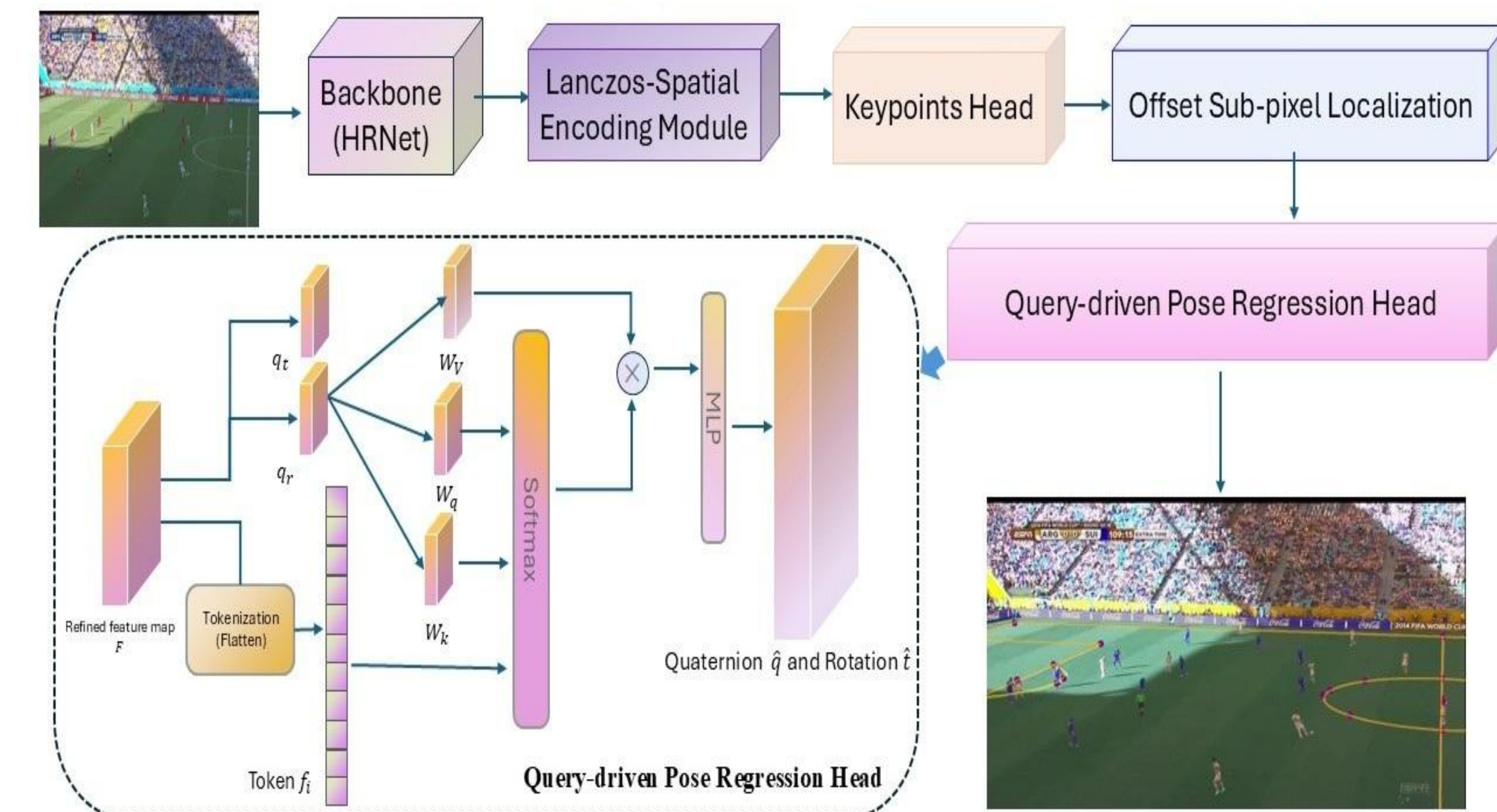


## Motivation

Sports field calibration is critical for mapping image coordinates to standardized coordinates, enabling precise analysis of player trajectories and tactical formations. However, traditional methods designed for TV broadcast footage rely on sparse field features that are susceptible to occlusion and viewpoint variations, limiting their effectiveness for tactical camera calibration. We proposed end-to-end learning framework that redefines football field calibration as a direct 6-DoF camera pose regression, thereby enabling automated calibration

