Vishwakarma Institute of Technology, Pune

Course Project Presentation

Computer Vision - TY ETD A.Y. 2022-2023 Sem II

Golf Swing Shot Recognition

CV CP PID - 15

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Introduction

Golf Swing

Collection of 3 major movements :

Back Swing

Down Swing

Punch Swing

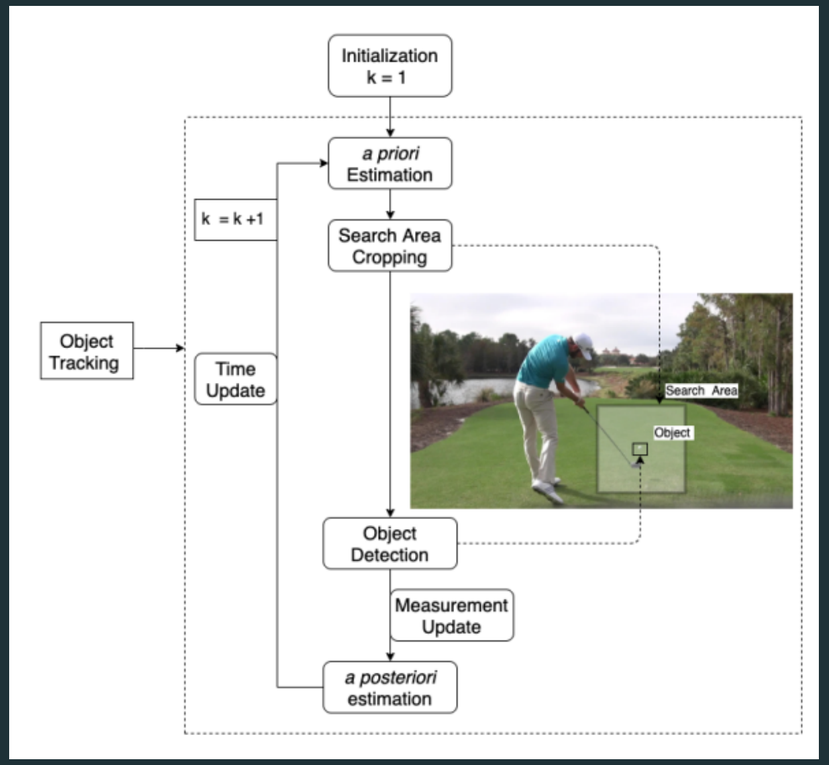
How to recognise which movement ?

Track the movement of the head of the golf club to yeild the trajectory then classify based on dataset

Applications

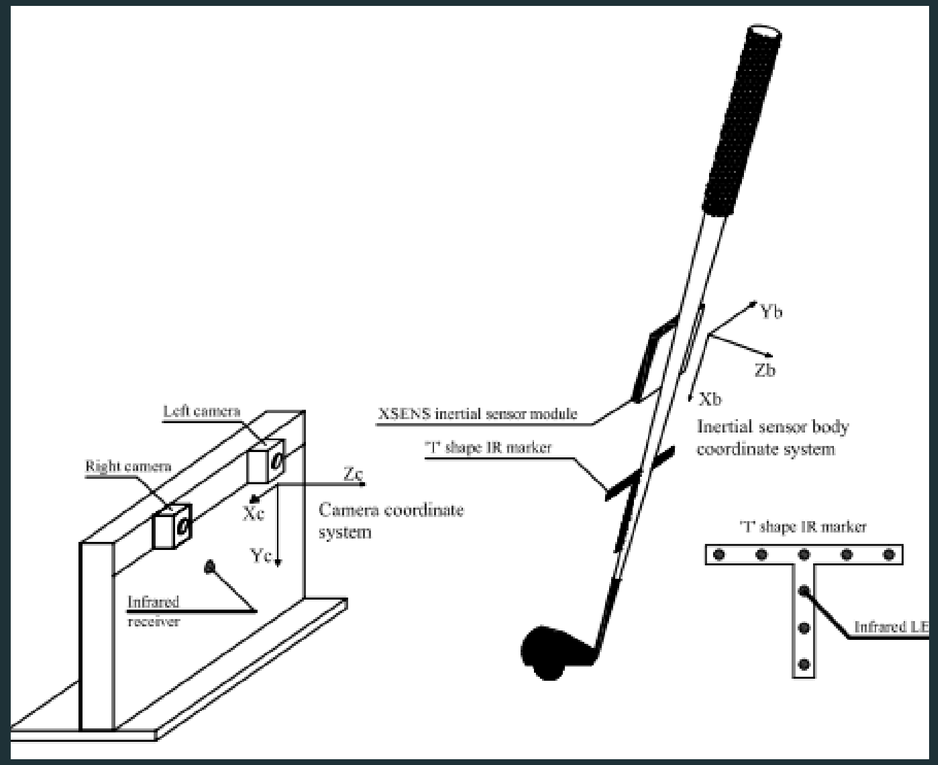
Training Tools, Automated Scoring, Virtual Reality and Gaming, Smart Clubs, etc

