# A Survey of Video-based Action Quality Assessment

*Shunli Wang, Dingkang Yang, Peng Zhai, Qing Yu, Tao Suo, Zhan Sun, Ka Li, Lihua Zhang\**

Mail: slwang19@fudan.edu.cn, lihuazhang@fudan.edu.cn
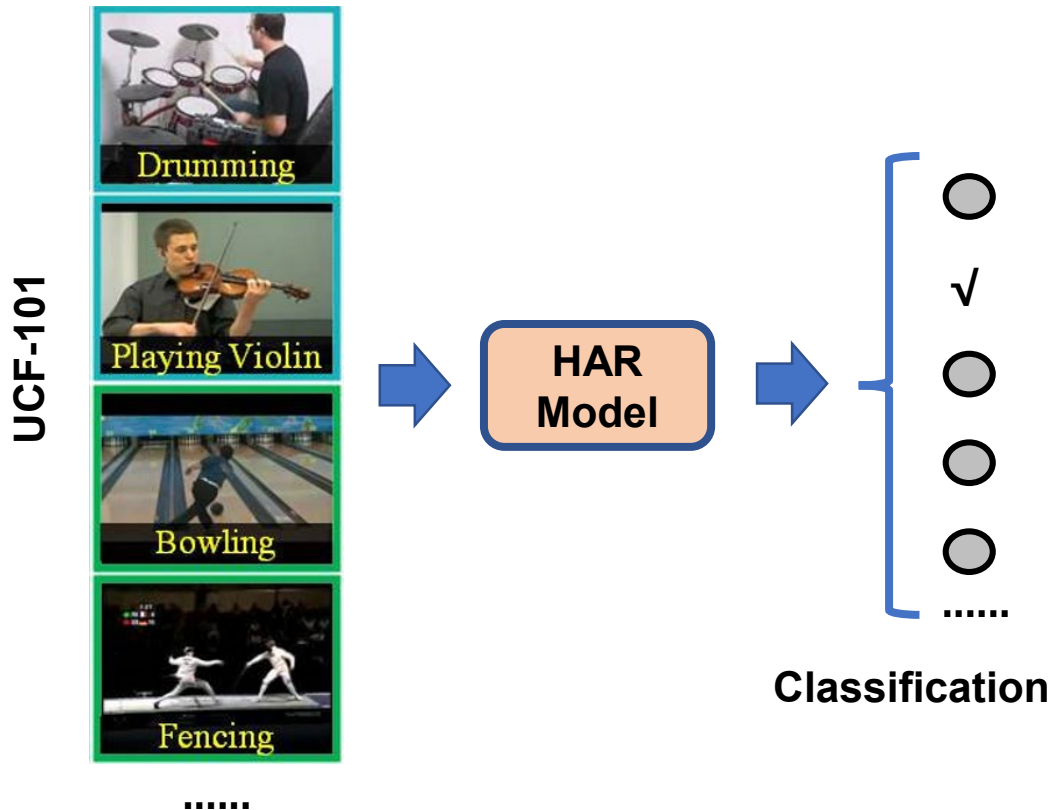
Fudan University, Shanghai, China

# Outline

- 1. Introduction to AQA

- 2. Challenges

- 3. Datasets and Models

- 4. Conclusion

# 1. Introduction to AQA



**Human Action Recognition (HAR)**

Models in HAR require distinguishing subtle differences between different actions.

UCF-101

HAR Model → Classification

**Action Quality Assessment (AQA)**

Models in AQA require evaluating a specific action's advantages and disadvantages.

