Multimodal Deep Neural Network for Behavior Recognition with FOS-R for Children with ASD

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Background

- The prevalence of Autism Spectrum Disorder (ASD) has been steadily increasing over the past decades, becoming a significant global concern (Chiarotti and Venerosi, 2020)
- Current statistics in the United States: 1 in 36 children is diagnosed with ASD (Maenner et al., 2023)
- Children with autism often experience symptoms such as somatosensory disturbances and atypical developmental patterns, which greatly impact daily social functioning (Mayes and Calboun, 1999)
- The **Family Observation Schedule (FOS)**: A comprehensive tool used to assess family interactions in different contexts.
  - FOS in autism research: Provide valuable insights for diagnosing, treating, and supporting children with autism by examining their social contexts and dynamics. (Lee and Chung, 2016)
- Presently, FOS data is encoded manually, a time-consuming and labor-intensive process. An automated FOS encoding algorithm could alleviate the burden on clinicians and researchers, ultimately benefiting numerous children with autism

Purpose

- This study proposed an efficient multi-modal deep learning model for FOS data encoding, using task-specific videos of children with autism as training data to optimize model efficacy.

Methods

❖Dataset Description

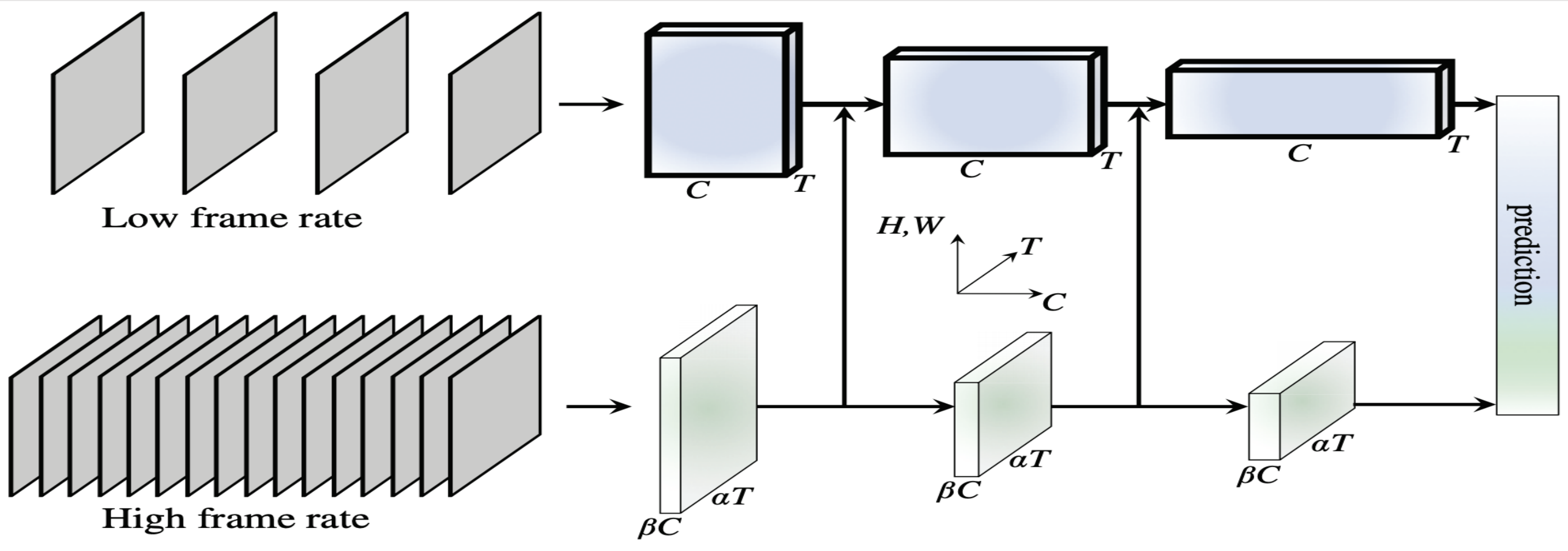
- 216 videos of children with autism or their parents/guardians
  - Duration: 5 – 10 mins
  - Subjects age: 1 – 12 years old
- The children in the videos performed three different task: **(1) playing with specific types of toys**, **(2) performing a series of specific instructions**, and **(3) free playing alone**
- Ground truth of the videos is the interaction styles (IS):
  - Some describing the IS of parents: Praise (**P**) and Affection (**AF**)
  - Some other describing IS of Child: on-compliance (**NC**) and Oppositional (**OP**)