Related Work



Real-time Golf Ball Detection and Tracking Based on Convolutional Neural Networks [1]

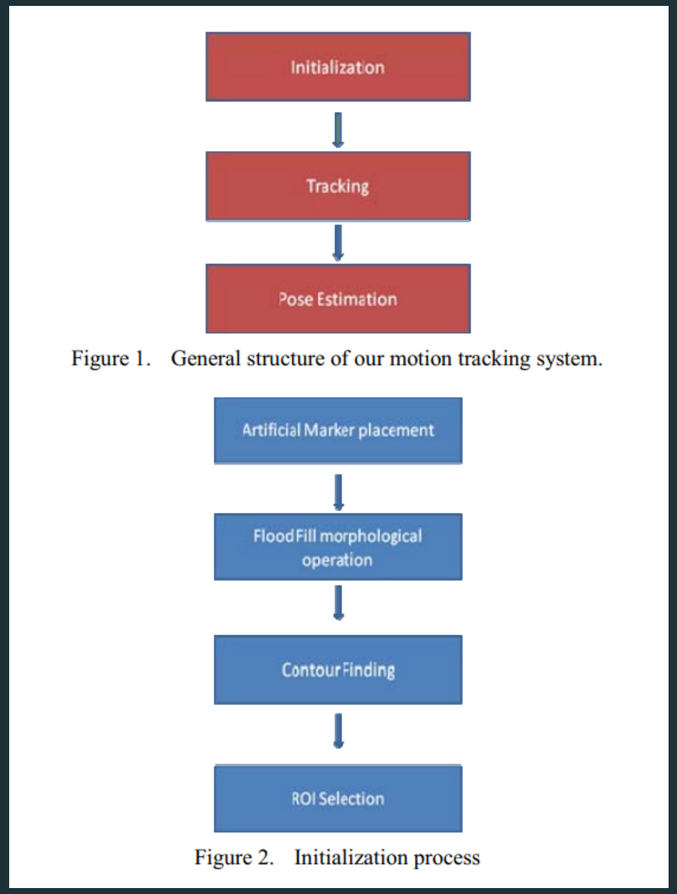
- ROI Selection
- Object Detection
- Object Tracking



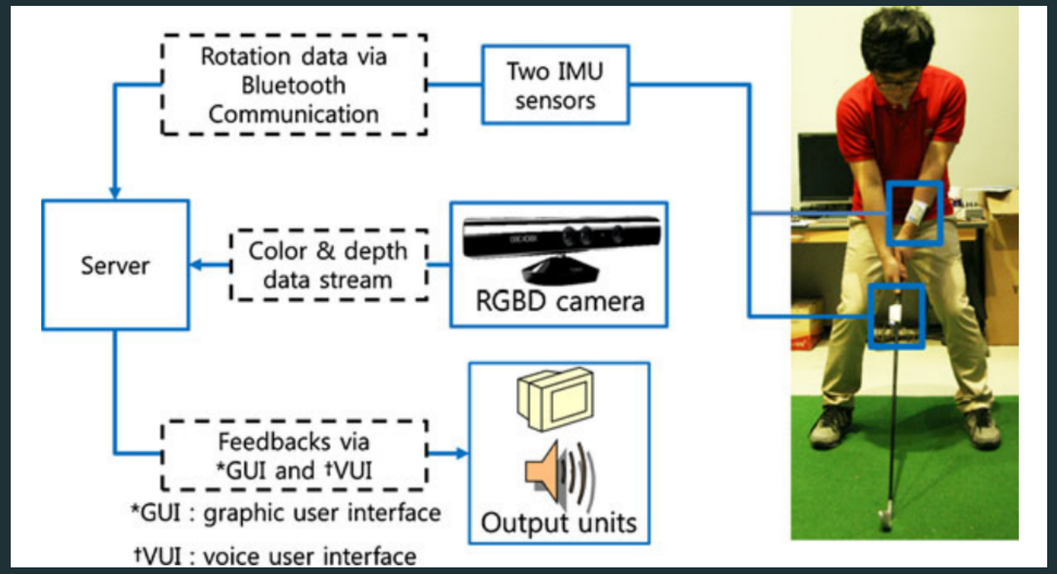
Golf Swing Motion Tracking Using Inertial Sensors and a Stereo Camera [2]