AQA Model → CLS, USDL, Reg

**AQA needs more acute action capture ability.**
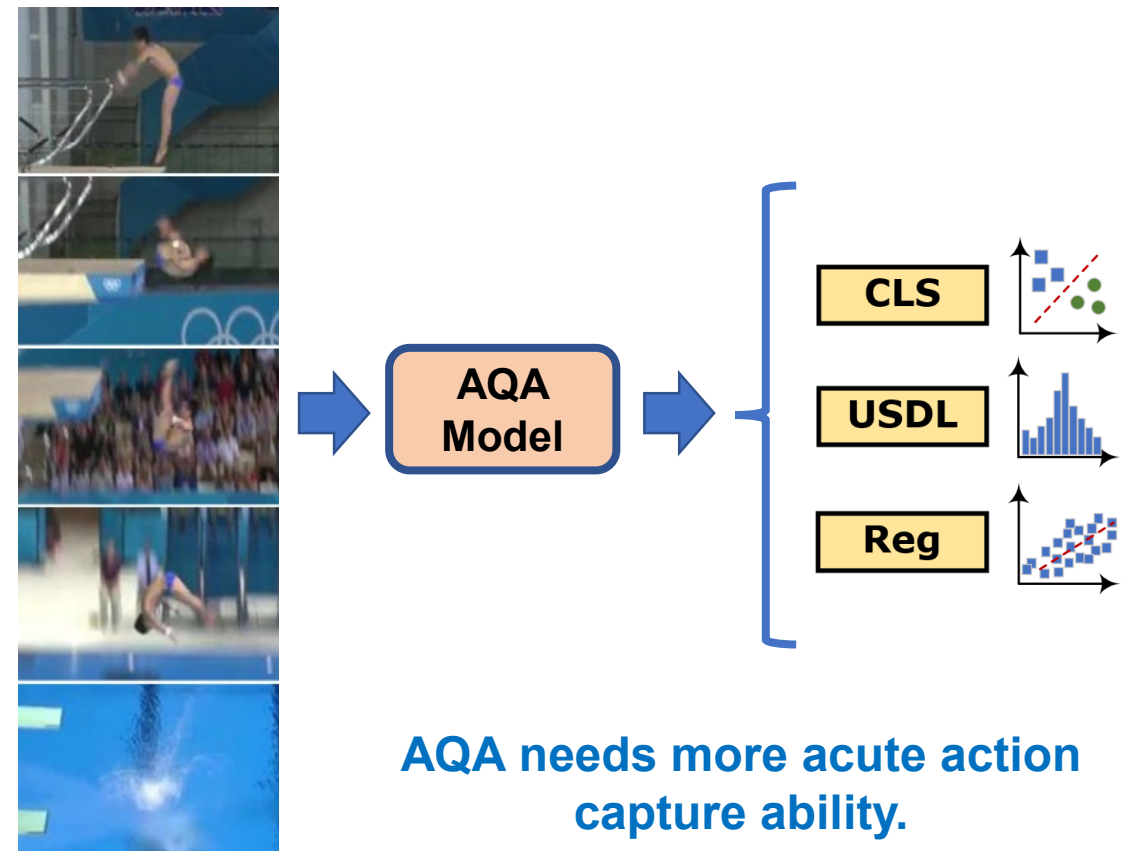
# 2. Challenges

**Challenges in specific areas.**
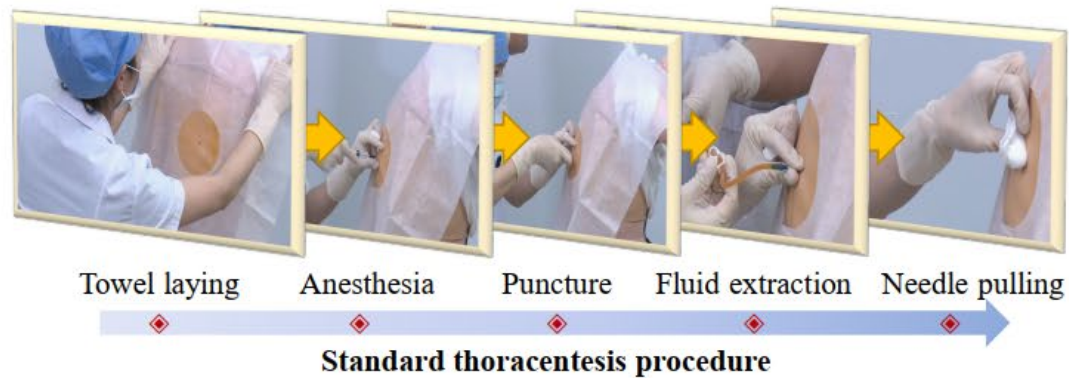


Fig. 1. Complexity of medical process: thoracentesis.

