Developing Motion Templates of Sport Training Using R-GDL Approach for Evaluating Extrinsic Feedback of Penalty Kicks

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***Abstract*—The study developed Motion Templates (MTs) using the Reverse-Gesture Description Language (R-GDL) method to evaluate extrinsic feedback in football penalty kick training. Traditional coaching methods often rely on subjective and qualitative assessments. To address this, motion capture (MoCap) technology was employed to collect kinematic data from two university football players (right- and left-footed) performing penalty kicks toward left (Set 1) and right (Set 2) goalpost and Score Rubric Assessment (SRA) form was used by professional coach to evaluate the performance. From the collected MoCap data, 40 successful penalty kicks were selected, converted into SKL format and generate MTs through Gesture Description Language (GDL) system using R-GDL, which standardized movement patterns through adaptive machine-learning-derived rules. The MTs incorporated features such as joint angles and limb trajectories, producing five rules per template for comparative analysis. Results demonstrated that MTs effectively differentiated players' techniques across sets (e.g., Player A required fewer attempts in Set 1 than Player B in Set 2). Cross-validation against coach-evaluated Score Rubric Assessment (SRA) outcomes revealed that extrinsic feedback scores from MTs did not surpass SRA benchmarks, confirming the uniqueness of each player's motion patterns. This highlights MTs' reliability in providing objective, granular feedback for skill improvement. The study concludes that R-GDL-based MTs offer a robust tool for enhancing sports training analytics, enabling data-driven coaching strategies. Future work will focus on scalability, cost reduction, and extending this approach to other sports.**

***Keywords*—Motion templates; motion capture; penalty kick; extrinsic feedback; reverse-gesture description language**

I. INTRODUCTION

Football or soccer is a well-known sport that has been played globally that engages participants across all skill levels, from amateur enthusiasts to elite professional [1]. In football, a team consists of eleven football players which are a combination of specific player position and role on the field. Set pieces are one of the key parts of football. A set piece refers to a situation where a dead ball is put into play after a stoppage. Penalty kicks are one of the set pieces besides corners, free kicks, goal kicks and throw-ins. Penalty kicks can be considered as the easiest compared to the others and have the most straightforward opportunity to score [2,3,5]. However, football players, even in professional teams, still need to practice on the training sessions to improve their skill.

Traditionally, coaching feedback in football has relied on subjective, verbal evaluation, where the coach identifies technical flaws based on observation. While this approach remains foundational, it has limitations, such as the lack of quantitative data and delayed feedback [4].

Nowadays, there are a lot of technology that has been explored and implemented in various sport, to make some improvements in the sport evaluation. Motion Capture (MoCap) is included in the current technology that is used in sport. In MoCap, there are two main techniques that have been used which are marker-based, which use markers on the subject for high precision tracking and markerless, which leverage on computer vision, high speed camera to analyze movement without physical markers [6, 7, 8, 13, 14].

Recently, MoCap has facilitated the development of Motion Templates (MTs), which standardize movement patterns for comparative analysis. Reverse-Gesture Description Language or R-GDL is an extension of the basic concept of GDL, focusing on a machine-learning approach for the recognition of full-body movements. R-GDL's methodology can be considered a form of reverse engineering compared to traditional GDL. While GDL focuses on predefined rules to classify movements, R-GDL infers these rules from recorded motion data, enabling adaptive recognition of complex, full-body gestures such [9, 10].

Through MTs, it provides feedback as the result and at the same time the result can be analyzed to make the improvement of the specific area such as athletic performance in sport area. Feedback can be classified into two types: Extrinsic and Intrinsic [10, 11, 12]

In this paper, the MTs of penalty kick were developed using the collected MoCap data using specific MoCap device. The MTs will be generated through GDL system using R-GDL method. Section II discusses related work. Section III present material and method. Then, Section IV presents the result, while Section V provides discussion. Finally, Section VI concludes the research and suggests future work.

II. Related Work

Several studies have explored MoCap techniques in sports analysis. Ángel-López et al. [2] conducted a kinematic study of soccer kicks using MoCap, emphasizing the value of motion data in assessing player performance. More recently, Yin et al. [4] introduced a MoCap-based deep learning system for football training, demonstrating its effectiveness in enhancing player development.

However, much of the existing MoCap research focuses on isolated movement analysis without incorporating machine-learning-based adaptive motion recognition. For example, Gouveia et al. [5] examined set-piece strategies in Portuguese football but did not employ data-driven evaluation models. This study seeks to bridge that gap by integrating R-GDL into MoCap-based assessments, providing a structured, data-driven approach to analyzing penalty kicks.

III. Material and Method

To evaluate the penalty kicks training activities, MTs of the penalty kicks must be developed first. To develop the new MTs, a framework for football training was adapted in study [11] as illustrated in Fig. 1. The framework consists of three main phases which are Development, Testing, and Evaluation. The first phase contains several processes which are recording the motion of football player using MoCap devices, exporting raw MoCap data, conversion of raw MoCap data into processed MoCap data and generating the MTs from the processed MoCap data. While the second phase only involves one process which is selection of SKL dataset. Lastly, the third phase contains a comparison process between the MTs and SKL datasets. Finally produce the results in Extrinsic Feedback (EF).

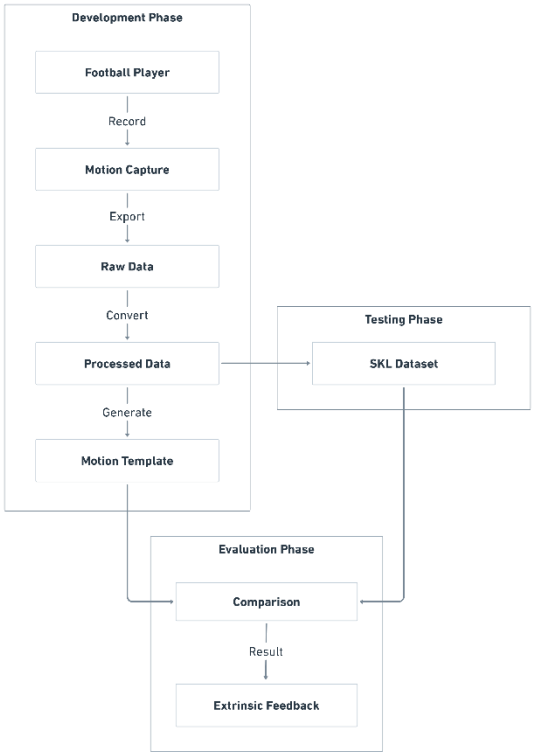


Fig. 1. Adapted proposed framework.

A. Experiment

The experiment was aimed at collecting the MoCap data of penalty kick training activities that were performed by football players. The certified professional football coach was involved in selecting the qualified football players and also supervising the performance of football players in the experiment.

1) Participant: In this study, two male football players from the Universiti Sultan Zainal Abidin (UniSZA) were selected by the Asian Football Confederation (AFC) certified professional football coach. Based on Table I, both football players have a difference in dominant leg where Player A is right footed, and Player B is left footed.

TABLE I. Football Player Information

Player	Age	Dominant Leg	Year Of Experience	Position In Football Team
A	23	Right	2 Year	Right Wing
B	22	Left	1 Year	Left Back

2) Procedure: In the experiment, each of the qualified football players, Player A and Player B, are needed to perform penalty kicks using their dominant leg to both side of the goalpost. As shown in Fig. 2, the left side of the goalpost is referred to as Set 1, and the right side is Set 2. Both players must complete 10 successful penalty kicks by scoring into the goalpost with right direction on each set.