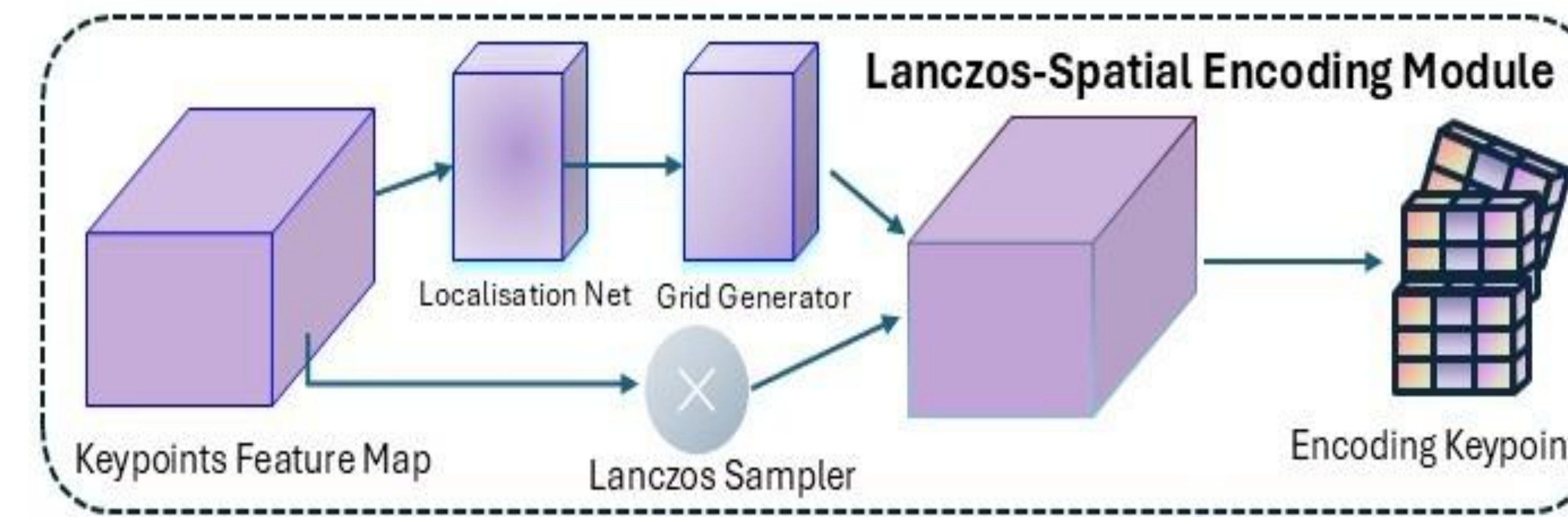
- 1, a Lanczos-based spatial encoding module that enhances keypoint feature generalization under perspective distortion and wide-angle viewing.
- 2, an offset-guided subpixel localization module that maintains robustness against occlusion and resolution degradation inherent.
- 3, Our pose regression architecture transforms spatially distributed keypoint features into landmark embeddings via self-attention mechanism.

