

# 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

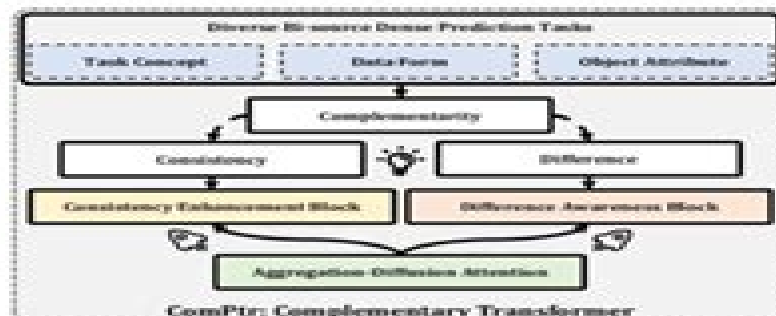


Fig. 1: Visual outline of the proposed ComPtr. For diverse bi-source dense prediction tasks, our method is based on the generic concept of complementarity. The consistency enhancement block (Sec. 3.2.3) and difference awareness block (Sec. 3.2.4) are constructed based on the proposed efficient aggregation-diffusion 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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## **Table of Contents Comptr Confms Xcl2v1**

1. Understanding the eBook Comptr Confms Xcl2v1
  - The Rise of Digital Reading Comptr Confms Xcl2v1
  - Advantages of eBooks Over Traditional Books
2. Identifying Comptr Confms Xcl2v1
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Comptr Confms Xcl2v1
  - User-Friendly Interface
4. Exploring eBook Recommendations from Comptr Confms Xcl2v1
  - Personalized Recommendations
  - Comptr Confms Xcl2v1 User Reviews and Ratings
  - Comptr Confms Xcl2v1 and Bestseller Lists
5. Accessing Comptr Confms Xcl2v1 Free and Paid eBooks

- Comptr Confms Xcl2v1 Public Domain eBooks
  - Comptr Confms Xcl2v1 eBook Subscription Services
  - Comptr Confms Xcl2v1 Budget-Friendly Options
6. Navigating Comptr Confms Xcl2v1 eBook Formats
- ePub, PDF, MOBI, and More
  - Comptr Confms Xcl2v1 Compatibility with Devices
  - Comptr Confms Xcl2v1 Enhanced eBook Features
7. Enhancing Your Reading Experience
- Adjustable Fonts and Text Sizes of Comptr Confms Xcl2v1
  - Highlighting and Note-Taking Comptr Confms Xcl2v1
  - Interactive Elements Comptr Confms Xcl2v1
8. Staying Engaged with Comptr Confms Xcl2v1
- Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Comptr Confms Xcl2v1
9. Balancing eBooks and Physical Books Comptr Confms Xcl2v1
- Benefits of a Digital Library
  - Creating a Diverse Reading Collection Comptr Confms Xcl2v1
10. Overcoming Reading Challenges
- Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
11. Cultivating a Reading Routine Comptr Confms Xcl2v1
- Setting Reading Goals Comptr Confms Xcl2v1
  - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Comptr Confms Xcl2v1
- Fact-Checking eBook Content of Comptr Confms Xcl2v1
  - Distinguishing Credible Sources
13. Promoting Lifelong Learning
- Utilizing eBooks for Skill Development

- Exploring Educational eBooks
- 14. Embracing eBook Trends
  - Integration of Multimedia Elements
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