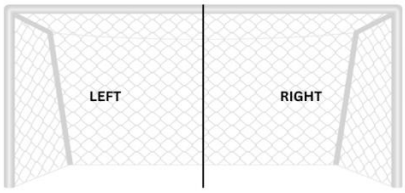
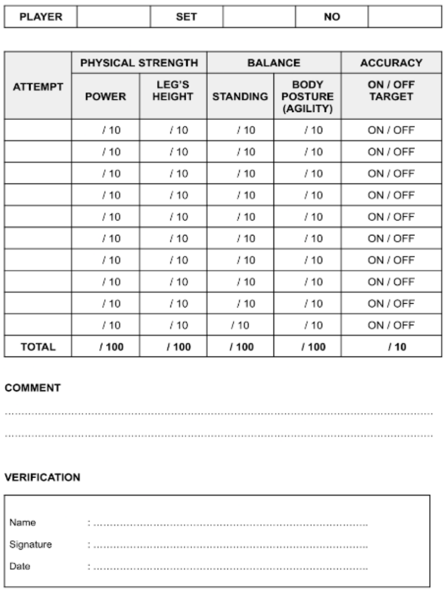


Fig. 2. Penalty kick training activity guidelines.

The players were required to wear the full body kit set of Perception Neuron 3, but due to the hardware limitations, only one player could wear the device at a time. Body strap and sensor were attached to the player's body as shown in Fig. 3, by following the guideline provided by the manufacturer. Then the sensor calibration procedure is executed before the player performs the penalty kicks attempt.

Fig. 3. Attachment of perception neuron 3 strap and sensor to player's body.

At the same time the players perform the penalty kicks by following the instructions given, the coach evaluated the performance using a Score Rubric Assessment (SRA) as shown in Fig. 4. Also, the coach will give direct feedback on the previous penalty kicks attempt and what aspects need to be improved. The main parameters evaluated are Physical Strength, Balance and Accuracy. The parameter in SRA was knowledge from the professional football coach and it is verified before been used for evaluation.



PLAYER		SET		NO	

ATTEMPT	PHYSICAL STRENGTH		BALANCE		ACCURACY
	POWER	LEG'S HEIGHT	STANDING	BODY POSTURE (AGILITY)	ON / OFF TARGET
	/ 10	/ 10	/ 10	/ 10	ON / OFF
	/ 10	/ 10	/ 10	/ 10	ON / OFF
	/ 10	/ 10	/ 10	/ 10	ON / OFF
	/ 10	/ 10	/ 10	/ 10	ON / OFF
	/ 10	/ 10	/ 10	/ 10	ON / OFF
	/ 10	/ 10	/ 10	/ 10	ON / OFF
	/ 10	/ 10	/ 10	/ 10	ON / OFF
	/ 10	/ 10	/ 10	/ 10	ON / OFF
	/ 10	/ 10	/ 10	/ 10	ON / OFF
	/ 10	/ 10	/ 10	/ 10	ON / OFF
TOTAL	/ 100	/ 100	/ 100	/ 100	/ 10

COMMENT

VERIFICATION

Name :

Signature :

Date :

Fig. 4. Score rubric assessment form.

3) Output of the experiment: Table II shows the results of the number of attempts in both set by Player A and Player B. Least attempt to completed 10 successful attempts was achieved by Player A in Set 12 with 12 attempts while the most attempted attempts was achieved by Player B in Set 2 with 21 attempts. This indicates that in reality, the penalty kick is quite challenging when it comes to score the ball on the right target.

TABLE II. SUMMARY OF PENALTY KICK ATTEMPTS

Player	A		B	
Set	1	2	1	2
Total Attempt	12	13	14	21
Successful Attempt's Number	1,3,4,5,6,8,9,10,11,12	1,2,3,5,6,7,8,10,11,13	1,4,5,6,7,8,9,10,11,14	1,3,4,5,8,11,12,17,19,21

Table III, IV, V, VI show the number of frames from MoCap data of penalty kick performed by both players in each set. Each of the MoCap data contains many frames, however, a filtration has been made by selecting only necessary frame number before been export to comma separate value (CSV) format.

Table VII presents the MoCap data of penalty kick performed by Player A in Set 1. Every successful attempt of MoCap data was exported using Axis Studio. It shows there are 1240 columns consisting of Frame-No and X, Y, Z axis of every joint.

TABLE III. EXPORTED FRAME FOR SET 1 OF PLAYER A

No	Attempt	Start Frame	End Frame	Total Frame
1	1	200	425	226
2	3	100	300	201
3	4	100	250	151
4	5	100	255	156
5	6	100	260	161
6	8	175	350	176
7	9	50	220	171
8	10	125	275	151
9	11	85	240	156
10	12	130	300	171
			Total All Frame	1720

TABLE IV. EXPORTED FRAME FOR SET 2 OF PLAYER A

No	Attempt	Start Frame	End Frame	Total Frame
1	1	250	450	201
2	2	200	400	201
3	3	100	300	201
4	5	0	225	226
5	6	125	275	151
6	7	150	325	176
7	8	150	350	201
8	10	100	300	201
9	11	140	315	176
10	13	75	250	176
			Total All Frame	1910

TABLE V. EXPORTED FRAME FOR SET 1 OF PLAYER B

No	Attempt	Start Frame	End Frame	Total Frame
1	1	150	325	176
2	4	50	245	196
3	5	100	250	151
4	6	150	300	151
5	7	100	260	161
6	8	125	275	151
7	9	50	225	176
8	10	100	290	191
9	11	100	255	156
10	14	100	220	121
			Total All Frame	1630

TABLE VI. EXPORTED FRAME FOR SET 2 OF PLAYER B

No	Attempt	Start Frame	End Frame	Total Frame
1	1	175	370	196
2	3	100	275	176
3	4	75	240	166
4	5	75	240	166
5	8	75	225	151
6	11	50	220	171
7	12	75	220	146
8	17	50	225	176
9	19	75	225	151
10	21	75	260	186
			Total All Frame	1685

TABLE VII. MOTION CAPTURE DATA EXPORTED FROM AXIS STUDIO FOR SET 1 OF PLAYER A

No of Row & Column	1	2	3	4	5	6	…	1238	1239	1240
1	Frame-No	Hips-Sensor-Lost	Hips-Sensor-Quat-x	Hips-Sensor-Quat-y	Hips-Sensor-Quat-z	Hips-Sensor-Quat-w	…	LeftHandPinky3-Bone-Quat-y	LeftHandPinky3-Bone-Quat-z	LeftHandPinky3-Bone-Quat-w
2	0	0	-0.66386	0.060831	0.743855	-0.0476	…	-0.103878	-0.638573	0.708215
3	1	0	-0.66423	0.06112	0.743497	-0.04771	…	-0.104262	-0.639145	0.707438
4	2	0	-0.66442	0.061317	0.743306	-0.04773	…	-0.104549	-0.639609	0.706676
5	3	0	-0.66486	0.061761	0.742886	-0.04769	…	-0.104768	-0.640055	0.705884
6	4	0	-0.66546	0.062018	0.742323	-0.04769	…	-0.104859	-0.640398	0.705245
…	…	…	…	…	…	…	…	…	…	…
571	569	0	0.994769	-0.0684923	0.0749661	0.0111035	…	0.692693	0.290682	-0.136922
572	570	0	0.994301	-0.0773182	0.0728729	0.00877947	…	-0.705678	-0.271298	0.127928
573	571	0	0.993919	-0.0832093	0.0717724	0.00705975	…	-0.709525	-0.249077	0.151382
574	572	0	0.993805	-0.0851083	0.0712113	0.00608253	…	-0.712126	-0.225642	0.17479
575	573	0	0.993707	-0.0880647	0.0691181	0.00356811	…	-0.713804	-0.199356	0.199772

B. Development of Penalty Kick Motion Templates

MTs were developed by using the MoCap data that was previously collected and exported. However, the exported MoCap data cannot be used directly on the GDL system because of the different file formats. MoCap data needs to be converted to SKL file format to make it compatible with the system.