### ➤ The framework of NeRF-guided Camera Optimization

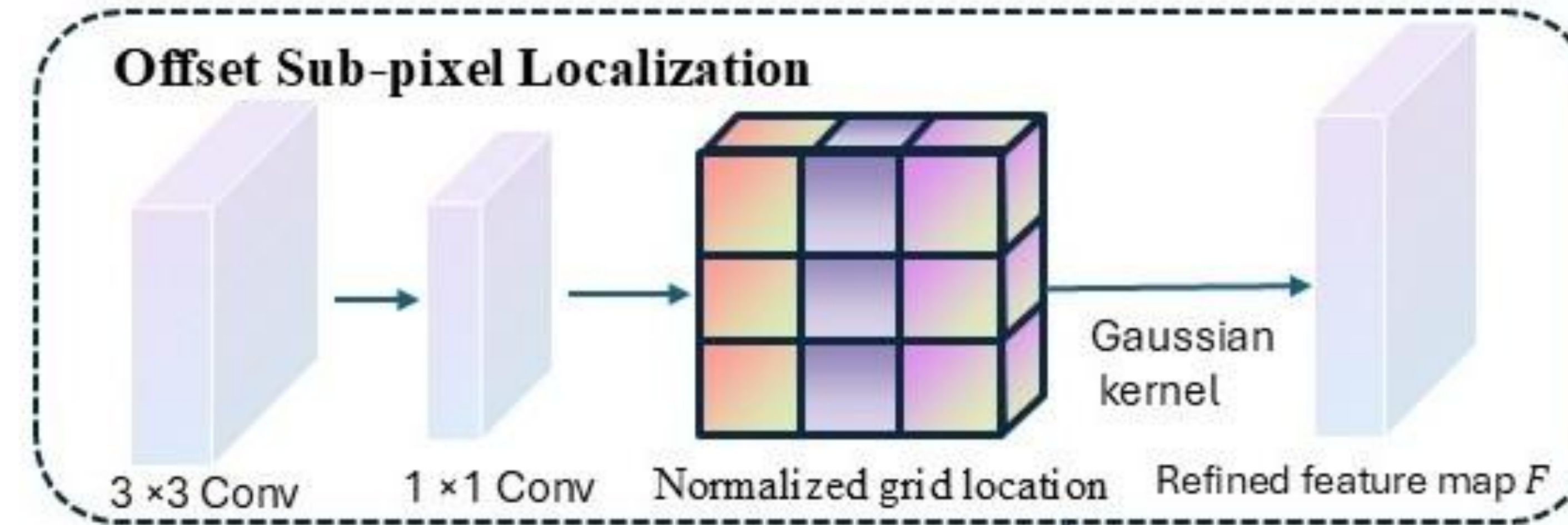


## Method

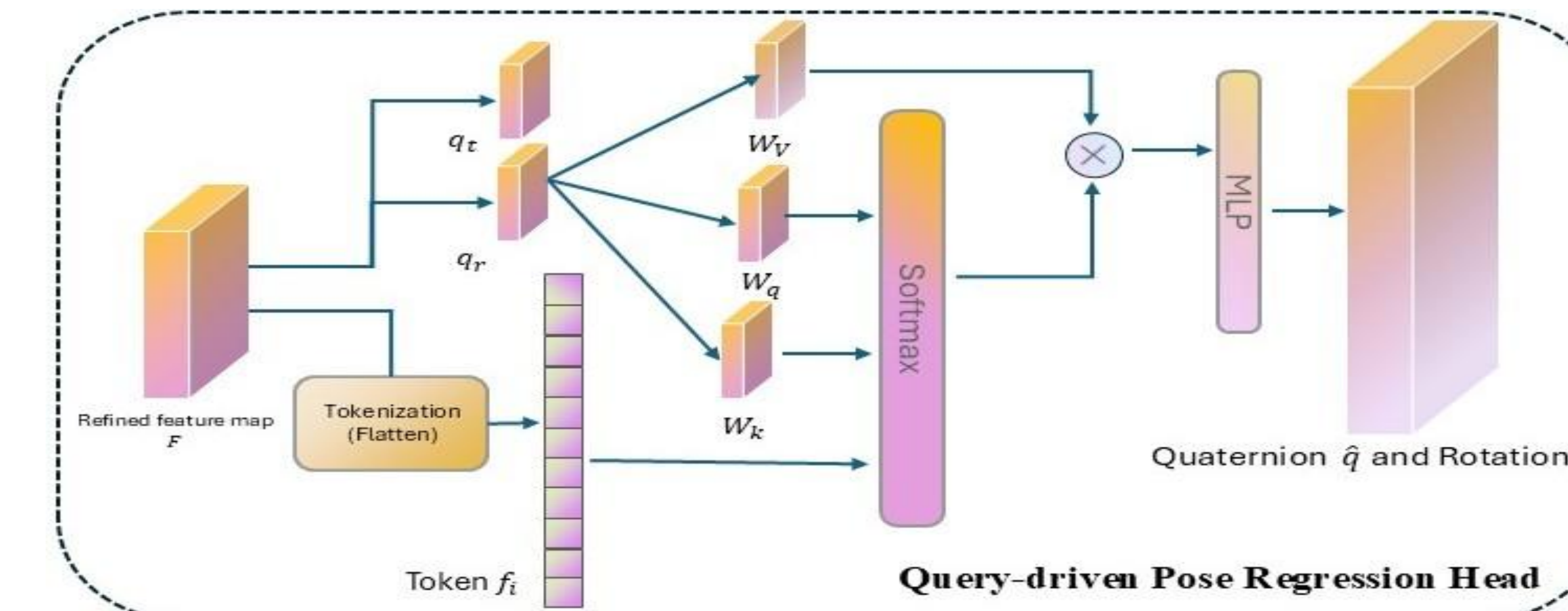
### ➤ Lanczos-Spatial Encoding Module



### ➤ Offset Sub-pixel Localization Strategy



### ➤ Query-driven Pose Regression



## Results

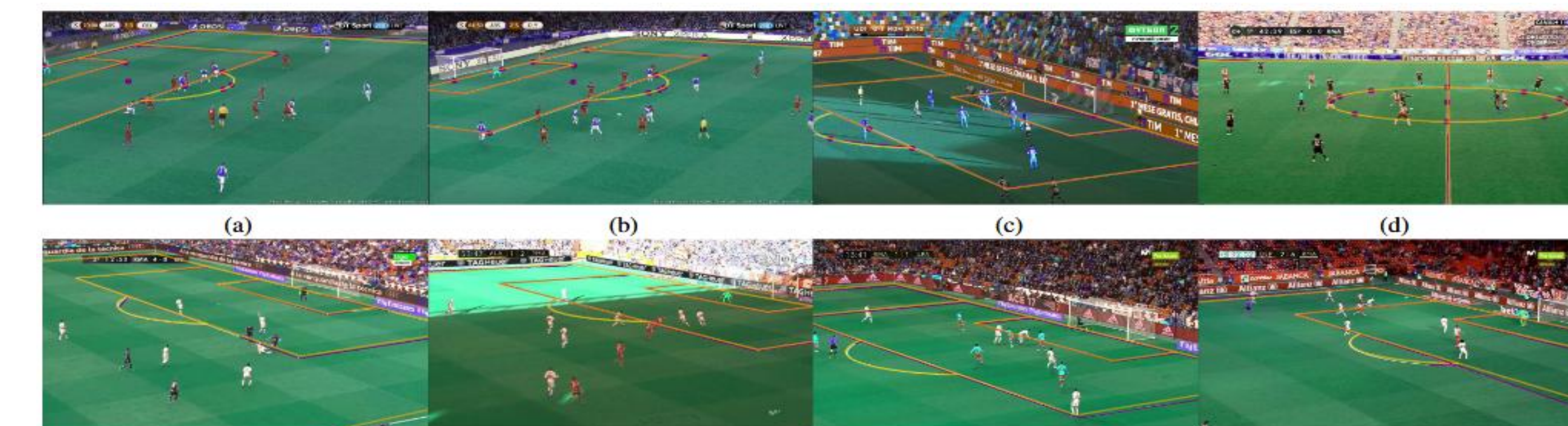
### ➤ Evaluation for calibration accuracy and projection optimization on WC14 dataset

Dataset	Approach	IoU <sub>part</sub> Mean ↑	IoU <sub>part</sub> Median ↑	IoU <sub>whole</sub> Mean ↑	IoU <sub>whole</sub> Median ↑
WC14 test	Sha et al. [31]	93.2	96.1	88.3	92.1
	Chen et al. [3]	94.5	96.1	89.4	93.8
	One-shot registration [15]	94.6	95.9	81.2	86.0
	Optimization-based registration [17]	95.1	96.7	89.8	92.9
	TVCalib [35]	95.3	96.6		
	Zhang et al. [38]	95.9	97.5	91.4	94.2
	Nie et al. [27]	95.8	97.2	90.3	92.2
	Nie et al. [27] - keypoints Only	95.8	97.2	91.5	93.3
	Nie et al. [27] - alignment	95.9	97.1	91.6	93.4