❖Data preprocessing

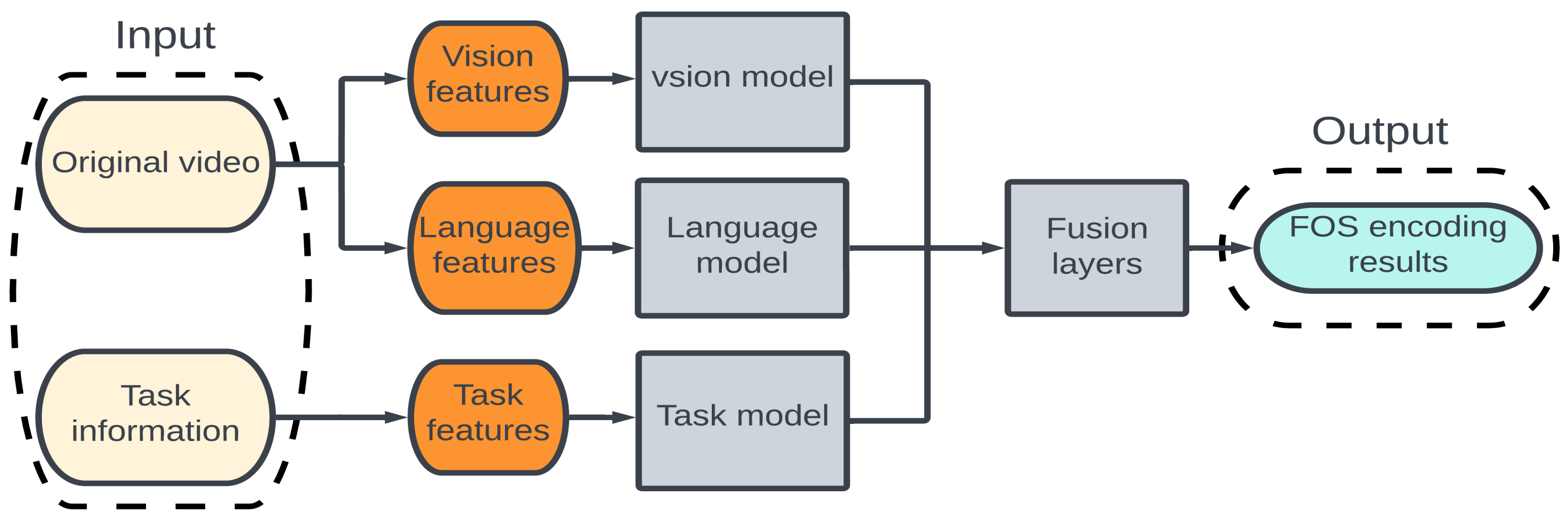
- Segmented the original video into 10-second intervals for each encoding
- Do the data argumentation by key frame random sampling
  - One video can be trained multiple time to study more features

❖Model training

- We divided the original dataset to three parts based on the ISs
  - Vision modality IS: primarily identified by action-based information, such as Physical Negative (**PN**)
  - Language modality IS: identified through language-based information, such as Praise (**P**)
  - Combined modality IS: Both language and vision information will used to make prediction, such as Non-compliance (**NC**)
- Currently, we designed vision-based model and continue working on the language-based mode and combined model
- Our vision-based model is modified from the **fast-slow Resnet** (Feichtenhofer et al., 2019), as shown in Fig. 1
- In the future research, we will also **integrate the task information** into our model to increase the recognition precision
- Fig. 2 shows the general structure of our research



<Figure 1> Basic structure of the fast-slow Resnet



<Figure 2> General structure of the multi-modality IS recognition.

Initial Results

- We finished training the **vision-based model**
- Evaluate dataset performance
  - General prediction accuracy: **82%**
  - Prediction F1 score: 0.59
  - Prediction precision: 0.51
  - Prediction recall: 0.68
- The language-based model's architecture is not decided yet
- We have decided to use a structure based on self-attention for multi-modal recognition, to fully leverage task information and language information, aiming to improve the predictive accuracy of the model

Conclusions

- **Deep learning-based behavior recognition of children with autism** : *Automate FOS data encoding, training* by task-specific videos of children with autism
- **Integrated task information and other multi-modal data**, such as video and audio, to enhance the model's efficacy, addressing a gap in previous studies
- The collected dataset includes 216 videos of children with autism or their guardians performing different tasks, which are then encoded to describe their interaction styles
- **A three-step sequential training** was carried out for the model based on vision, language, and combined vision-language modalities
- **Preliminary results showed promising accuracy of over 80%** for the initial visual information classification model, built on the fast-slow Resnet architecture
- Future work: commence the construction of a language model and a multi-modal approach and improve the overall model accuracy

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More Information

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