1) Processed motion capture data of penalty kick: Below is the SKL dataset of the penalty kick after being converted from the data in CSV format. In every SKL dataset, all the MoCap data of 10 successful penalty kicks are being compiled together.

- SKL dataset for Set 1 of Player A

```
0 . . . 0.011392 -0.175648004 3.103630066 0.029925413 0.082994491 3.13511157 -0.004251763 0.39565444 3.187204838 -0.008846544 0.480144501
3.184156895 -0.174901873 0.328984499 3.119466066 -0.179005891 0.067114502 3.02061224 -0.220634878 -0.189332515 3.026201487 -0.220634878 -
0.189332515 3.026201487 0.158097118 0.356564403 3.287026882 0.226442128 0.088924438 3.241686821 0.222264111 -0.17099151 3.24672389
0.222264111 -0.17099151 3.24672389 -0.083260685 -0.163432509 3.05785656 0.005445883 -0.605948567 3.063213825 0.081576012 -1.023455501
3.05425787 0.081576012 -1.023455501 3.05425787 0.106020115 -0.188788503 3.148964167 0.031613614 -0.607881546 3.295220852 0.027938612 -
1.02256453 3.344147921 0.027938612 -1.02256453 3.344147921 0.024105117 0.208924428 3.15600276 -0.240588874 -0.265725523 3.06886673 -
0.24939689 -0.332835525 3.073159933 0.197326124 -0.254686505 3.268237829 0.19483912 -0.321813494 3.258237839 2 2 2 2 2 2 2 2 2 1 1 1 2 2 2 2 2 2 2 2
2 2 2 2 2 2 636359000000000000 17/7/2017 10:00:00 AM
…
1719 . . . -0.0247873 -0.138750004 7.784103106 -0.012646187 0.121554491 7.77353487 -0.031728083 0.43756444 7.810164738 -0.034540984 0.517594501
7.785364895 -0.209031873 0.363764499 7.852794726 -0.191308891 0.097944502 7.93048494 -0.170299878 -0.137594515 8.028624887 -0.170299878 -
0.137594515 8.028624887 0.161401118 0.403104403 7.788714882 0.371578128 0.227194438 7.733204821 0.572252111 0.06415449 7.70704489
0.572252111 0.06415449 7.70704489 -0.133358885 -0.130436509 7.79654476 -0.104606887 -0.520544567 8.020144725 -0.135205888 -0.885232501
7.81323487 -0.135205888 -0.885232501 7.81323487 0.082563115 -0.147284503 7.770594867 0.097639514 -0.595227546 7.816374852 0.079273312 -
1.01564453 7.825584921 0.079273312 -1.01564453 7.825584921 -0.014750983 0.248844428 7.78306476 -0.116759874 -0.190191523 8.07927493 -
0.11212189 -0.246032525 8.120774833 0.622295124 -0.008545505 7.726844829 0.64822312 -0.069485494 7.708924839 2 2 2 2 2 2 2 2 2 1 1 1 2 2 2 2 2 2 2 2
2 2 2 2 2 2 636359000000000000 17/7/2017 10:00:00 AM
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- SKL dataset for Set 2 of Player A

```
0 . . . 0.013763 -0.1681080039999999 3.074301206 0.014601813 0.0873744909999998 3.1275771700000004 -0.020500183 0.3968344399999999 3.195943338
-0.022181184 0.481464501 3.194921695 -0.180425873 0.3411544989999999 3.095547526 -0.186042891 0.0782345019999999 2.99931294 -0.237167878 -
0.1748955149999999 3.029155087 -0.237167878 -0.1748955149999999 3.029155087 0.132832118 0.3455844029999999 3.305704882 0.209020128
0.0779944379999999 3.274242821 0.208084111 -0.1819365099999998 3.28010689 0.208084111 -0.1819365099999998 3.28010689 -0.078033985 -
0.1550835090000001 3.01056476 -0.043581087 -0.604791567 3.0095247250000003 0.029527012 -1.020623501 3.01714297 0.029527012 -1.020623501
3.01714297 0.105267115 -0.181279503 3.138093367 0.034679214 -0.604933546 3.272835852 0.042187012 -1.02304953 3.285170921 0.042187012 -
1.02304953 3.285170921 0.005426517 0.2115244280000001 3.15567046 -0.2583508739999999 -0.2448305229999998 3.08080543 -0.27458389 -
0.3093285250000001 3.093658833 0.165849124 -0.2591585049999999 3.301762829 0.17497412 -0.3258364939999999 3.322713839 2 2 2 2 2 2 2 2 2 1 1 1 2
2 2 2 2 2 2 2 2 2 2 2 2 2 636359000000000000 17/7/2017 10:00:00 AM
…
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1909 . . . -1.0643524 -0.1575730039999999 7.401853106000001 -1.0550628869999998 0.102214491 7.405704870000001 -1.066172883 0.41752444 7.449784738 -1.0599828839999998 0.4990745010000001 7.430024895 -1.2477228729999998 0.336244499 7.456064725999999 -1.215422891 0.0958545019999999 7.59361494 -1.2132728780000002 -0.1397625149999999 7.703504886999999 -1.2132728780000002 -0.1397625149999999 7.703504886999999 -0.874674882 0.3831744029999999 7.449614882 -0.651179872 0.230364438 7.379054821 -0.439123889 0.0899744900000001 7.326264890000001 -0.439123889 0.0899744900000001 7.326264890000001 -1.174172885 -0.152544509 7.394854759999999 -1.143372887 -0.595790567 7.469974725 -1.075462888 -0.912929501 7.2024048700000005 -1.075462888 -0.912929501 7.2024048700000005 -0.955726885 -0.159950503 7.407904866999999 -0.954936886 -0.6052665460000001 7.471714852 -0.974691888 -1.02006553 7.427524921 -0.974691888 -1.02006553 7.427524921 -1.0559428830000002 0.228794428 7.419504760000001 -1.185022874 -0.2073035229999998 7.75472493 -1.18411289 -0.2706315250000001 7.778724833 -0.391420876 0.0135444950000001 7.329854829 -0.37604388 -0.0489154939999998 7.307184839 2 2 2 2 2 2 2 2 2 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 636359000000000000 17/7/2017 10:00:00 AM

