Context-Guided Spatio-Temporal Video Grounding

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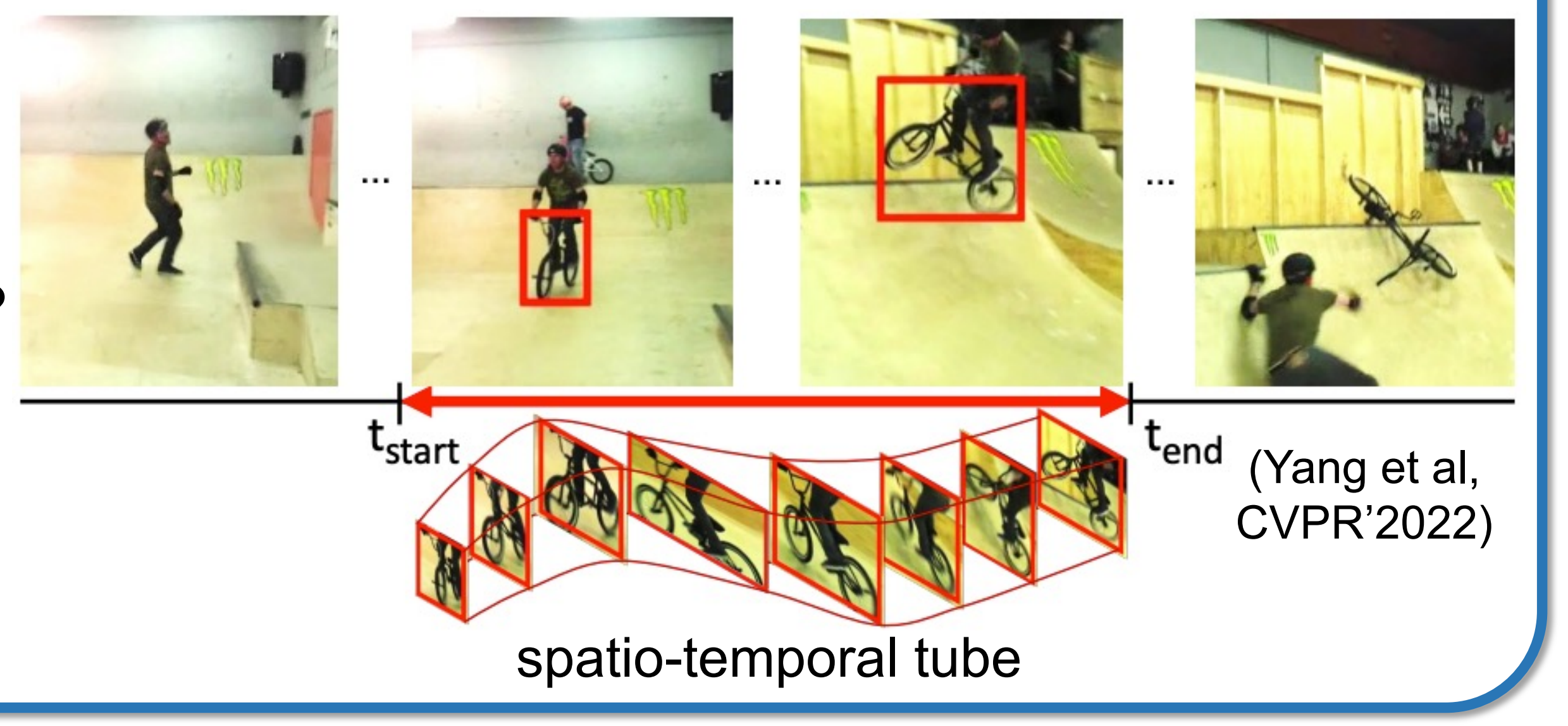
Spatio-Temporal Video Grounding

- **What is spatio-temporal video grounding (STVG)?**
  - STVG aims to localize the object of interest in an untrimmed video with a spatio-temporal tube given a free-form textual query