Towel laying — Anesthesia — Puncture — Fluid extraction — Needle pulling

**Standard thoracentesis procedure**



Motion blur — Self-occlusion — Distortion — Turnover
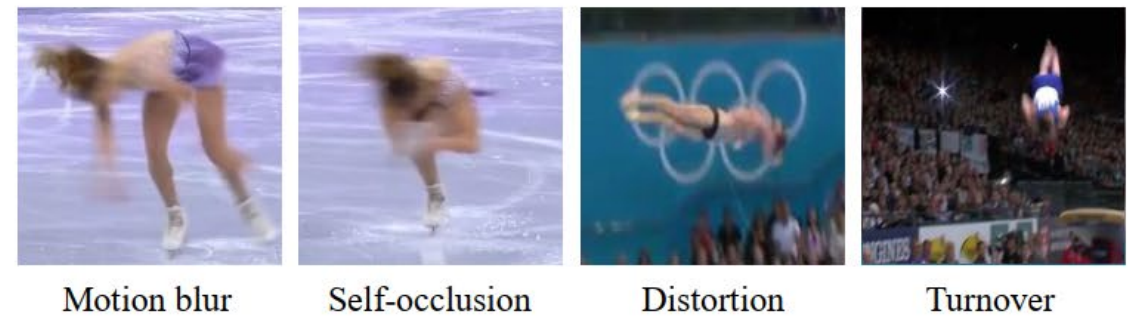
Fig. 2. The complexity of athletes' postures.

**Common challenges.**

| Efficiency | Model Interpretability | View Occlusion |
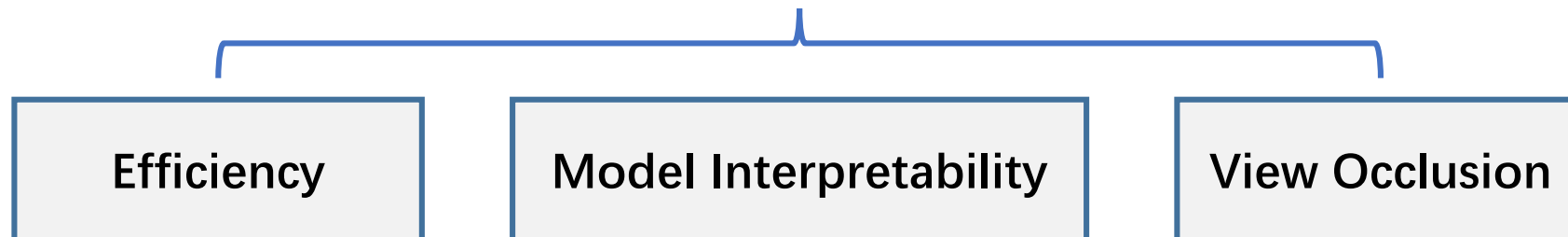
# 3. Datasets of AQA

TABLE I
SUMMARY OF EXISTING AQA DATASETS.