- Pose Estimation
- Edge Detection
- Machine Learning
- PCA
- Keyframe Selector

Related Work



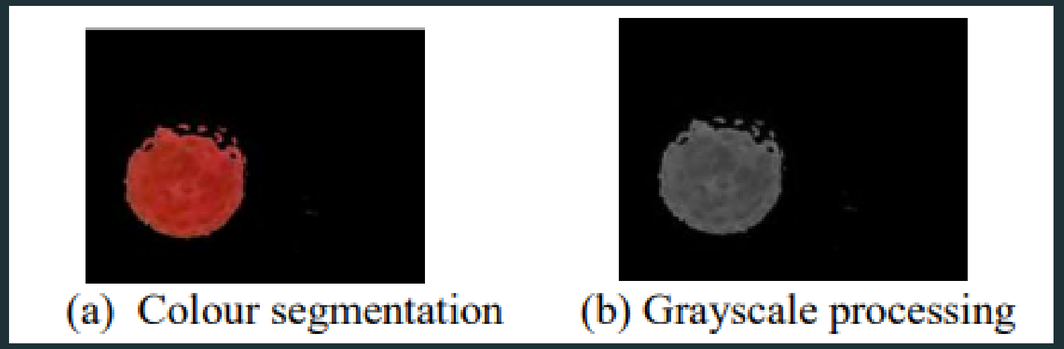
Human Motion Tracking on Broadcast Golf Swing Video Using Optical Flow and Template Matching [3]



A sensor-aided self coaching model for uncocking improvement in golf swing [4]

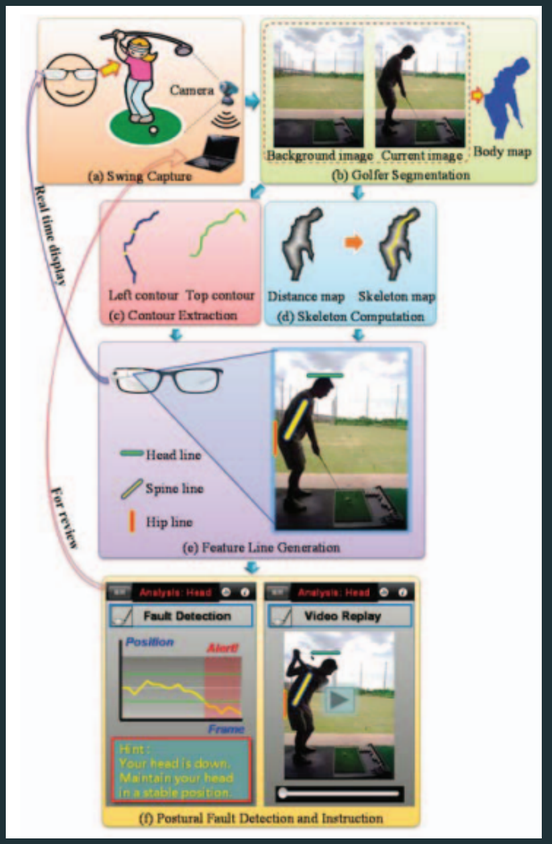
- Sensing
- Wrist Angle Computation
- Motion Segmentation
- Uncocking Evaluation
- Feedback generation

Related Work



Target Detection in NAO Robot Golfing [5]

- NAO robot captures images through camera.
- Median filtering of the images.
- Colour space conversion: Convert RGB colour space to HSV colour space
- Red ball detection:
- Return the coordinates of the red ball in the picture.