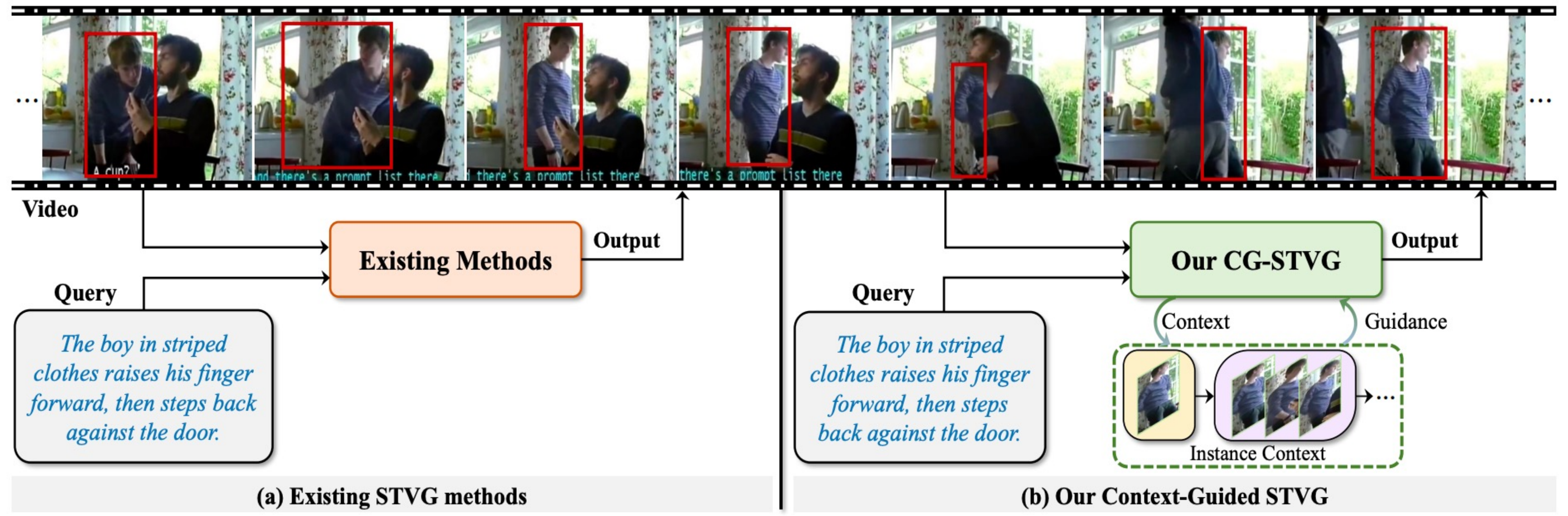
Input text query:
What does the adult ride in the playground?

Output:
A spatio-temporal tube



(Yang et al, CVPR'2022)

Motivation


Video
Query
The boy in striped clothes raises his finger forward, then steps back against the door.
Existing Methods
Output
Our CG-STVG
Context
Guidance
Instance Context

