarthi application was developed as a mobile app with the use of Flutter framework in application UI design and Firebase for authentication and data management purposes. Table 1 shows that the implementation of the application follows the process outlined in the system architecture in terms of component flow. The implemented

screens provide a of the flow of activities starting from authentication to interaction with activities and assessments.

### 5.1 User Registration and Authentication

The application starts with the user registration form interface, depicted in Figure 2. The user registration form allows users to create a KhelSaarthi account as well as setting up their credentials for future access. After having created an account, the user gets access to the login form interface, depicted in Figure 3. The login form allows user access based on their credentials.

**Figure 2.** Registration page

Firebase Authentication used as the implementation of authentication. This ensures that user identity management is separate from the application interface while allowing the authenticated user to be linked to the respective assessment and performance logs stored in Firebase. The system architecture ensures that there is a connection between the authenticated user and subsequent actions done through the application.

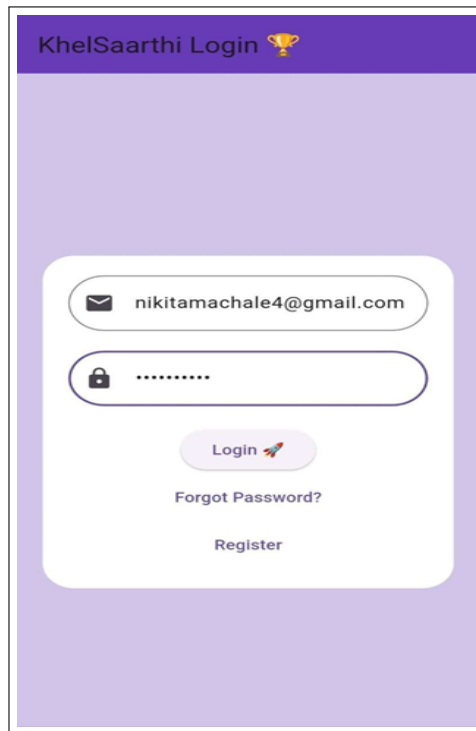


**Figure 3.** Login page

## 5.2 Sports Module and Activity Selection

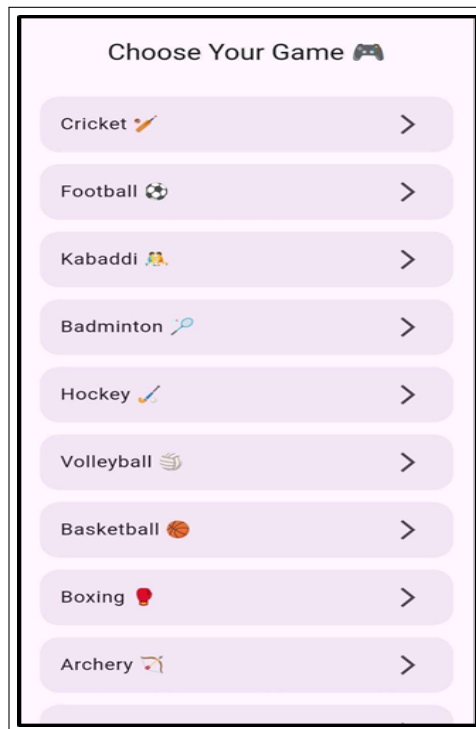


**Figure 4.** Game list

The application opens up the sports category selection screen after successful authentication shown in Figure 4. This screen shows various categories of sports, including

cricket, football, kabaddi, badminton, hockey, volleyball, basketball, boxing, and archery. This interaction acts as an entry for sports and enables the user to choose a domain in which further details need to be provided

The implementation separates the process of choosing sport and the assessment itself. This allows the program to arrange different types of sports into a single mobile environment but still let each type of sports have their own content and assessment functions. The fact that there are many types of sports modules available will also make it possible for the program to become extendable through adding new sports into it.

### 5.3 Sport Information Interface

The sport is selected using the information interface illustrated in Figure 5. In the given cricket module, the application offers information about the sport, which includes the basics of the sport, playing conditions, rules, disciplines, equipment, playing roles, information governance, and developments.