| Scene | Dataset | Publishing | Action class | Size | Label form | Website |
|-------|---------|-----------|:---:|:---:|-----------|---------|
| Sports | MIT-Diving [5] | ECCV 2014 | 1 | 159 | AQA score | https://www.csee.umbc.edu/ hpirsiav/quality.html |
| | MIT-Skating [5] | ECCV 2014 | 1 | 159 | AQA score | https://www.csee.umbc.edu/ hpirsiav/quality.html |
| | UNLV Dive [6] | CVPRW 2017 | 1 | 370 | AQA score | http://rtis.oit.unlv.edu/datasets.html |
| | UNLV Vault [6] | CVPRW 2017 | 1 | 176 | AQA score | http://rtis.oit.unlv.edu/datasets.html |
| | BPAD [7] | ICCV 2017 | 1 | 48 | AQA score | —— |
| | AQA-7 [8] | WACV 2019 | 7 | 1189 | AQA score | http://rtis.oit.unlv.edu/datasets.html |
| | MTL-AQA [9] | WACV 2019 | 16 | 1412 | AQA score / Action class / Commentary | https://github.com/ParitoshParmar/MTL-AQA |
| | FisV-5 [10] | TCSVT 2020 | 1 | 500 | TES, PCS | https://github.com/loadder/MS_LSTM.git |
| | FR-FS [11] | ACM MM 2021 | 1 | 417 | Action class | https://github.com/Shunli-Wang/TSA-Net |
| Medical Care | JIGSAWS [12] | MICCAI 2014 | 3 | 103 | AQA score | http://cirl.lcsr.jhu.edu/jigsaws. |
| Daily Life | EPIC-Skills [13] | CVPR 2018 | 3 | 196 | Pair-Rank | https://drive.google.com/file/d 1oX0dPM5IP638nB0YHt4L70aigIdqqpYr/ |
| | BEST [14] | CVPR 2019 | 5 | 500 | Pair-Rank | https://github.com/hazeld/rank-aware-attention-network |
| | Infant Grasp [15] | arXiv 2019 | 1 | 94 | Pair-Rank | —— |

**Metrics**

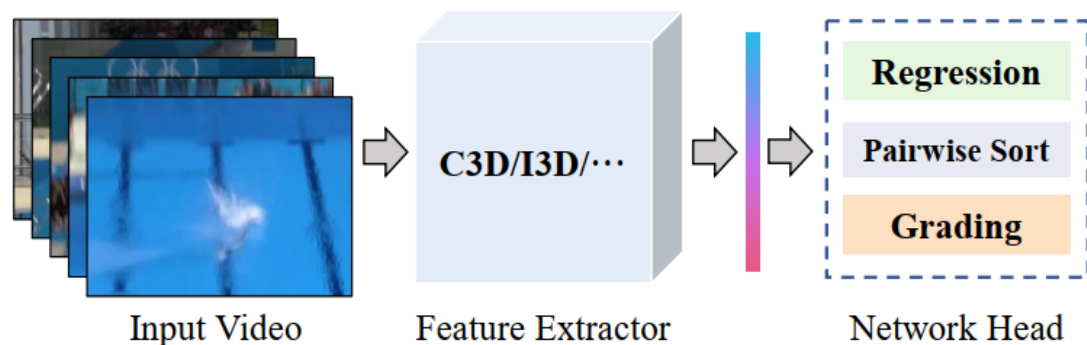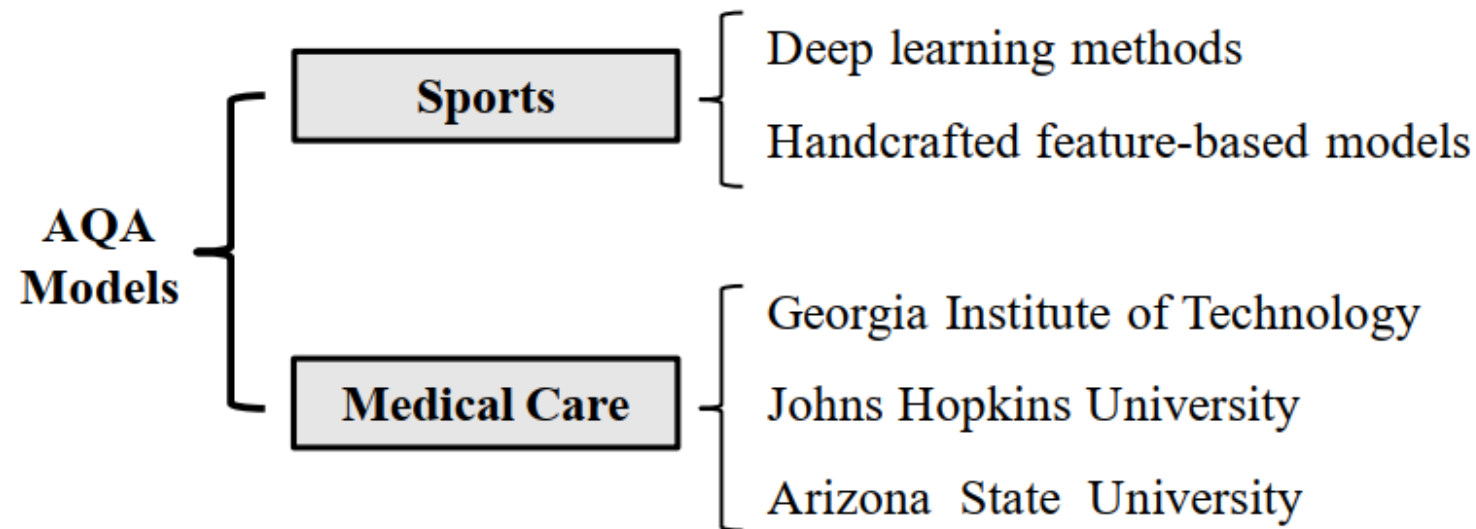| Mean square error | Classification accuracy | Spearman correlation coefficient |