Improving Golf Swing Skills Using Intelligent Glasses [6]

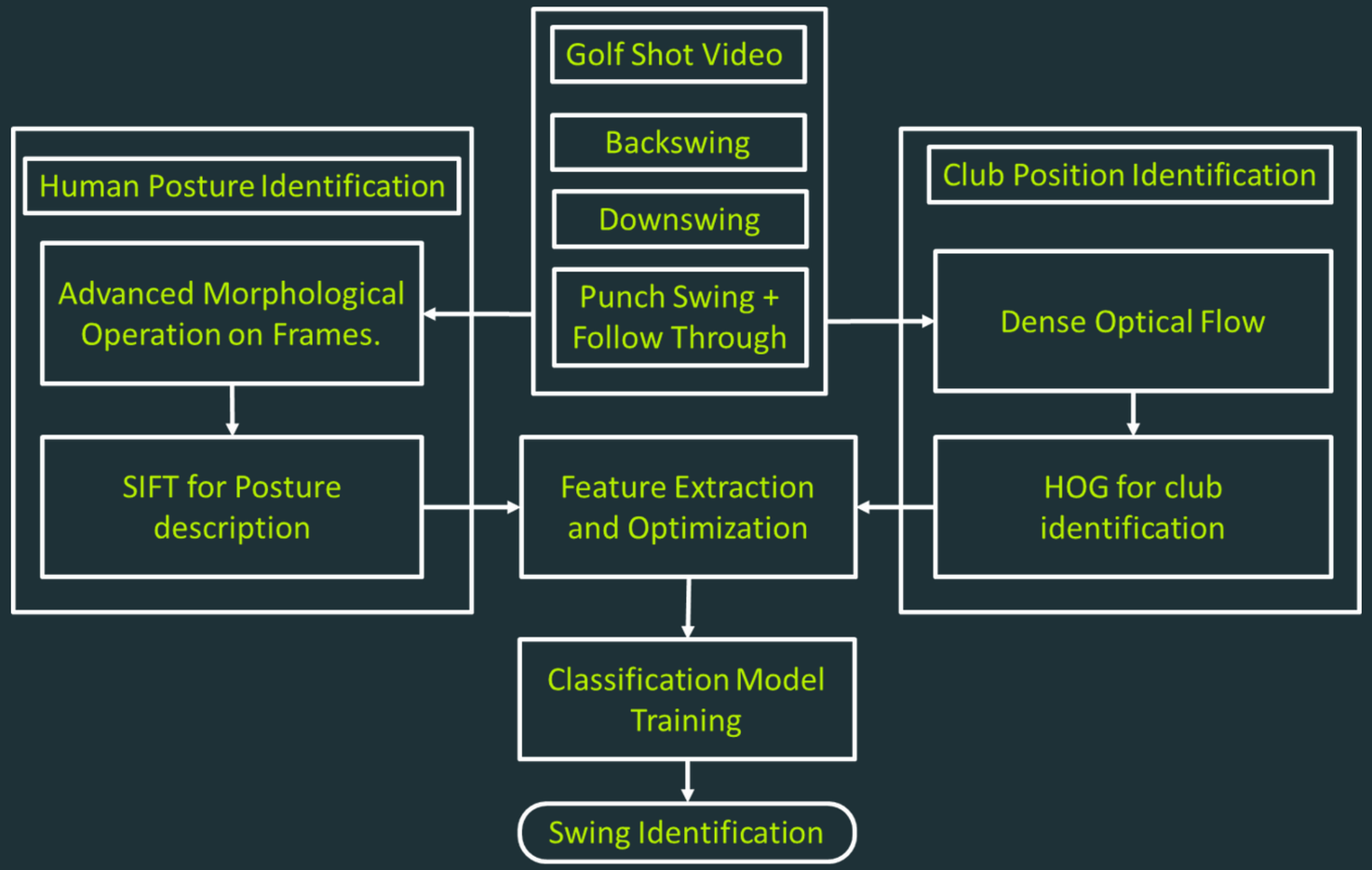
Research Gap

Limited Dataset
Lack of standardized evaluation metrics
Lack of real-time performance
Limited analysis of swing mechanics
Human posture based recognition rather than club trajectory based
Most models employ assistance of additional sensors