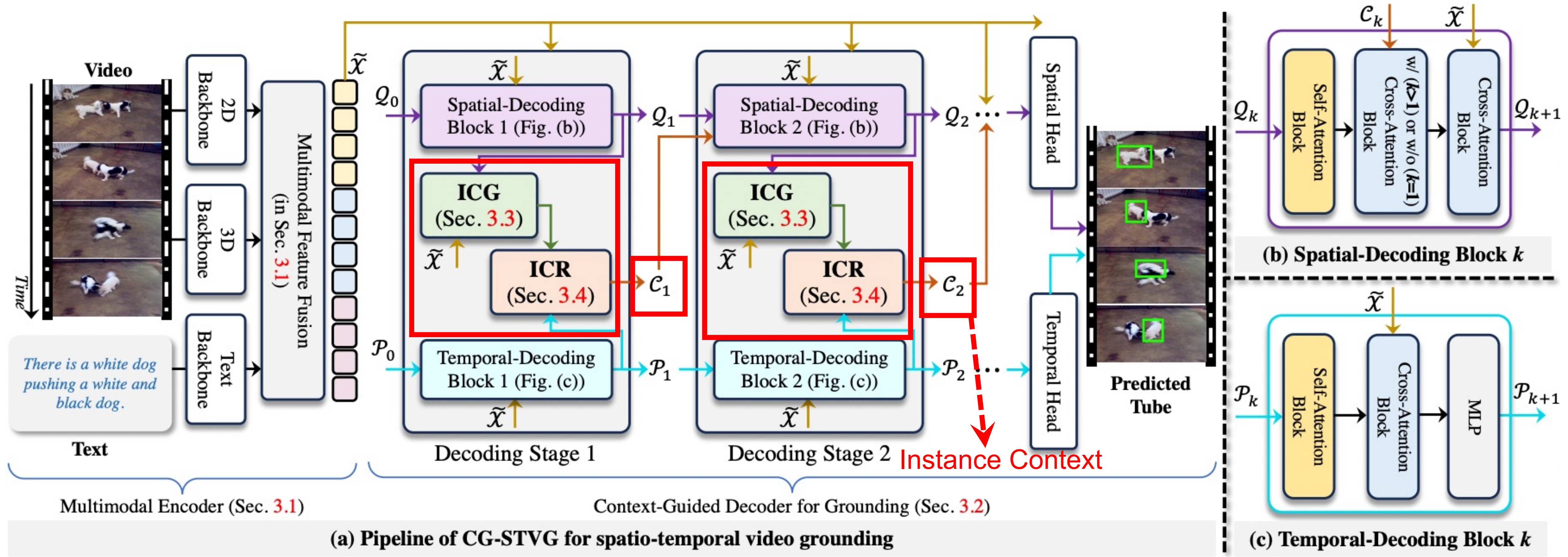
(a) Existing STVG methods

(b) Our Context-Guided STVG

Figure 1: Comparison of existing methods (a) with our context-guided STVG (b)

- **Existing STVG Methods (Fig. 1 (a))**
  - Text query as the *only* cue for target localization
  - *Insufficient* to distinguish foreground object in complex scenes
  - Enhance text with more fine-grained information: (i) *laborious*; (ii) *more computational overheads*; (iii) *still difficult to describe visual details*.
- **Our context-guided STVG (Fig. 1 (b))**
  - A famous adage: "*A Picture Is Worth a Thousand Words*"
  - Exploit visual information of the object to offer a guidance, directly from the vision perspective, for improving STVG

The Proposed Methodology



(a) Pipeline of CG-STVG for spatio-temporal video grounding

(b) Spatial-Decoding Block *k*

(c) Temporal-Decoding Block *k*

Figure 2: Overview of the proposed context-guided spatio-temporal video grounding

- **Context-guided spatio-temporal video grounding:** Mining instance visual context from the video to guide spatio-temporal target localization (Fig. 2)
  - Feature extraction and interaction for video (2D appearance and 3D motion features) and text
  - Spatial- and temporal-decoding for target localization
  - Instance visual context is mined during decoding, via ICG and ICR, and used for guiding localization
- **Core modules:** ICG for instance context generation and ICR instance context refinement