- SKL dataset for Set 1 of Player B

0 . . . -0.0649136 -0.1567190039999999 3.101111506 -0.029988387 0.0970044909999998 3.1488753700000003 0.050551317 0.3812544399999999 3.268223738 0.070112116 0.4586345010000001 3.297319895 -0.107747873 0.318284499 3.369318726 -0.199289891 0.0590545019999999 3.31615894 -0.128856878 -0.1911825149999999 3.311715887 -0.128856878 -0.1911825149999999 3.311715887 0.190355118 0.3235544029999999 3.136182182 0.183738128 0.048684438 3.083223321 0.192443111 -0.2075155099999999 3.1266200900000003 0.192443111 -0.2075155099999999 3.1266200900000003 -0.142655885 -0.158853509 3.17506166 -0.097801687 -0.606720567 3.1956028250000004 -0.111103888 -1.023099501 3.13602017 -0.111103888 -1.023099501 3.13602017 0.014240615 -0.154939503 3.026615467 0.060600614 -0.603128546 3.016711752 0.063656012 -1.02392353 3.007035921 0.063656012 -1.02392353 3.007035921 -0.0009139829999999 0.2141344280000001 3.19041426 -0.070122674 -0.2540865229999999 3.33319993 -0.0471019899999999 -0.3164255250000001 3.347265833 0.196857124 -0.286040505 3.169649529 0.18874912 -0.353015494 3.175991439 2 2 2 2 2 2 2 2 2 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 636359000000000000 17/7/2017 10:00:00 AM
…
1629 . . . 1.8142376 -0.1451820039999999 4.836963106 1.836957113 0.111364491 4.787564870000001 1.865287117 0.42505444 4.836104738 1.877987116 0.508744501 4.836014895 1.6746971270000002 0.4020144989999998 4.814234726 1.684747109 0.1728745019999999 4.967134939999999 1.819677122 0.0136744850000001 5.100654887 1.819677122 0.0136744850000001 5.100654887 2.043147118 0.346714403 4.867254882 2.082857128 0.070444438 4.884944821 2.119987111 -0.1691535099999999 4.95176489 2.119987111 -0.1691535099999999 4.95176489 1.711507115 -0.1499015090000001 4.79381476 1.556567113 -0.555500567 4.914044725 1.873457112 -0.7979855010000001 4.7850348700000005 1.873457112 -0.7979855010000001 4.7850348700000005 1.913047115 -0.1464935029999999 4.880124867 1.850617114 -0.561370546 5.041544852 1.760157112 -0.97761953 5.043964921 1.760157112 -0.97761953 5.043964921 1.845527117 0.239394428 4.79494476 1.894717126 0.002714477 5.14595493 1.92749711 -0.024285525 5.203214833 2.169167124 -0.2272745049999999 4.995464828999999 2.20145712 -0.286040494 5.008994839 2 2 2 2 2 2 2 2 2 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 636359000000000000 17/7/2017 10:00:00 AM

- SKL dataset for Set 2 of Player B

0 . . . -0.001223956 -0.157215004 3.165142306 0.0083367529999999 0.1037344909999999 3.16072247 0.011331017 0.4226044399999999 3.168772238 0.016290316 0.507384501 3.171967195 -0.140548873 0.352584499 3.280283726 -0.149996891 0.0741545019999998 3.30810494 -0.113732878 -0.1796845149999999 3.351061887 -0.113732878 -0.1796845149999999 3.351061887 0.169559118 0.3642244029999999 3.061623982 0.1911011279999999 0.085134438 3.0562530210000003 0.205413111 -0.1738305099999999 3.03855539 0.205413111 -0.1738305099999999 3.03855539 -0.085500485 -0.1532805090000001 3.23331676 -0.055664087 -0.602716567 3.2530117250000004 -0.074189088 -1.023548501 3.23112987 -0.074189088 -1.023548501 3.23112987 0.083658815 -0.161714503 3.098595867 0.024293314 -0.607946546 3.081515852 -0.0296507879999999 -1.02330553 3.053902121 -0.0296507879999999 -1.02330553 3.053902121 0.011040717 0.231334428 3.16187976 -0.067737374 -0.2430835229999999 3.39308693 -0.0540512899999999 -0.304902525 3.417336833 0.225657124 -0.2541675049999999 3.073489729 0.22902312 -0.3219594939999999 3.072146239 2 2 2 2 2 2 2 2 2 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 636359000000000000 17/7/2017 10:00:00 AM
…
1684 . . . 1.3991676 -0.1538720039999999 7.1193431060000005 1.405807113 0.1063744909999999 7.10543487 1.388857117 0.4243844399999998 7.118974738 1.391127116 0.5092445010000002 7.118054895 1.225987127 0.3517944989999999 7.024744726 1.169607109 0.0907645019999998 6.94187494 1.158397122 -0.0473155149999999 7.161184886999999 1.158397122 -0.0473155149999999 7.161184886999999 1.557307118 0.362234403 7.210034881999999 1.583407128 0.0926744379999999 7.274664821 1.566867111 -0.1379175099999999 7.37564489 1.566867111 -0.1379175099999999 7.37564489 1.307777115 -0.153421509 7.05711476 1.246857113 -0.595804567 7.105454725 1.281647112 -1.0104025010000002 7.15024487 1.281647112 -1.0104025010000002 7.15024487 1.491327115 -0.153861503 7.1829248670000005 1.482437114 -0.603491546 7.212684852 1.446237112 -1.02245353 7.1953849210000005 1.446237112 -1.02245353 7.1953849210000005 1.4013871169999998 0.2337944279999999 7.10684476 1.119577126 -0.0460055229999998 7.23924493 1.06988711 -0.057195525 7.286164832999999 1.550077124 -0.1824905049999999 7.450894829 1.55440712 -0.2366104939999999 7.492574838999999 2 2 2 2 2 2 2 2 2 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 636359000000000000 17/7/2017 10:00:00 AM

2) Penalty kick motion templates using R-GDL: To generate MTs from SKL dataset of every penalty kick set, several processes were executed using R-GDL method that is integrated in the GDL system. The full features of GDL as shown below are one of the requirements. Then the SKL dataset will be selected before computing to produce the MTs. In the R-GDL setting, Cluster Count where set at 5, where it will produce 5 rules.

FEATURE angle(ShoulderRight.xyz[0] - ElbowRight.xyz[0], WristRight.xyz[0] - ElbowRight.xyz[0]) AS RightElbow
FEATURE angle(ShoulderLeft.xyz[0] - ElbowLeft.xyz[0], WristLeft.xyz[0] - ElbowLeft.xyz[0]) AS LeftElbow
FEATURE angle(ShoulderCenter.xyz[0] - ShoulderRight.xyz[0], ElbowRight.xyz[0] - ShoulderRight.xyz[0]) AS RightShoulder
FEATURE angle(ShoulderCenter.xyz[0] - ShoulderLeft.xyz[0], ElbowLeft.xyz[0] - ShoulderLeft.xyz[0]) AS LeftShoulder
FEATURE angle(HipRight.xyz[0] - KneeRight.xyz[0], AnkleRight.xyz[0] - KneeRight.xyz[0]) AS RightKnee
FEATURE angle(HipLeft.xyz[0] - KneeLeft.xyz[0], AnkleLeft.xyz[0] - KneeLeft.xyz[0]) AS LeftKnee
FEATURE angle(ShoulderRight.xyz[0] - ElbowRight.xyz[0], ShoulderLeft.xyz[0] - ElbowLeft.xyz[0]) AS BetweenWrists
FEATURE angle(KneeLeft.xyz[0] - HipLeft.xyz[0], KneeRight.xyz[0] - HipRight.xyz[0]) AS BetweenLeg

3) Output: The system will produce the MTs that consist of numerous lines of unique values assigned to specific features. Table VIII shows difference in values in "R-GDLv1.0 FEATURES" section that generated by the system for Set 1 of Player A. These values were generated through the system's automated calculations process for all set of both players.