	Self-supervised data mining [32]	96.6	97.8	93.1	94.8
	Chu et al. [7]	96.0	97.0	91.2	93.1
	Four-point camera calibration [40]	95.9	97.3	91.4	94.1
	Maglo et al. [24]	96.3	97.4	92.0	94.1
	Residual attention net [28]	96.9	97.9	92.9	94.6
	sMV [13]	96.4	97.9	92.4	94.8
	PnLcalib [14]	97.0	98.2	93.4	95.5
Ours	97.2	98.0	93.8	96.0	

### ➤ Evaluation for calibration accuracy and projection optimization on occerNet2023

Dataset	Approach	JaC@5°	JaC@10°	JaC@20°	CR	FS
SoccerNet23 -test	sMV [13]	73.7	86.7	90.4	77.5	57.1
	PnLcalib [14]	76.7	87.2	90.1	79.5	60.9
	Ours	78.2	88.4	91.6	80.7	64.1
WC14 test	Chen et al. [3]+HDdecomp	32.7	67.3	78.3	81.7	26.7
	Optimization-based registration [17]+HDdecomp	36.9	66.4	83.9	84.9	26.7
	TVCalib [35]	39.9	71.9	90.5	100.0	39.9
	TVCalib (r) [35]	41.3	73.6	91.4	95.7	39.5
	sMV [13]	77.6	89.8	93.7	100.0	77.6
	PnLcalib [14]	85.2	94.0	96.1	100.0	85.2
Ours	85.9	94.3	97.0	100.0	85.9	

### ➤ The Visualization calibration results



### ➤ Keypoint prediction performance