Novelty

Stand-alone system; does not involve any additional sensors
Application of SIFT to support the features obtained by performing HOG
Feature Extraction from Trajectory of Head of Golf Club
Application of Farneback Algorithm against Lucas Kanade Optical Flow

Methodology / Implementation



Dataset Creation

Raw Data - Videos of an entire golf swing

Frame Size of Each Video = 160x160

Frame Rate = 29.97 fps

1. Select all videos with golfer's face-on orientation.
2. Convert all videos to same frame size.
3. Divide the video into 3 videos for each of the movement.

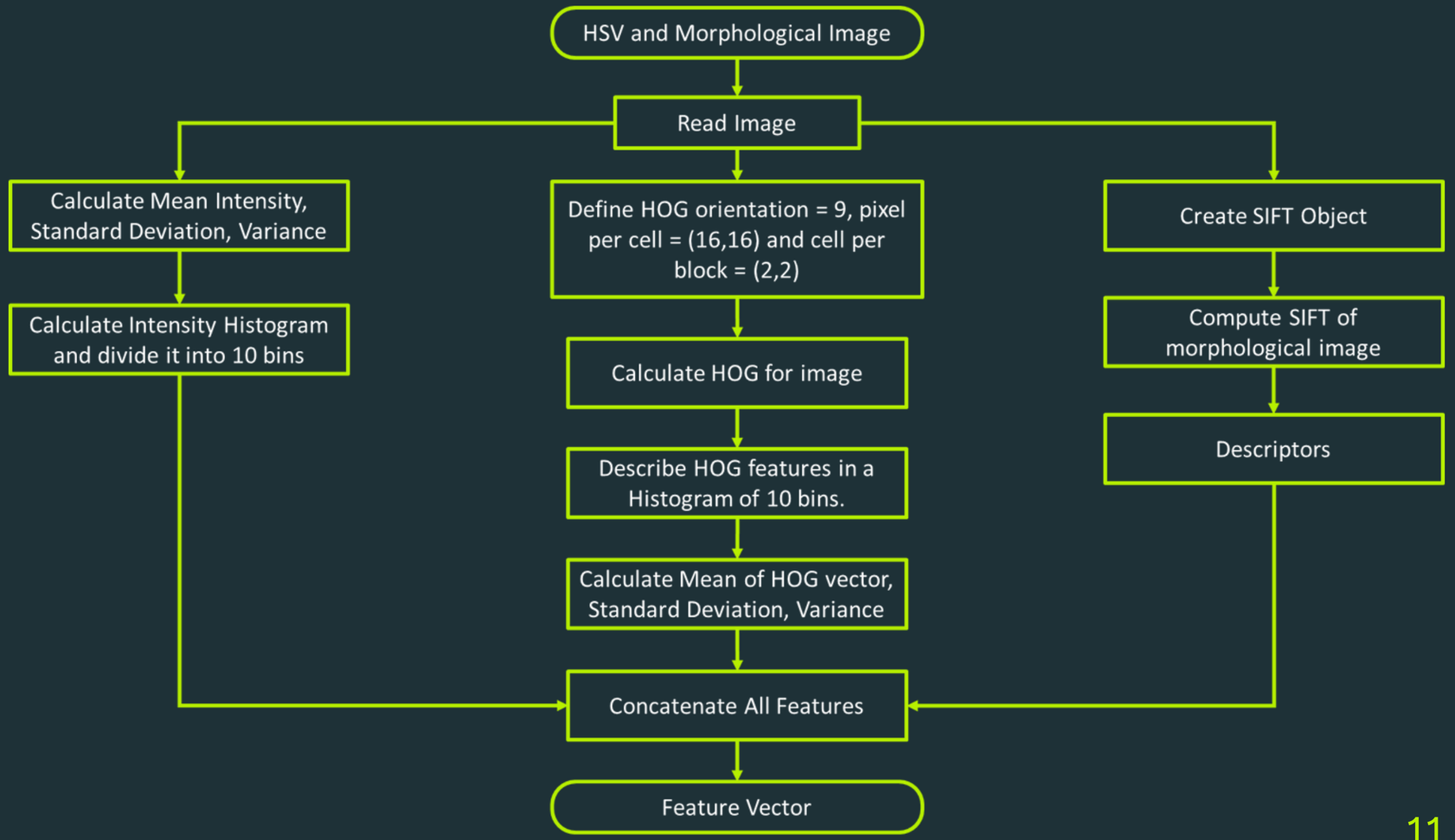
Database Credits - W. McNally, K. Vats, T. Pinto, C. Dulhanty, J. McPhee and A. Wong, "GolfDB: A Video Database for Golf Swing Sequencing", 2019 [7]