TABLE VIII. INITIAL RULES GENERATED IN MOTION TEMPLATES

Set 1 of Player A

--R-GDLv1.0 FEATURES--
FEATURE 20 AS rightelbow_EPS
FEATURE 20 AS leftelbow_EPS
FEATURE 20 AS rightshoulder_EPS
FEATURE 20 AS leftshoulder_EPS
FEATURE 20 AS betweenwrists_EPS
FEATURE 20 AS rightknee_EPS
FEATURE 20 AS leftknee_EPS
FEATURE 20 AS righthip_EPS
FEATURE 20 AS lefthip_EPS
FEATURE 20 AS betweenankles_EPS

FEATURE 106.336998582893 AS rightelbow_MEAN_0
FEATURE 13.1139202643628 AS rightelbow_DEV_0
FEATURE 111.931768946927 AS leftelbow_MEAN_0
FEATURE 16.279260838591 AS leftelbow_DEV_0
FEATURE 77.8211317564257 AS rightshoulder_MEAN_0
FEATURE 9.03672871287418 AS rightshoulder_DEV_0
FEATURE 71.1484875027894 AS leftshoulder_MEAN_0
FEATURE 10.9077642787255 AS leftshoulder_DEV_0
FEATURE 50.9186450838485 AS betweenwrists_MEAN_0
FEATURE 11.0803751404462 AS betweenwrists_DEV_0
FEATURE 108.874683013516 AS rightknee_MEAN_0
FEATURE 11.93130321173 AS rightknee_DEV_0
FEATURE 149.156948658987 AS leftknee_MEAN_0
FEATURE 10.2888168221331 AS leftknee_DEV_0
FEATURE 91.9348099276002 AS righthip_MEAN_0
FEATURE 2.79016496193393 AS righthip_DEV_0
FEATURE 77.6750024329378 AS lefthip_MEAN_0
FEATURE 5.24739215760645 AS lefthip_DEV_0
FEATURE 33.6417169734493 AS betweenankles_MEAN_0
FEATURE 18.9552818556593 AS betweenankles_DEV_0

FEATURE 161.67405717709 AS rightelbow_MEAN_1
FEATURE 13.7688830141838 AS rightelbow_DEV_1
FEATURE 169.998385749575 AS leftelbow_MEAN_1
FEATURE 6.07979421748773 AS leftelbow_DEV_1
FEATURE 84.137402228041 AS rightshoulder_MEAN_1
FEATURE 18.0521107649073 AS rightshoulder_DEV_1
FEATURE 80.5176575460657 AS leftshoulder_MEAN_1
FEATURE 15.866453040511 AS leftshoulder_DEV_1
FEATURE 53.4046031280089 AS betweenwrists_MEAN_1
FEATURE 18.831577914113 AS betweenwrists_DEV_1
FEATURE 139.612954239907 AS rightknee_MEAN_1
FEATURE 25.1354602347783 AS rightknee_DEV_1
FEATURE 141.993387022331 AS leftknee_MEAN_1
FEATURE 22.9164800357978 AS leftknee_DEV_1
FEATURE 90.4169571730294 AS righthip_MEAN_1
FEATURE 9.61737343744283 AS righthip_DEV_1
FEATURE 88.0951775605438 AS lefthip_MEAN_1
FEATURE 6.31896812644332 AS lefthip_DEV_1
FEATURE 22.0317664695786 AS betweenankles_MEAN_1
FEATURE 15.7481529487839 AS betweenankles_DEV_1

FEATURE 166.123780140398 AS rightelbow_MEAN_2
FEATURE 13.4432332288253 AS rightelbow_DEV_2
FEATURE 155.866437283878 AS leftelbow_MEAN_2
FEATURE 16.6954833053196 AS leftelbow_DEV_2
FEATURE 128.68619510958 AS rightshoulder_MEAN_2
FEATURE 10.548562473852 AS rightshoulder_DEV_2
FEATURE 102.521435570819 AS leftshoulder_MEAN_2
FEATURE 13.934667379349 AS leftshoulder_DEV_2
FEATURE 126.936037220103 AS betweenwrists_MEAN_2
FEATURE 21.4211098913996 AS betweenwrists_DEV_2
FEATURE 132.644420694928 AS rightknee_MEAN_2
FEATURE 21.3821506755227 AS rightknee_DEV_2
FEATURE 140.599346407743 AS leftknee_MEAN_2
FEATURE 24.3291550568978 AS leftknee_DEV_2
FEATURE 90.6011611839223 AS righthip_MEAN_2
FEATURE 6.44335692150773 AS righthip_DEV_2
FEATURE 85.7785456429334 AS lefthip_MEAN_2
FEATURE 9.13983363102599 AS lefthip_DEV_2
FEATURE 52.0629724047714 AS betweenankles_MEAN_2
FEATURE 30.9126958280828 AS betweenankles_DEV_2

FEATURE 111.179638306027 AS rightelbow_MEAN_3
FEATURE 9.06077385959137 AS rightelbow_DEV_3
FEATURE 120.524393526105 AS leftelbow_MEAN_3
FEATURE 15.5168770181906 AS leftelbow_DEV_3
FEATURE 83.6466326006824 AS rightshoulder_MEAN_3
FEATURE 14.2638062084096 AS rightshoulder_DEV_3
FEATURE 68.5902289970723 AS leftshoulder_MEAN_3
FEATURE 4.19419783784462 AS leftshoulder_DEV_3
FEATURE 51.1352497012421 AS betweenwrists_MEAN_3
FEATURE 18.6085030409822 AS betweenwrists_DEV_3
FEATURE 142.376728219369 AS rightknee_MEAN_3
FEATURE 12.0049398269651 AS rightknee_DEV_3
FEATURE 117.157737007072 AS leftknee_MEAN_3
FEATURE 13.9301174825556 AS leftknee_DEV_3
FEATURE 92.1289230576721 AS righthip_MEAN_3
FEATURE 2.67608452234092 AS righthip_DEV_3
FEATURE 80.8848690527167 AS lefthip_MEAN_3
FEATURE 4.11512330600877 AS lefthip_DEV_3
FEATURE 29.1621744428287 AS betweenankles_MEAN_3
FEATURE 16.9470274704543 AS betweenankles_DEV_3

FEATURE 123.460501654771 AS rightelbow_MEAN_4
FEATURE 14.8788477507988 AS rightelbow_DEV_4
FEATURE 120.969957486522 AS leftelbow_MEAN_4
FEATURE 15.0184217770757 AS leftelbow_DEV_4
FEATURE 67.5309455407309 AS rightshoulder_MEAN_4
FEATURE 4.36045515243756 AS rightshoulder_DEV_4
FEATURE 66.9143213900875 AS leftshoulder_MEAN_4
FEATURE 2.72147347493239 AS leftshoulder_DEV_4
FEATURE 30.9797835821773 AS betweenwrists_MEAN_4
FEATURE 6.81184455360391 AS betweenwrists_DEV_4
FEATURE 161.867589275961 AS rightknee_MEAN_4
FEATURE 13.4293373845736 AS rightknee_DEV_4
FEATURE 160.466590079784 AS leftknee_MEAN_4
FEATURE 14.3975811522919 AS leftknee_DEV_4
FEATURE 89.2154152157987 AS righthip_MEAN_4
FEATURE 4.29620681095577 AS righthip_DEV_4
FEATURE 81.4919202674557 AS lefthip_MEAN_4
FEATURE 5.91108811290804 AS lefthip_DEV_4
FEATURE 26.0144775487115 AS betweenankles_MEAN_4
FEATURE 9.03763043268459 AS betweenankles_DEV_4

"R-GDLv1.0 RULES" is the next section in MTs after "R-GDLv1.0 FEATURES". Every MTs basically have the same format in determining different rules. The system defined the first rules as Rules0. As earlier, the Cluster Count was set to 5, the rules generated are Rules0, Rules1, Rules2, Rules3 and Rules4.