# 3. Models of AQA

**Taxonomy adopted by this paper:**

AQA Models
- **Sports**
  - Deep learning methods
  - Handcrafted feature-based models
- **Medical Care**
  - Georgia Institute of Technology
  - Johns Hopkins University
  - Arizona State University



Input Video → Feature Extractor (C3D/I3D/···) → Network Head (Regression, Pairwise Sort, Grading)

Fig. 4.  Framework of AQA model based on deep learning.



**GIT**
Simulated surgery

**JHU**
Da Vinci Robot

**ASU**
Laparoscopic surgery

Fig. 5.  Dataset acquisition platforms of three three research series.

# 3. Models of AQA

TABLE II

SUMMARY OF EXISTING AQA METHODS.

| Ref. | Published | Dataset | Backbone | Network Head | Metrics | Website |
|------|-----------|---------|----------|--------------|---------|---------|
| [17] | RO-MAN 2016 | Powerlifting | RSO Net | Feedback | Time Series Analysis | —— |
| [18] | ICIP 2018 | AQA-7 JIGSAWS | P3D | Reg | Spearman Rank Cor. | https://github.com/YeTianJHU/diving-score |
| [19] | PCM 2018 | UNLV-Diving UNLV-Vault MIT-Skate | C3D | Rank loss Reg | Spearman Rank Cor. Mean Euclidean Dis. | —— |
| [8] | WACV 2019 | AQA-7 | C3D | Reg | Spearman Rank Cor. | http://rtis.oit.unlv.edu/datasets.html |
| [9] | CVPR 2019 | MTL-AQA | C3D | Caption Cls Reg | Spearman Rank Cor. | https://github.com/ParitoshParmar/MTL-AQA |
| [20] | ICCV 2019 | AQA-7 JIGSAWS | I3D | Reg | Spearman Rank Cor. | —— |
| [10] | TCSVT 2020 | FisV MIT-Skate | C3D | Reg | Spearman Rank Cor. Mean Square Error | https://github.com/loadder/MS_LSTM.git |
| [21] | CVPR 2020 | AQA-7 MTL-AQA JIGSAWS | I3D | Reg | Spearman Rank Cor. | https://github.com/nzl-thu/MUSDL |
| [11] | ACM MM 2021 | FR-FS AQA-7 MTL-AQA | I3D | Reg Cls | Spearman Rank Cor. | https://github.com/Shunli-Wang/TSA-Net |
| [7] | ICCV 2017 | First-Person Basketball | Att. to scale | Pair-Rank | Ranking Acc. | —— |
| [13] | CVPR 2018 | EPIC-Skills JIGSAWS | TSN | Pair-Rank | Ranking Acc. | —— |
| [14] | CVPR 2019 | BEST EPIC-Skills | I3D | Pair-Rank | Ranking Acc. | https://github.com/hazeld/ rank-aware-attention-network |
| [15] | ICCVW 2019 | Infant Grasp EPIC-Skills JIGSAWS | ResNet101 | Pair-Rank | Ranking Acc. | —— |

# 3. Summary of AQA models:

- From the perspective of development history, the AQA problem in medical care was put forward earlier than that in sports.