Feature Extraction

Input Data - HSV and Morphological Images of trajectory from cut videos

Size of feature vector:
1058 x 150

8 - Optical Flow
14 - HOG
128 - SIFT



Classification

Training
Data = 80%

Testing
Data=20%

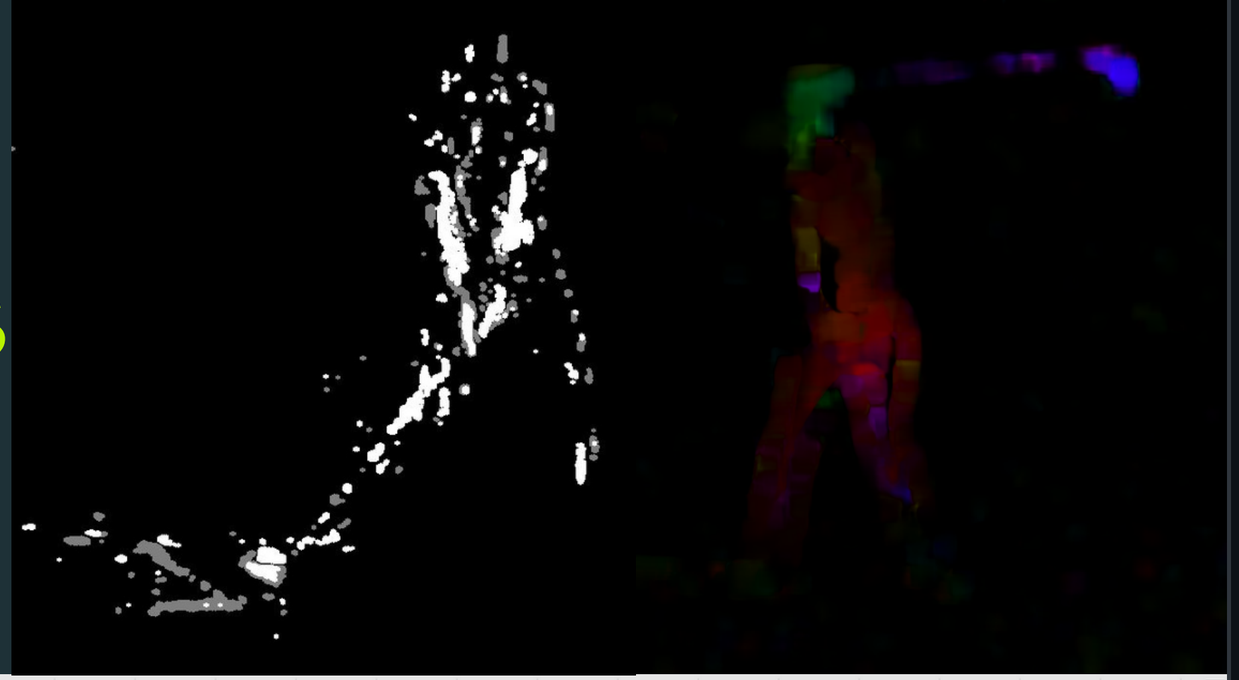
The Random Forest Classifier was implemented with the following hyperparameters:

- n_estimators: [50, 100, 200],
- max_depth: [2, 4, 6],
- min_samples_split: [2, 5, 10],
- min_samples_leaf: [1, 2, 4],
- criterion: ['gini', 'entropy'],
- max_features: ['sqrt', 'log2']

