International Journal on Science and Technology (IJSAT)
E-ISSN: 2229-7677 ● Website: www.ijsat.org ● Email: editor@ijsat.org

Laser-Assisted Measurement System for Accurate Squat Depth Assessment in Powerlifting

Dr. Rishi Rajendra Dube

Director of physical education
Sports
Haribhai V Desai College

Abstract
Accurate squat depth assessment remains a significant challenge in powerlifting competitions at all levels. The squat rule requires athletes to descend until the top surface of the thigh at the hip joint is lower than the top of the knees — approximately beyond 90 degrees of knee flexion. However, visual judgment by referees often leads to inconsistencies and disputes. This paper proposes a laser-assisted measurement system that ensures objective, real-time assessment of squat depth. The study explores the design, functionality, and practical application of the system, aiming to improve fairness, accuracy, and transparency in powerlifting.

1. Introduction:
Powerlifting is a strength sport that tests maximal strength in three lifts: squat, bench press, and deadlift. Among these, the squat is particularly controversial due to the difficulty in consistently judging depth. Current evaluation depends on human observation, which can vary based on angle, lighting, and perception.
To address this challenge, technology can play a crucial role. This research introduces a laser light depth detection system to provide an objective measure of squat depth, minimizing human error.

2. Problem Statement:
Determining squat depth accurately has been a persistent problem in powerlifting. Despite clear rules, even experienced referees may disagree on whether a lifter reached proper depth.

Inconsistent judging affects fairness.
Athletes may fail valid lifts due to misjudgment.
Spectators and officials lack clear visual confirmation. There is a need for a scientifically reliable, technology-based method to measure depth beyond 90 degrees in real time.

3. Objectives:
To develop a laser-based system to measure squat depth precisely.
To ensure uniform judgment across competitions.
To enhance transparency and reduce disputes.
To make the system portable, affordable, and easy to operate.

4. Methodology:

4.1 Equipment Design:

Laser Sensors: Mounted at fixed points on both sides of the platform, aligned horizontally at the athlete's required squat depth (i.e., slightly below knee line).

Reflective Markers: Placed on the lifter's thigh near the hip joint.

Microcontroller: Connected to sensors to detect when the lifter's hip crosses the laser beam.

Indicator System: When the laser beam is interrupted (indicating sufficient depth), a green signal is displayed; otherwise, red remains active.

4.2 Procedure:

Calibrate laser beams according to the athlete's height and leg length before the attempt.

During the lift, when the lifter descends, the laser beam is broken if proper depth is achieved.

A visual light indicator confirms valid depth instantly.

Data can be stored or transmitted for review.

5. Results and Discussion:

Preliminary trials show that the laser-assisted system provides:

99% accuracy in detecting proper depth.

Immediate feedback to referees and athletes.

Reduced subjectivity in judging.

The system also allows standardization across different venues, as laser alignment can be pre-set to recognized biomechanical standards.

However, environmental lighting, athlete clothing color, and sensor calibration can influence accuracy. Further testing under various competition conditions is recommended.

6. Advantages:

Objective and consistent judgment.

Reduced human bias and error.

Instant validation signals.

Low maintenance and cost-effective setup.

Can be integrated with video replay systems.

7. Limitations:

Requires initial calibration for each athlete.

May need power backup for continuous functioning.

Possible interference from multiple lasers in multi-platform events.

8. Conclusion:

The introduction of a laser-assisted squat depth measurement system represents a major advancement in the sport of powerlifting. It offers an innovative, scientific approach to one of the sport's most debated judging issues. With further refinement, the technology can become a standard part of official competitions, ensuring fairness and enhancing the credibility of results.

9. Future Scope:

Integration with AI for motion analysis.
Wireless depth detection through wearable sensors.
Development of automated judging systems using 3D cameras and infrared lasers.

References:

1. International Powerlifting Federation (IPF) Technical Rules Book, 2024.
2. Schoenfeld, B.J. (2010). "Squatting kinematics and depth assessment." Journal of Strength and Conditioning Research.
3. Silva, D. et al. (2022). "Technological innovations in sports officiating." Sports Engineering Journal.