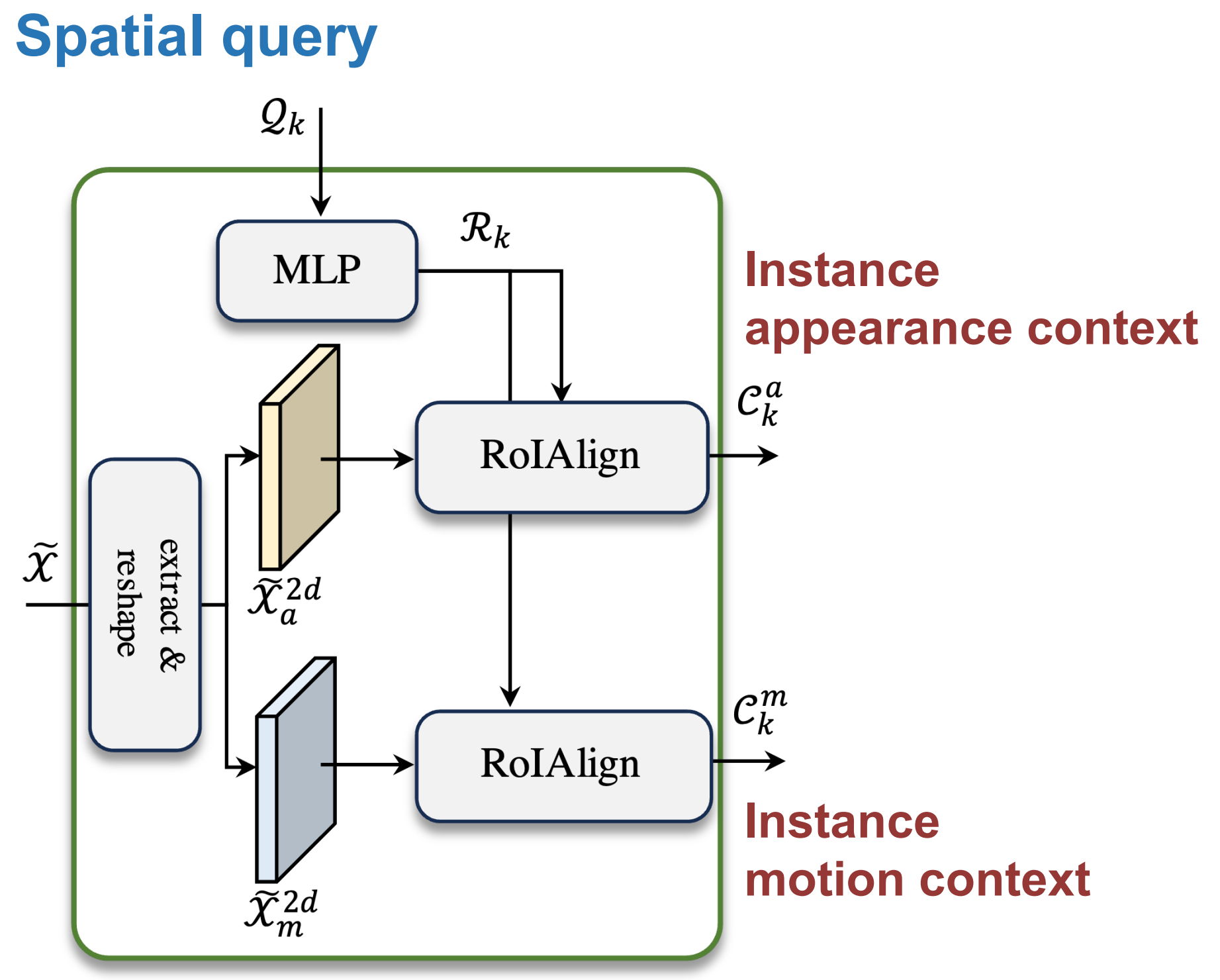


Figure 3: