

ComPtr: Towards Diverse Bi-source Dense Prediction Tasks via A Simple yet General Complementary Transformer

Youwei Pang, Xiaoqi Zhao, Lihe Zhang, and Huchuan Lu

Abstract—Deep learning (DL) has advanced the field of dense prediction, while gradually dissolving the inherent barriers between different tasks. However, most existing works focus on designing architectures and constructing visual cues only for the specific task, which ignores the potential uniformity introduced by the DL paradigm. In this paper, we attempt to construct a novel Complementary transformer, **ComPtr**, for diverse bi-source dense prediction tasks. Specifically, unlike existing methods that over-specialize in a single task or a subset of tasks, ComPtr starts from the more general concept of bi-source dense prediction. Based on the basic dependence on information complementarity, we propose consistency enhancement and difference awareness components with which ComPtr can evaluate and collect important visual semantic cues from different image sources for diverse tasks, respectively. ComPtr treats different inputs equally and builds an efficient dense interaction model in the form of sequence-to-sequence on top of the transformer. This task-generic design provides a smooth foundation for constructing the unified model that can simultaneously deal with various bi-source information. In extensive experiments across several representative vision tasks, i.e. remote sensing change detection, RGB-T crowd counting, RGB-DiT salient object detection, and RGB-D semantic segmentation, the proposed method consistently obtains favorable performance. The code will be available at <https://github.com/ywpang/ComPtr>.

Index Terms—Bi-source Dense Prediction Tasks, Bi-source Transformer, Complementary Transformer, Task-generic Architecture.

1 INTRODUCTION

WITH the development of vision transformer [1], [2], recent works achieve stunning performance on many important benchmarks. The task-generic characteristic of the sequence-to-sequence interaction architecture prompts the gaps among different tasks to be further eliminated.

Dense prediction is an important and fundamental problem of computer vision. It often requires laborious and dense annotations of various objects of interest. Typical tasks include remote sensing image segmentation [3], [4], crowd counting (density map estimation) [5], salient object detection [6], [7], [8], and scene image semantic segmentation [9]. Existing schemes have achieved impressive performance in their respective tasks. Among them, the bi-source input paradigm is a common style due to its practicability and effectiveness. For example, the exploration of scene monitoring in a large time span and scene understanding in complex environments rely on more auxiliary data for joint information mining. However, because of the fragmented definitions, these approaches usually focus on a single task. This task-specific design brings repetitive exploration, redundant parameters, and resource overhead. In this work, we explore the potential commonalities of architecture design and visual semantics among various tasks.

The complementarity between two inputs can be decomposed into consistency and difference. Based on it, we design a simple yet effective framework ComPtr, as shown in Fig. 3, to address the general bi-source vision modeling. Specifically, we design a complementary transformer, which contains consistency enhancement blocks and difference

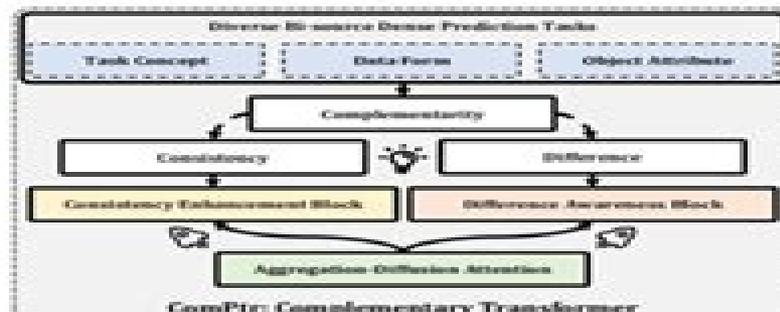


Fig. 1: Visual outline of the proposed ComPtr. For diverse bi-source dense prediction tasks, our method is based on the generic concept of complementarity. The consistency enhancement block (Sec. 3.2.3) and difference awareness block (Sec. 3.2.4) are constructed based on the proposed efficient aggregation-diffusion attention (Sec. 3.2.1) from the perspectives of consistency and difference, respectively. Such a design as a whole serves the implementation of the task-generic architecture.

awareness blocks, i.e., CEM and DAM. The “consistency” tends to highlight the commonality between multi-source data. The CEM blocks are equipped in the encoder to strengthen the object-related representation. While the “difference” depicts the specificity of each stream. We build the DAM-based decoder, which continuously endows the

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