Classifier Performance

Classifier / Metric	Accuracy	Precision
Decision Tree	80.66	73.21
Random Forest	84.43	79.49
KNN	75.94	70.58
SVM	75.00	75.00

Results & Discussions



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
1		Unnamed:	Mean	Standard D	Variance	Label	Bin 5	Bin 6	Bin 7	Bin 8	Bin 9	Sum HOG	Mean HOG	Standard D	Variance H	HOG Hist 0	HOG Hist 1	HOG Hist 2	HOG Hist 3	HOG Hist 4	HOG Hist 5	HOG Hist 6	HOG Hist 7	HO
2	0	0	0.556674	4.69625	22.05476	back	1094022	31458	15121	7711	6220	2814.904	0.152868	0.114908	0.013204	7461	5333	3577	1417	440	158	21	3	
3	1	1	0.35938	3.186641	10.15468	back	1114348	23904	10572	4861	4056	1880.101	0.148472	0.113794	0.012949	5316	3680	2455	780	306	100	21	3	
4	2	2	0.741009	4.105302	16.85351	back	1072170	38711	16174	8883	8404	3193.181	0.146449	0.105264	0.01108	8958	6592	4379	1443	332	77	16	5	
5	3	3	0.795212	5.239447	27.4518	back	1078831	33555	14005	9516	9568	2813.931	0.145536	0.10569	0.01117	7994	5903	3802	1234	276	108	13	3	
6	4	4	0.414621	3.618001	13.08993	back	1111613	22207	11422	6288	4955	1720.967	0.143342	0.110784	0.012273	5208	3572	2208	640	266	86	19	4	
7	5	5	0.302861	2.109079	4.448214	back	1119150	21802	9410	4838	3716	1813.211	0.15408	0.115822	0.013415	4805	3270	2401	885	283	100	16	4	
8	6	6	1.190262	5.899761	34.80718	back	987226	99695	33884	14745	10402	6339.244	0.136085	0.100097	0.010019	21085	12555	10122	2419	304	84	9	1	
9	7	7	0.888056	5.877172	34.54115	back	1076478	38928	13764	7709	7278	3358.124	0.157755	0.115904	0.013434	8215	6313	4285	1658	568	210	26	8	
10	8	8	1.123593	7.251447	52.58348	back	1087274	28124	11150	7257	6995	3444.332	0.162384	0.119331	0.01424	8035	6016	4225	2050	674	186	18	3	
11	9	9	1.153762	7.353334	54.07152	back	1073489	31928	14327	8684	8704	3873.612	0.159994	0.114113	0.013022	9064	7175	4957	2158	659	176	15	5	
12	10	10	0.796547	4.790711	22.95091	back	1064682	58519	15077	6614	5262	5120.786	0.157282	0.111559	0.012446	12637	8719	7422	3055	576	124	16	5	
13	11	11	0.494942	4.239778	17.97572	back	1123431	14735	7847	4819	3559	1194.172	0.132186	0.104635	0.010948	4296	2539	1609	402	130	48	7	1	
14	12	12	0.663044	5.536897	30.65723	back	1113532	18651	8392	5464	4451	1450.572	0.133239	0.105251	0.011078	5131	3031	1978	540	142	53	9	1	
15	13	13	0.873397	6.925355	47.96055	back	1106522	19838	9425	5703	5203	1649.576	0.1354	0.110136	0.01213	5753	3312	2196	606	212	85	14	3	
16	14	14	1.078042	7.779588	60.522	back	1092525	26220	11593	6743	5884	2322.752	0.143406	0.113261	0.012828	7240	4341	3102	1031	336	125	16	3	
17	15	15	1.462489	10.14919	103.006	back	1078957	32869	12598	6491	6026	2956.421	0.14667	0.113614	0.012908	8663	5662	3791	1429	469	108	26	6	
18	16	16	1.344938	9.394715	88.26067	back	1084631	29488	12749	6576	5393	2479.919	0.142713	0.11024	0.012153	7692	4892	3253	1055	353	104	20	6	
19	17	17	1.163083	8.371007	70.07376	back	1090829	25191	12734	6248	5750	2078.443	0.13683	0.107773	0.011615	7060	4173	2791	823	238	88	9	4	
20	18	18	1.488351	7.936485	62.9878	back	1001073	85064	28138	12769	9488	5903.883	0.14082	0.103263	0.010663	18324	11650	8760	2647	449	72	17	4	
21	19	19	1.007191	8.074211	65.19289	back	1114067	12855	6698	4601	4918	1359.671	0.135777	0.107439	0.011543	4637	2855	1758	523	178	47	11	2	
22	20	20	1.146145	8.527663	72.72103	back	1092120	28028	11058	5585	4798	2390.57	0.146141	0.1136	0.012905	7011	4729	3077	1026	353	121	30	5	
23	21	21	1.349706	8.521768	72.62053	back	1035501	72316	19511	8901	6310	5553.267	0.148622	0.107464	0.011549	15474	9892	8582	2863	437	93	17	3	
24	22	22	1.077003	8.010258	64.16423	back	1106281	15849	8405	4520	5030	1465.536	0.132316	0.103004	0.01061	5223	3162	1966	530	139	41	12	1	
25	23	23	1.205662	9.251923	85.59808	back	1101474	17187	9509	6287	6092	1595.344	0.133023	0.106654	0.011375	5648	3388	2095	617	162	59	16	2	
26	24	24	1.183078	8.503029	72.3015	back	1095250	21247	10961	6784	5806	1872.407	0.135338	0.1047	0.010962	6384	3883	2603	716	170	62	10	5	
27	25	25	1.249748	8.623346	74.3621	back	1096982	18793	10724	6425	6166	1699.09	0.132617	0.104213	0.01086	6063	3559	2321	639	155	67	4	1	
28	26	26	1.273567	8.547984	73.06802	back	1094396	21606	9332	5526	5451	1885.426	0.134856	0.105324	0.011093	6584	3938	2423	751	200	66	15	2	
29	27	27	1.352502	9.394196	88.25092	back	1096372	21124	8942	5165	5182	2024.502	0.140172	0.112073	0.01256	6615	3895	2625	929	253	110	10	1	