Illustration of ICG

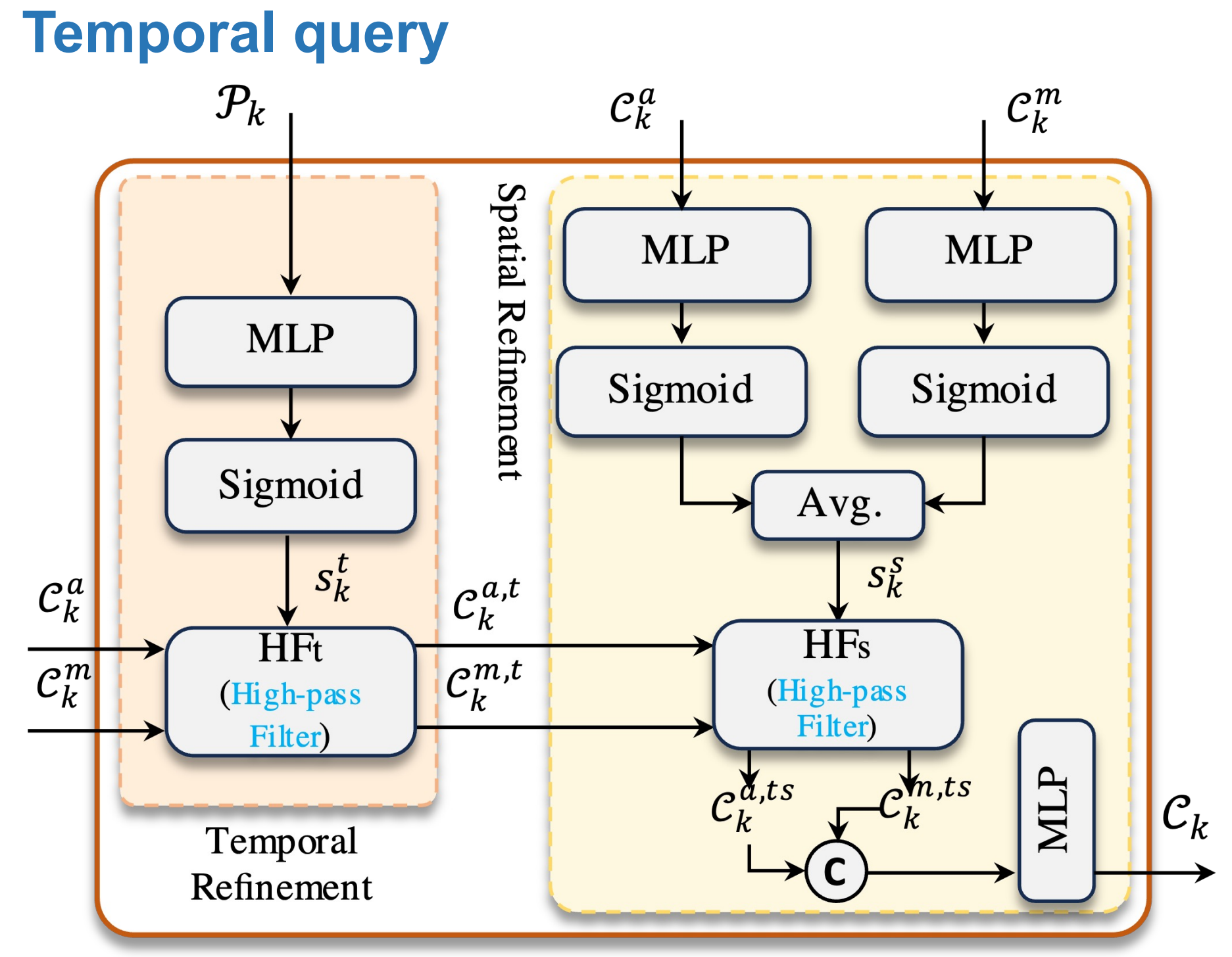