-- R-GDLv1.0 RULES--
RULE abs(rightelbow -rightelbow_MEAN_0) <= rightelbow_DEV_0 + rightelbow_EPS & abs(leftelbow -leftelbow_MEAN_0) <= leftelbow_DEV_0 + leftelbow_EPS & abs(rightshoulder -rightshoulder_MEAN_0) <= rightshoulder_DEV_0 + rightshoulder_EPS & abs(leftshoulder -leftshoulder_MEAN_0) <= leftshoulder_DEV_0 + leftshoulder_EPS & abs(betweenwrists -betweenwrists_MEAN_0) <= betweenwrists_DEV_0 + betweenwrists_EPS & abs(rightknee -rightknee_MEAN_0) <= rightknee_DEV_0 + rightknee_EPS & abs(leftknee -leftknee_MEAN_0) <= leftknee_DEV_0 + leftknee_EPS & abs(righthip -righthip_MEAN_0) <= righthip_DEV_0 + righthip_EPS & abs(lefthip -lefthip_MEAN_0) <= lefthip_DEV_0 + lefthip_EPS & abs(betweenankles -betweenankles_MEAN_0) <= betweenankles_DEV_0 + betweenankles_EPS THEN Rules0
RULE abs(rightelbow -rightelbow_MEAN_1) <= rightelbow_DEV_1 + rightelbow_EPS & abs(leftelbow -leftelbow_MEAN_1) <=

leftelbow_DEV_1 + leftelbow_EPS & abs(rightshoulder - rightshoulder_MEAN_1) <= rightshoulder_DEV_1 + rightshoulder_EPS & abs(leftshoulder -leftshoulder_MEAN_1) <= leftshoulder_DEV_1 + leftshoulder_EPS & abs(betweenwrists -betweenwrists_MEAN_1) <= betweenwrists_DEV_1 + betweenwrists_EPS & abs(rightknee - rightknee_MEAN_1) <= rightknee_DEV_1 + rightknee_EPS & abs(leftknee -leftknee_MEAN_1) <= leftknee_DEV_1 + leftknee_EPS & abs(righthip -righthip_MEAN_1) <= righthip_DEV_1 + righthip_EPS & abs(lefthip -lefthip_MEAN_1) <= lefthip_DEV_1 + lefthip_EPS & abs(betweenankles -betweenankles_MEAN_1) <= betweenankles_DEV_1 + betweenankles_EPS THEN Rules1
RULE abs(rightelbow -rightelbow_MEAN_2) <= rightelbow_DEV_2 + rightelbow_EPS & abs(leftelbow -leftelbow_MEAN_2) <= leftelbow_DEV_2 + leftelbow_EPS & abs(rightshoulder - rightshoulder_MEAN_2) <= rightshoulder_DEV_2 + rightshoulder_EPS & abs(leftshoulder -leftshoulder_MEAN_2) <= leftshoulder_DEV_2 + leftshoulder_EPS & abs(betweenwrists -betweenwrists_MEAN_2) <= betweenwrists_DEV_2 + betweenwrists_EPS & abs(rightknee - rightknee_MEAN_2) <= rightknee_DEV_2 + rightknee_EPS & abs(leftknee -leftknee_MEAN_2) <= leftknee_DEV_2 + leftknee_EPS & abs(righthip -righthip_MEAN_2) <= righthip_DEV_2 + righthip_EPS & abs(lefthip -lefthip_MEAN_2) <= lefthip_DEV_2 + lefthip_EPS & abs(betweenankles -betweenankles_MEAN_2) <= betweenankles_DEV_2 + betweenankles_EPS THEN Rules2
RULE abs(rightelbow -rightelbow_MEAN_3) <= rightelbow_DEV_3 + rightelbow_EPS & abs(leftelbow -leftelbow_MEAN_3) <= leftelbow_DEV_3 + leftelbow_EPS & abs(rightshoulder - rightshoulder_MEAN_3) <= rightshoulder_DEV_3 + rightshoulder_EPS & abs(leftshoulder -leftshoulder_MEAN_3) <= leftshoulder_DEV_3 + leftshoulder_EPS & abs(betweenwrists -betweenwrists_MEAN_3) <= betweenwrists_DEV_3 + betweenwrists_EPS & abs(rightknee - rightknee_MEAN_3) <= rightknee_DEV_3 + rightknee_EPS & abs(leftknee -leftknee_MEAN_3) <= leftknee_DEV_3 + leftknee_EPS & abs(righthip -righthip_MEAN_3) <= righthip_DEV_3 + righthip_EPS & abs(lefthip -lefthip_MEAN_3) <= lefthip_DEV_3 + lefthip_EPS & abs(betweenankles -betweenankles_MEAN_3) <= betweenankles_DEV_3 + betweenankles_EPS THEN Rules3
RULE abs(rightelbow -rightelbow_MEAN_4) <= rightelbow_DEV_4 + rightelbow_EPS & abs(leftelbow -leftelbow_MEAN_4) <= leftelbow_DEV_4 + leftelbow_EPS & abs(rightshoulder - rightshoulder_MEAN_4) <= rightshoulder_DEV_4 + rightshoulder_EPS & abs(leftshoulder -leftshoulder_MEAN_4) <= leftshoulder_DEV_4 + leftshoulder_EPS & abs(betweenwrists -betweenwrists_MEAN_4) <= betweenwrists_DEV_4 + betweenwrists_EPS & abs(rightknee - rightknee_MEAN_4) <= rightknee_DEV_4 + rightknee_EPS & abs(leftknee -leftknee_MEAN_4) <= leftknee_DEV_4 + leftknee_EPS & abs(righthip -righthip_MEAN_4) <= righthip_DEV_4 + righthip_EPS & abs(lefthip -lefthip_MEAN_4) <= lefthip_DEV_4 + lefthip_EPS & abs(betweenankles -betweenankles_MEAN_4) <= betweenankles_DEV_4 + betweenankles_EPS THEN Rules4

However, through pilot testing and observations on the result using the MTs over SKL dataset, the pattern of recorded rules in each result was consistent but the arrangement in term of rule name was incorrect. In MTs for Set 1 of Player A (A-S1-MTs), the correct rules arrangement is Rules4, Rules1, Rules3, Rules2 and Rules0. Table IX shows the new arrangements of rules, and it was renamed as "Step" to differentiate between old and new rules name.

TABLE IX. RESULT OF RULES REVISION FOR ALL MOTION TEMPLATES

Rules	A-S1-MTs	A-S2-MTs	B-S1-MTs	B-S2-MTs
Rules0	Step_5	Step_5	Step_5	Step_2
Rules1	Step_2	Step_1	Step_2	Step_1
Rules2	Step_4	Step_4	Step_1	Step_5
Rules3	Step_3	Step_2	Step_3	Step_3
Rules4	Step_1	Step_3	Step_4	Step_4

IV. ANALYSIS AND RESULTS

This section presents and discusses the evaluation result from SRA and MTs of every penalty kick set.

A. Score Rubric Assessment Result

Table X, XI, XII, XIII show the scores given during the experiment of each parameter that were calculated. The score from all successful attempts for every set were total up as the overall score and it will act as the passing mark.

Table XIV presents the overall score and its equivalent percentage for Player A and Player B across both sets. The data in percentage obtained will be used as the benchmark of passing mark to validate the result of EF.

In terms of overall ranking, Player B in Set 2 achieved the highest score and percentage, with a percentage of 83.50% and a score of 334. Besides, the lowest percentage and score was achieved by Player A \ in Set 2 with 73.75% in percentage and a score of 295.