features(1)

Ready Accessibility: Unavailable 100%

```
Count back :  1
Count Down :  0
Count Follow :  0


Count back :  2
Count Down :  0
Count Follow :  0


Count back :  2
Count Down :  1
Count Follow :  0


Count back :  3
Count Down :  1
Count Follow :  0


Count back :  4
Count Down :  1
Count Follow :  0
...

Count back :  248
Count Down :  65
Count Follow :  84
```

Conclusion

- Golf Swing Shot Recognition is facilitated by OpenCV.
- Gunnar – Farneback Optical flow produces better results for trajectory mapping as compared to Lucas Kanade.
- SIFT along with HOG extracts better features than other methods.
- Random Forest Classifier serves to be the best suitable classifier among others as it provides teh highest accuracy.

References

[1] Real-time Golf Ball Detection and Tracking Based on Convolutional Neural Networks

[2] Kim, Theodore T., Mohamed A. Zohdy, and Michael P. Barker. "Applying pose estimation to predict amateur golf swing performance using edge processing." IEEE Access 8 (2020): 143769-143776.

[3] Sim, K. F., and K. Sundaraj. "Human motion tracking on broadcast golf swing video using optical flow and template matching." In 2010 International Conference on Computer Applications and Industrial Electronics, pp. 169-173. IEEE, 2010.

[4] Chun, S., Kang, D., Choi, HR. et al. A sensor-aided self coaching model for uncocking improvement in golf swing. Multimed Tools Appl 72, 253–279 (2014). https://doi.org/10.1007/s11042-013-1359-2

[5] Su, Erwei, Long Chen, Yingli Xu, and Bin Hu. "Target Detection in NAO Robot Golfing." In Journal of Physics: Conference Series, vol. 1828, no. 1, p. 012171. IOP Publishing, 2021.

[6] Chen, Hua-Tsung, Tzu-Wei Huang, Chien-Li Chou, Hou-Chun Tsai, and Suh-Yin Lee. "Improving golf swing skills using intelligent glasses." In 2015 Visual Communications and Image Processing (VCIP), pp. 1-4. IEEE, 2015.

Thank You

We Would Like To Extend Our Sincere Gratitude and Thank The Reviewers, Project Guide, Head of the Department, for Giving us the Opportunity to Present Our Project Report.