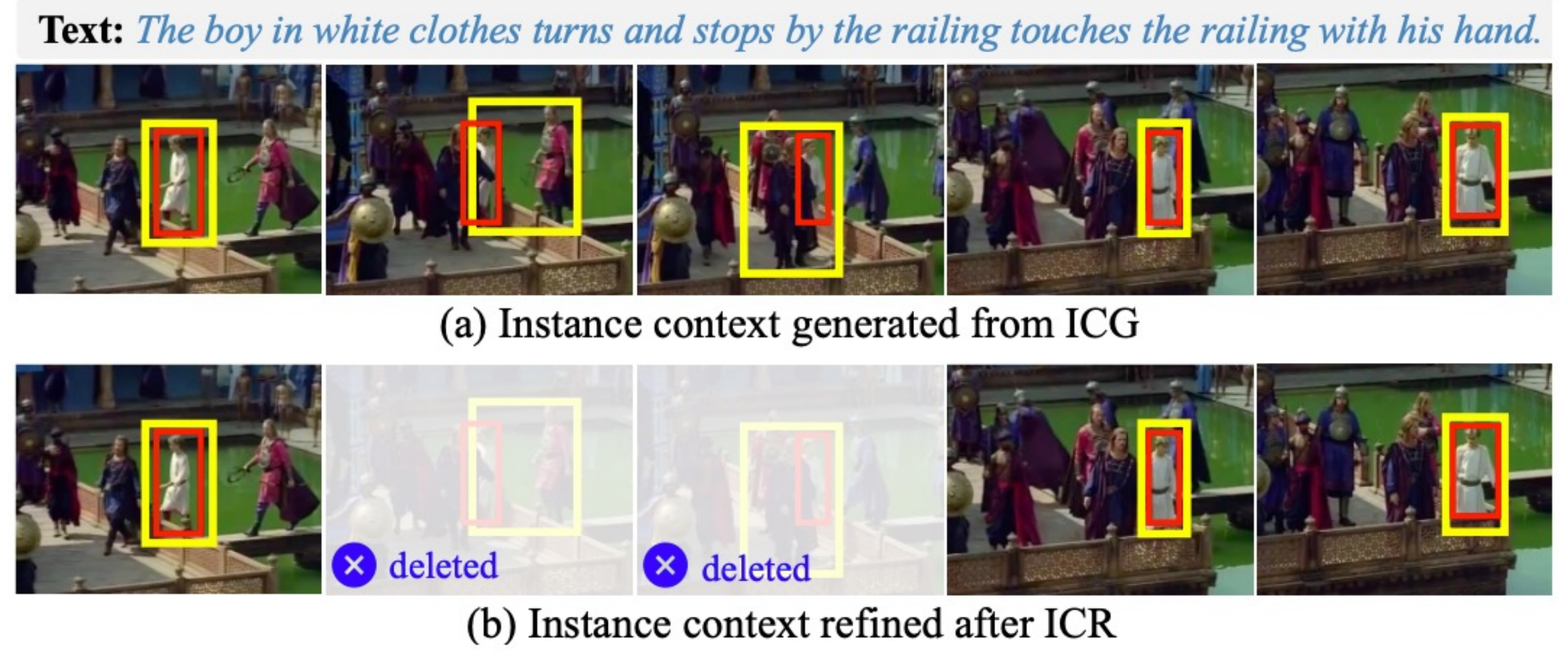