TABLE X. SRA RESULT FOR SET 1 OF PLAYER A

Attempt	Power	Leg Height	Standing	Agility	Total
1	7	7	8	8	30
3	8	8	8	9	33
4	9	9	9	9	36
5	9	9	8	9	35
6	8	8	9	8	33
8	8	8	8	8	32
9	10	10	9	9	38
10	8	8	7	8	31
11	7	7	7	7	28
12	8	9	8	8	33
Total Score					329
Min	7	7	7	7	28
Max	10	10	9	9	38
Average	8.2	8.3	8.1	8.3	32.9

TABLE XI. SRA RESULT FOR SET 2 OF PLAYER A

Attempt	Power	Leg Height	Standing	Agility	Total
1	8	7	7	8	30
2	9	8	8	8	33
3	7	7	7	7	28
5	7	7	7	7	28
6	7	7	8	8	30
7	8	8	7	7	30
8	6	7	7	6	26
10	7	8	7	7	29
11	9	8	8	8	33
13	7	7	7	7	28
Total Score					295
Min	6	7	7	6	26
Max	9	8	8	8	33
Average	7.5	7.4	7.3	7.3	29.5

TABLE XII. SRA RESULT FOR SET 1 OF PLAYER B

Attempt	Power	Leg Height	Standing	Agility	Score
1	8	8	7	8	31
4	7	7	7	8	29
5	8	8	8	8	32
6	9	8	8	8	33
7	8	8	7	7	30
8	8	7	8	8	31
9	8	9	8	8	33
10	8	8	9	8	33
11	8	7	7	8	30
14	8	8	8	8	32
Total Score					314
Min	7	7	7	7	28
Max	9	9	9	8	35
Average	8	7.8	7.7	7.9	31.4

TABLE XIII. SRA RESULT FOR SET 2 OF PLAYER B

Attempt	Power	Leg Height	Standing	Agility	Score
1	7	7	7	7	28
3	9	9	8	9	35
4	10	10	9	9	38
5	10	10	9	8	37
8	8	8	8	8	32
11	9	9	8	9	35
12	8	8	9	9	34
17	8	8	8	8	32
19	8	8	7	7	30
21	8	8	9	8	33
Total Score					334
Min	7	7	7	7	28
Max	10	10	9	9	38
Average	8.5	8.5	8.2	8.2	33.4

When comparing both players, Player A led in Set 1 with an overall score of 329 (82.25%), outperforming Player B, who scored 314 (78.50%). However, Player B surpassed Player A in Set 2 by a significant score gain of 334 (83.50%) compared to 295 (73.75%).

TABLE XIV. SUMMARY OF SCORE RUBRIC ASSESSMENT RESULT

Player	Set	Overall Score	Percentage
A	1	329	82.25%
	2	295	73.75%
B	1	314	78.50%
	2	334	83.50%

B. Step Count Result

Table XV, XVI, XVII, XVIII present the result the step count where the step was automatically detected and recorded from SKL dataset using the MTs through GDL system. With the result, the Step Range was determined using Min (MinSR) and Max (MaxSR) value of every set.

TABLE XV. STEP COUNT FOR SET 1 OF PLAYER A

Attempt	Step_1	Step_2	Step_3	Step_4	Step_5	Total Step
1	28	79	36	33	50	226
3	52	55	38	23	33	201
4	24	47	32	20	28	151
5	52	43	26	17	18	156
6	38	52	24	35	12	161
8	27	49	41	31	28	176
9	36	46	29	19	41	171
10	19	54	38	19	21	151
11	16	52	36	19	33	156
12	12	57	37	22	43	171
Total	304	534	337	238	307	1720
Min	12	43	24	17	12	108
Max	52	79	41	35	50	257
Average	30.4	53.4	33.7	23.8	30.7	172

TABLE XVI. STEP COUNT FOR SET 1 OF PLAYER A

Attempt	Step_1	Step_2	Step_3	Step_4	Step_5	Total Step
1	59	44	20	52	26	201
2	33	65	19	36	48	201
3	33	49	21	38	60	201
5	53	54	21	43	55	226
6	34	44	16	40	17	151
7	23	45	18	41	49	176
8	47	44	22	58	30	201
10	55	40	21	36	49	201
11	45	52	15	23	41	176
13	22	39	31	45	39	176
Total	404	476	204	412	414	1910
Min	22	39	15	23	17	116
Max	59	65	31	58	60	273
Average	40.4	47.6	20.4	41.2	41.4	191

TABLE XVII. STEP COUNT FOR SET 1 OF PLAYER A

Attempt	Step_1	Step_2	Step_3	Step_4	Step_5	Total Step
1	62	51	12	12	39	176
4	40	73	37	16	30	196
5	32	34	36	17	32	151
6	32	61	24	5	29	151
7	38	38	20	37	28	161
8	46	46	8	19	32	151
9	60	43	10	35	28	176
10	49	43	27	42	30	191
11	26	58	33	9	30	156
14	28	42	15	10	26	121
Total	413	489	222	202	304	1630
Min	26	34	8	5	26	99
Max	62	73	37	42	39	253
Average	41.3	48.9	22.2	20.2	30.4	163

TABLE XVIII. STEP COUNT FOR SET 1 OF PLAYER A

Attempt	Step_1	Step_2	Step_3	Step_4	Step_5	Total Step
1	70	51	44	13	18	196
3	62	46	38	12	18	176
4	47	54	35	11	19	166
5	48	59	36	11	12	166
8	33	41	42	11	24	151
11	36	55	48	14	18	171
12	30	62	28	11	15	146
17	59	70	16	13	18	176
19	37	58	29	8	19	151
21	46	88	19	18	15	186
Total	468	584	335	122	176	1685
Min	30	41	16	8	12	107
Max	70	88	48	18	24	248
Average	46.8	58.4	33.5	12.2	17.6	168.5

- Motion Templates Set 1 of Player A

C. Extrinsic Feedback Result

Extrinsic Feedback (EF) results were obtained by comparing the Step Range of every MTs. For example, Step Range from Set 1 of Player A will be used on cross validation with the value of every step count of other set except its own set which is Set 1 of Player A and the result whether "TRUE" or "FALSE". If the step count in *step_n* (*n= 1-5*) are in the Step Range of *n*, the result will produce "TRUE" and vice versa for "FALSE" result. Tables XIX, XX, and XXI present the EF results for MTs Set 1 of Player A. Subsequently, Tables XXII, XXIII, and XXIV display the EF results for MTs Set 2 of Player A. Meanwhile, Tables XXV, XXVI, and XXVII show the EF results for MTs Set 1 of Player B. Lastly, Tables XXVIII, XXIX, and XXX contain the EF results for MTs Set 2 of Player B.

TABLE XIX. EXTRINSIC FEEDBACK FOR SET 2 OF PLAYER A

Step	Attempt 1	Attempt 2	Attempt 3	Attempt 5	Attempt 6	Attempt 7	Attempt 8	Attempt 10	Attempt 11	Attempt 13
step_1	FALSE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE
step_2	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	FALSE
step_3	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE
step_4	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE
step_5	TRUE	TRUE	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
Result	40%	60%	40%	20%	60%	60%	60%	20%	80%	60%

TABLE XX. EXTRINSIC FEEDBACK FOR SET 1 OF PLAYER B

Step	Attempt 1	Attempt 4	Attempt 5	Attempt 6	Attempt 7	Attempt 8	Attempt 9	Attempt 10	Attempt 11	Attempt 14
Step_1	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE
step_2	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	FALSE
step_3	FALSE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	TRUE	TRUE	FALSE
step_4	FALSE	FALSE	TRUE	FALSE	FALSE	TRUE	TRUE	FALSE	FALSE	FALSE
step_5	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
Result	40%	80%	80%	80%	40%	80%	60%	80%	80%	40%

TABLE XXI. EXTRINSIC FEEDBACK FOR SET 2 OF PLAYER B

Step	Attempt 1	Attempt 3	Attempt 4	Attempt 5	Attempt 8	Attempt 11	Attempt 12	Attempt 17	Attempt 19	Attempt 21
step_1	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE
step_2	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	FALSE
step_3	FALSE	TRUE	TRUE	TRUE	FALSE	FALSE	TRUE	FALSE	TRUE	FALSE
step_4	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE
step_5	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
Result	40%	60%	80%	80%	40%	60%	80%	40%	80%	60%