- From the perspective of feature extractor, most of the methods before 2014 constructed the AQA system through handcrafted features and traditional classifiers.

- From the perspective of the datasets, it is more difficult to construct datasets in medical care than sports.

# 4. Prospect of Future Work
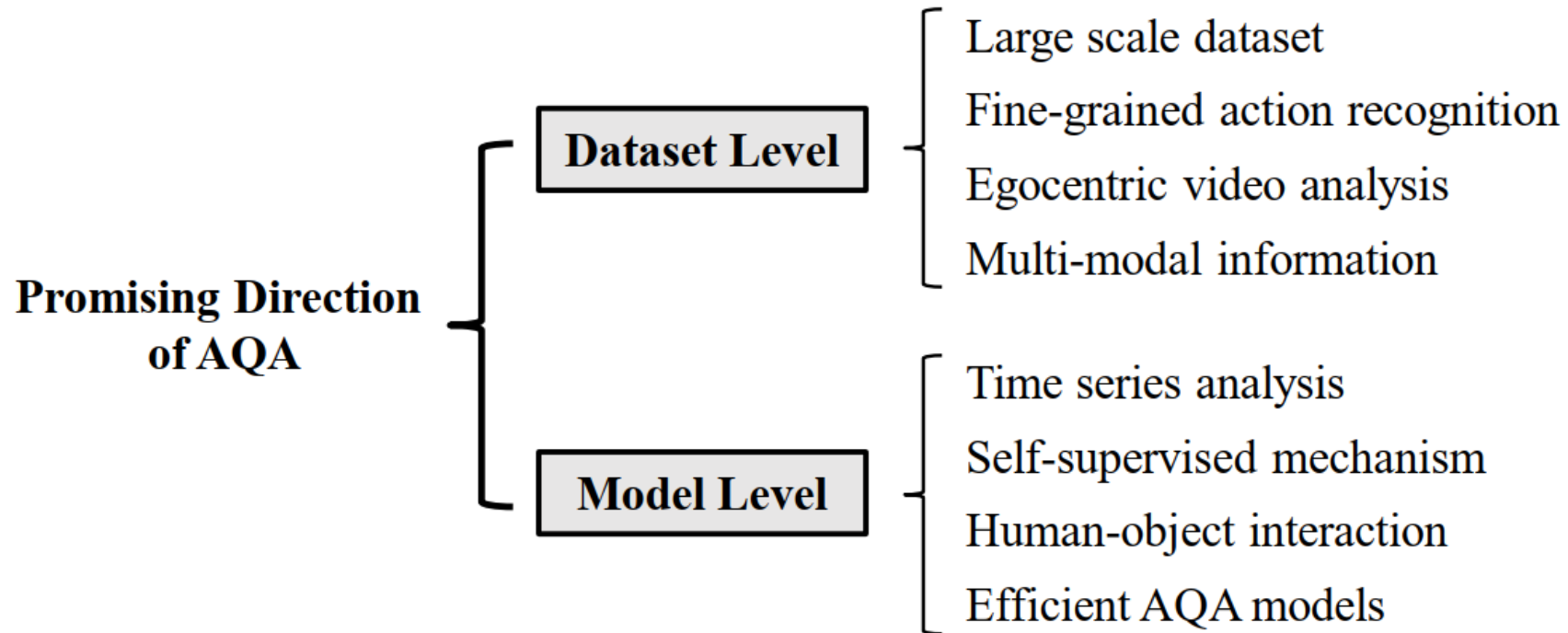


Some promising research directions of AQA task.

# 4. Conclusion

- This paper summarizes the AQA datasets and methods according to the categorization methodology of sports and medical care.

- The challenges of AQA task in two fields are discussed in detail.

- We discuss the future development direction combined with recent studies.

# Thanks!
## Q & A