Figure 4: Illustration of ICR

Analysis

- **Illustration of ICG and ICR**


Text: The boy in white clothes turns and stops by the railing touches the railing with his hand.
deleted
deleted

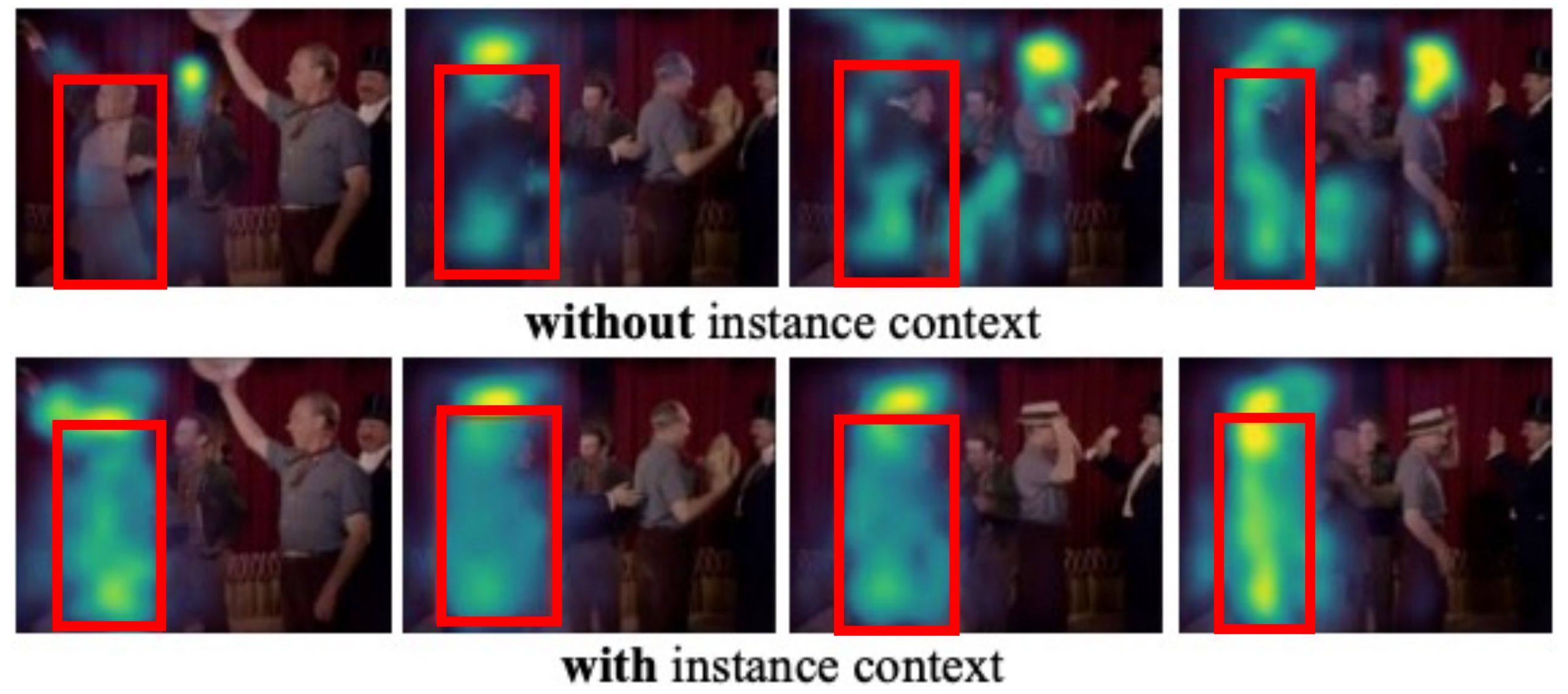
(a) Instance context generated from ICG

(b) Instance context refined after ICR

Red box: target object of interest;

Yellow box: generated target box for instance visual context mining

- **Attention maps**



Text: *The bald man waves his hat, then turns and walks away.*

Red box: target object of interest;

Experiments

Methods	m_tIoU	m_vIoU	vIoU@0.3	vIoU@0.5
STGVT [TCSVT21] [32]	-	18.2	26.8	9.5
STVGBert [ICCV2021] [30]	-	20.4	29.4	11.3
TubeDETR [CVPR22] [36]	43.7	32.4	49.8	23.5
STCAT [NeurIPS22] [17]	49.4	35.1	57.7	30.1
CSDVL [CVPR23] [22]	-	36.9	**62.2**	34.8
Baseline	50.4	36.5	58.6	32.3
CG-STVG	**52.8** (+2.4)	**38.4** (+1.9)	61.5 (+2.9)	**36.3** (+4.0)

Table: Results on HCSTVG-v1 test set (%)

Methods	m_tIoU	m_vIoU	vIoU@0.3	vIoU@0.5
PCC [arxiv2021] [8]	-	30.0	-	-
2D-Tan [arxiv2021] [31]	-	30.4	50.4	18.8
MMN [AAAI22] [35]	-	30.3	49.0	25.6
TubeDETR [CVPR22] [36]	-	36.4	58.8	30.6
CSDVL [CVPR23] [22]	58.1	38.7	**65.5**	33.8
Baseline	58.6	37.8	62.4	32.1
CG-STVG	**60.0** (+1.4)	**39.5** (+1.7)	64.5 (+2.1)	**36.3** (+4.2)

Table: Results on HCSTVG-v2 test set (%)

Methods	Declarative Sentences				Interrogative Sentences			
	m_tIoU	m_vIoU	vIoU@0.3	vIoU@0.5	m_tIoU	m_vIoU	vIoU@0.3	vIoU@0.5
STGRN [CVPR20] [43]	48.5	19.8	25.8	14.6	47.0	18.3	21.1	12.8
OMRN [IJCAI20] [41]	50.7	23.1	32.6	16.4	49.2	20.6	28.4	14.1
STGVT [TCSVT21] [32]	-	21.6	29.8	18.9	-	-	-	-
STVGBert [ICCV21] [30]	-	24.0	30.9	18.4	-	22.5	26.0	16.0
TubeDETR [CVPR22] [36]	48.1	30.4	42.5	28.2	46.9	25.7	35.7	23.2
STCAT [NeurIPS22] [17]	50.8	33.1	46.2	32.6	49.7	28.2	39.2	26.6
CSDVL [CVPR23] [22]	-	33.7	47.2	32.8	-	28.5	39.9	26.2
Baseline	49.7	32.4	45.0	31.4	48.8	27.7	38.7	25.6
CG-STVG	**51.4** (+1.7)	**34.0** (+1.6)	**47.7** (+2.7)	**33.1** (+1.7)	**49.9** (+1.1)	**29.0** (+1.3)	**40.5** (+1.8)	**27.5** (+1.9)

Visual context has significantly improved the performance!

Table: Results on VidSTG test set (%)

Code/ Results