- Motion Templates for Set 2 of Player A

TABLE XXII. EXTRINSIC FEEDBACK FOR SET 1 OF PLAYER A

Step	Attempt 1	Attempt 3	Attempt 4	Attempt 5	Attempt 6	Attempt 8	Attempt 9	Attempt 10	Attempt 11	Attempt 12
step_1	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE
step_2	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
step_3	FALSE	FALSE	FALSE	TRUE	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE
step_4	TRUE	TRUE	FALSE	FALSE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE
step_5	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE
Result	60%	80%	60%	80%	80%	80%	80%	40%	40%	40%

TABLE XXIII. EXTRINSIC FEEDBACK FOR SET 1 OF PLAYER B

Step	Attempt 1	Attempt 4	Attempt 5	Attempt 6	Attempt 7	Attempt 8	Attempt 9	Attempt 10	Attempt 11	Attempt 14
step_1	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE
step_2	TRUE	FALSE	FALSE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE
step_3	FALSE	FALSE	FALSE	TRUE	TRUE	FALSE	FALSE	TRUE	FALSE	TRUE
step_4	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	TRUE	TRUE	FALSE	FALSE
step_5	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
Result	40%	40%	40%	80%	80%	60%	60%	100%	60%	80%

TABLE XXIV. EXTRINSIC FEEDBACK FOR SET 2 OF PLAYER B

Step	Attempt 1	Attempt 3	Attempt 4	Attempt 5	Attempt 8	Attempt 11	Attempt 12	Attempt 17	Attempt 19	Attempt 21
step_1	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
step_2	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	FALSE
step_3	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE
step_4	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
step_5	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	FALSE	TRUE	TRUE	FALSE
Result	40%	40%	60%	40%	60%	60%	60%	60%	80%	40%

- Motion Templates for Set 1 of Player B

TABLE XXV. EXTRINSIC FEEDBACK FOR SET 1 OF PLAYER A

Step	Attempt 1	Attempt 3	Attempt 4	Attempt 5	Attempt 6	Attempt 8	Attempt 9	Attempt 10	Attempt 11	Attempt 12
step_1	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE
step_2	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
step_3	TRUE	FALSE	TRUE	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE	TRUE
step_4	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
step_5	FALSE	TRUE	TRUE	FALSE	FALSE	TRUE	FALSE	FALSE	TRUE	FALSE
Result	60%	80%	80%	80%	80%	80%	80%	40%	80%	60%

TABLE XXVI. EXTRINSIC FEEDBACK FOR SET 2 OF PLAYER A

Step	Attempt 1	Attempt 2	Attempt 3	Attempt 5	Attempt 6	Attempt 7	Attempt 8	Attempt 10	Attempt 11	Attempt 13
step_1	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE	FALSE
step_2	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
step_3	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
step_4	FALSE	TRUE	TRUE	FALSE	TRUE	TRUE	FALSE	TRUE	TRUE	FALSE
step_5	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	TRUE
Result	80%	80%	80%	60%	80%	60%	80%	80%	80%	60%

TABLE XXVII. EXTRINSIC FEEDBACK FOR SET 2 OF PLAYER B

Step	Attempt 1	Attempt 3	Attempt 4	Attempt 5	Attempt 8	Attempt 11	Attempt 12	Attempt 17	Attempt 19	Attempt 21
step_1	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
step_2	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE
step_3	FALSE	FALSE	TRUE	TRUE	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE
step_4	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
step_5	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Result	40%	60%	80%	80%	60%	60%	80%	80%	80%	60%

- Motion Templates for Set 2 of Player B

TABLE XXVIII. EXTRINSIC FEEDBACK FOR SET 1 OF PLAYER A

Step	Attempt 1	Attempt 3	Attempt 4	Attempt 5	Attempt 6	Attempt 8	Attempt 9	Attempt 10	Attempt 11	Attempt 12
step_1	FALSE	TRUE	FALSE	TRUE	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE
step_2	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
step_3	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
step_4	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
step_5	FALSE	FALSE	FALSE	TRUE	TRUE	FALSE	FALSE	TRUE	FALSE	FALSE
Result	40%	60%	40%	100%	80%	40%	60%	60%	40%	40%

TABLE XXIX. EXTRINSIC FEEDBACK FOR SET 2 OF PLAYER A

Step	Attempt 1	Attempt 2	Attempt 3	Attempt 5	Attempt 6	Attempt 7	Attempt 8	Attempt 10	Attempt 11	Attempt 13
step_1	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE	FALSE
step_2	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	FALSE
step_3	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE
step_4	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
step_5	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
Result	60%	60%	60%	60%	80%	40%	60%	40%	40%	20%

TABLE XXX. EXTRINSIC FEEDBACK FOR SET 1 OF PLAYER B

Step	Attempt 1	Attempt 4	Attempt 5	Attempt 6	Attempt 7	Attempt 8	Attempt 9	Attempt 10	Attempt 11	Attempt 14
step_1	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE
step_2	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE
step_3	FALSE	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	TRUE	TRUE	FALSE
step_4	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE
step_5	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Result	60%	80%	60%	60%	40%	40%	40%	60%	60%	40%

V. DISCUSSIONS

A. Extrinsic Feedback Score

Table XXXI presents the result of the average percentage obtained after being compared with different values of MinSR and MaxSR of every MTs. The previous results from EF were summed up into percentage as EF score (EFS) by averaging "TRUE" over "FALSE" result.

As the result, the percentage ranged from lowest of 50% to the highest of 72%. The lowest percentage was achieved by EFS-S2-A, that has been compared to MinSR and MaxSR of A-S1-MTs. While the highest percentage was by analyzing the dataset of EFS-S2-A with MinSR and MaxSR of B-S1-MTs.

TABLE XXXI. SUMMARY OF EXTRINSIC FEEDBACK SCORE

	A-S1-MTs	A-S2-MTs	B-S1-MTs	B-S2-MTs
EFS-S1-A		64.00%	72.00%	56.00%
EFS-S2-A	50.00%		74.00%	52.00%
EFS-S1-B	66.00%	64.00%		54.00%
EFS-S2-B	62.00%	54.00%	68.00%	

B. Extrinsic Feedback Score over Passing Mark Cross Validation

The result of EFS was being cross validated with the passing mark given by the coach in the SRA. For Player A, the passing mark was 82.25% in Set 1 and 73.75% in Set 2. Similarly, for Player B, the passing mark was 78.50% in Set 1 and 83.50% in Set 2.

Following the cross-validation process, the result presented in Table XXXII shows that only "FALSE" values were obtained. This indicates that the EFS did not surpass the respective passing marks, and each penalty kick set does not reflect to the other set except for its own set.

Finally, this proves that the MTs is reliable to use, where it can produce unique rules for each player. Furthermore, step count produced through MTs evaluation of penalty kick dataset can differentiate between individual players across different sets.

TABLE XXXII. CROSS VALIDATION RESULT BETWEEN EFS AND SRA

	SRA-A-S1	**SRA-A-S2**	**SRA-B-S1**	**SRA-B-S2**
A-S1-MTs		FALSE	FALSE	FALSE
A-S2-MTs	FALSE		FALSE	FALSE
B-S1-MTs	FALSE	FALSE		FALSE
B-S2- MTs	FALSE	FALSE	FALSE	

VI. CONCLUSION AND FUTURE WORK

The cross-validation result showed that none of the EFS from MTs evaluation surpassed each of the respective passing marks. This indicates that MTs can differentiate each set of penalty kicks that are performed by different football players. Therefore, utilizing MoCap by developing specific MTs can significantly improve the evaluation process in sport training by providing plenty of data that can be analyzed to make further improvement in sport training. Future work will focus on improving scalability and expanding the use of MTs across other sports.

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