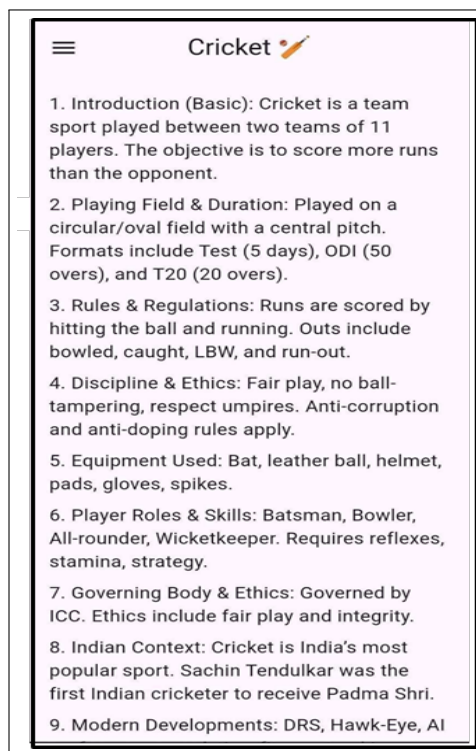


**Figure 5.** Game information

The information stage acts as an interface before the assessment interface. The user can gain knowledge about the chosen sporting category before engaging in the evaluation process. In terms of implementation, the fact that the assessment and informational parts are separate

makes it possible to present information about specific sports separately from the assessment process.

#### 5.4 Assessment Interface

The assessment interface presented in Figure 6 provides a way to carry out the assessment task through interaction. The presented interface includes an assessment question alongside the answer choices and also shows the location of the user in the assessment process. This clearly indicates that the system uses the interactive assessment process and not just the reporting of performance information after processing.



**Figure 6.** Assessment test

The assessment interface connects to the chosen sports module and serves the purpose of gathering the answers provided by the user through the assessment process. The assessment data that has been gathered can then be tied to the authenticated user and stored within his/her performance history. This ensures that the user interface pathway necessary for converting an assessment into a digital record has been set up.

#### 5.5 Fitness Assessment Module

Apart from the sport-specific assessment, the system has implemented an interface which carries out fitness assessment, as illustrated in Figure 7 below. The interface is made up

of assessments of the height, weight, sit-and-reach, and standing vertical jump activities. These are physical attributes that fall into various categories.

The fitness assessment module provides a standard interface for accessing several physical assessments. Each activity can be chosen separately, thus enabling the application to group various measurements under one profile of an athlete. This is especially useful when it comes to long-term monitoring since the measurements collected in separate sessions may belong to the same user and be accessed further as a part of his/her performance record. The initial system specification highlights these activities as being included in the implemented assessment functionality.

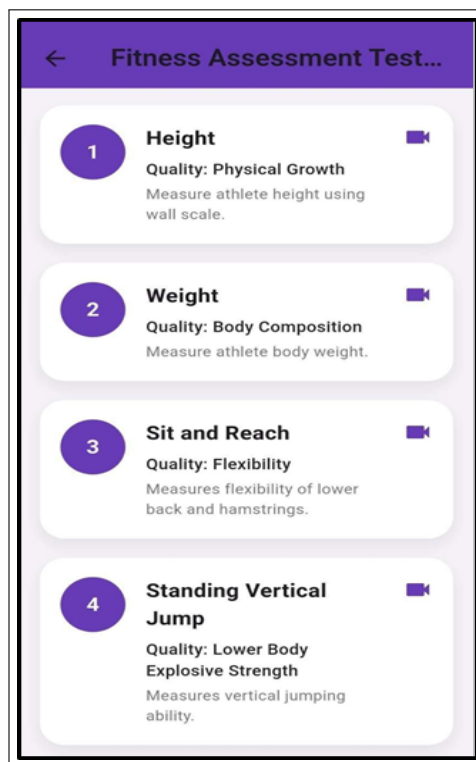


**Figure 7.** Fitness assessment test

## 5.6 Integration with Firebase Services

The implementation of the application relies on Firebase as the cloud backend to store user and assessment data. Firebase Authentication handles the authentication of accounts, whereas Cloud Firestore stores structured data such as athlete profiles, assessment data, and performance data. Firebase Storage can be used for assessment-related multimedia data.

## 6. Conclusion

KhelSaarthi system is a good answer to the drawbacks associated with conventional sports training because it has been developed as a holistic AI-powered mobile platform for assessment and tracking the performance of individuals. It is a successful combination of features such as motion detection, automated grading, instant feedback, and cloud computing all included in one mobile application. Implementation shows better efficiency in terms of athlete performance analysis, secure data management by using Firebase, and better accessibility through the mobile application based on the Flutter framework. The athletes have an advantage of a structured electronic performance record that monitors progress, whereas the coaches and institutions have reliable means of monitoring and evaluation. Despite the fact that the system functions successfully, its accuracy is conditioned by correct camera setup, constant participation of users, and development of AI models. Further improvement may be made in the direction of using computer vision technology, sports categories support, and prediction of injuries and performances. KhelSaarthi plays a key role in the digital revolution in the sports training sector because it has used technologies like AI, mobile devices, and cloud computing in developing its smart sports assessment platform.

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