AI-based Web Application for Children with Autism Spectrum Disorder

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Abstract. Autism spectrum disorder has recently become increasingly popular with people as they struggle with their ability to adapt and interact. This project aims to help children with autism spectrum disorders learn language, emotion and sensory functions through the development of web applications using AI computer vision technology. This project applies ABA therapy and PECS programs, and provides functions such as emotional playroom, word playroom, and tree growing. In addition, object recognition is performed using YOLOv8, the latest deep learning model, and real-time webcams provide experiences for autistic children to execute and achieve on their own. The goal of this project will help improve the learning environment and quality of life of autistic children by overcoming the limitations of existing educational programs and developing web applications with high accessibility and effectiveness.

Keywords: AI · YOLOv8 · ADS.

1 Introduction

Autism spectrum disorder (ASD) is a developmental disorder that affects the way individuals communicate, interact, and perceive the world around them. It is characterized by a wide range of symptoms and levels of severity, which can result in significant challenges for those affected and their families. In recent years, the prevalence of ASD has increased significantly, with Korea experiencing an eight-fold increase in cases over the past 20 years. This growing prevalence highlights the urgent need for effective interventions and support systems to help individuals with ASD and their families.

One of the primary challenges faced by children with ASD is learning language, emotion, and sensory functions, which are critical for social adaptation and interaction. Existing educational programs for autistic children often lack effectiveness and accessibility, and may also be associated with high costs. Consequently, there is a pressing need for novel and innovative approaches to help children with ASD overcome these learning challenges.

In this paper, we present a web application that leverages AI computer vision technology to help children with ASD learn language, emotion, and sensory functions. By integrating Applied Behavior Analysis (ABA) therapy and the Picture Exchange Communication System (PECS) programs, our solution aims to overcome the limitations of existing educational approaches and provide a more engaging and effective learning experience for autistic children. The web application includes features such as an emotional playroom, word playroom, and tree-growing activity, all designed to foster a sense of accomplishment and motivation for continued learning.

We employ YOLOv8, the latest deep learning model for object and facial expression recognition, in combination with real-time webcams to facilitate independent learning experiences for children with ASD. This approach not only increases accessibility but also allows autistic children to execute and achieve tasks on their own, which can greatly enhance their sense of accomplishment and overall learning experience.

Ultimately, our project aims to improve the learning environment and quality of life for children with ASD by providing a more accessible and effective educational platform. By harnessing the power of AI and innovative learning techniques, we strive to empower children with ASD to develop the skills necessary for social adaptation and interaction, thus alleviating some of the challenges faced by them and their families.

2 Motivation and objective

2.1 Motivation

Autism spectrum disorder has recently attracted public attention due to the influence of the drama "Extraordinary Attorney Woo" but the grievances of people with autism and their families still exist in reality. In particular, Korea's prevalence of autism spectrum disorder is high in the world and seems to have increased eight times over the past 20 years, desperately requiring social attention and management. To solve these problems, we propose the development of web applications using AI computer vision technology. Through this, we want to help children with autism learn language, emotion, and sensory functions.

2.2 Objective

Children with autism spectrum disorders need a lot of learning to adapt to society, but there is a lack of related programs and cost problems. Also, online programs and applications are not enough. This project can provide an important solution to these problems. Most of the existing autistic children's education programs were conducted by uploading photos taken during the photo imitation stage. However, this method is difficult for autistic children to practice alone, so more effective methods are needed. In this project, we intend to apply two learning methods for autistic children: ABA therapy and PECS programs. To

this end, web applications are provided with functions such as emotional playroom, word playroom, and tree-raising. We also use the latest deep learning model, YOLOv8, to perform object recognition, and use real-time webcams to provide experiences for autistic children to execute and achieve on their own. This approach is expected to overcome the limitations of existing approaches and provide more effective learning experiences for autistic children.

3 Problem statement and proposed solution

Children with autism spectrum disorders typically have difficulty learning language, emotion, and sensory functions. This difficulty in learning also affects their social adaptation and interaction skills, which can reduce the quality of life for them and their families. There are currently educational programs for autistic children in the marketplace, but they often lack effectiveness and accessibility, and there are also cost problems. Therefore, in this project, we want to solve the following problems.

3.1 Problem statement

Low accessability
Traditional online education programs required a cumbersome process for children with autism spectrum disorders to take pictures, access galleries, and upload photos. Not only does this process make it difficult for children, but it also hinders them from focusing on learning. These problems make it difficult for children with autism spectrum disorders to easily access and understand the program and reduce their interest in using it.

Low accomplishment
Existing online education programs lack personalized feedback or clear learning goal setting, making it difficult for children with autism spectrum disorders to feel a sense of accomplishment. This reduces learning motivation and hinders continuous learning. In addition, even if you get the right answer, there is a lack of a compensation system through various activities, so there is no environment for children to enjoy learning. For this reason, it is difficult for children with autism spectrum disorders to feel a sense of accomplishment in the learning process.

3.2 Proposed solution

To achieve the objectives of this project, the following strategies have been planned: In the past, most people used to upload photos taken during the photo imitation phase But because it's hard for autistic children to do this alone, we're going to use real-time webcams to improve our ability to communicate success on a real-time screen, giving autistic children the experience of self-execution and achievement

Using YOLOv8, the latest deep learning model, we perform object recognition and facial expression recognition. Real-time webcams are designed to make it easier for children with autism spectrum disorders to start and progress programs without the help of their guardians. Through this, children can feel a sense of accomplishment and enjoy the learning experience alone. This accessibility provides an independent learning environment for autistic children and is an important factor in reducing the burden on carers. Our program tries to give rewards such as praise narration if you get the right answer. In addition, we introduced the following reward idea of 'growing trees'. Allow children to collect stickers or badges according to their goals or levels achieved in the learning process. Through the collected stickers, trees can be grown, and through this, children can continue to maintain motivation and feel a sense of accomplishment.

Through these initiatives, the project will contribute to improving the learning environment and quality of life of children with autism spectrum disorders by providing more effective and novel learning methods.

4 Background and related work

Autism Spectrum Disorder (ASD) is a developmental disorder that usually affects language, social interaction, interest and behavior patterns. ASD covers a wide range of symptoms, and the severity and extent of the symptoms vary widely. For this reason, the term "spectrum" is used and refers to a collective characteristic that includes various aspects and degrees of symptoms, rather than a single specific disease. There are four typical treatments for autism spectrum disorder

- Behavioral Therapy - intended to inhibit inappropriate behavior
- Music therapy – controlling emotions and improving social skills
- Physical therapy – immature movement, improved sense of balance
- PECS (Photo Exchange Communication System) – Communication and Appraisal

In this project, we use two widely used and validated techniques, the Photo Exchange Communication System (PECS) and Applied Behavioral Analysis (ABA), to aid the learning process of children with Autism Spectrum (ASD). These technologies have been used in various situations, but the combination of artificial intelligence-based computer vision technology and web applications is a new approach in this project.

4.1 PECS

PECS is a communication intervention method designed specifically for individuals with autism spectrum disorder and other communication difficulties. This method focuses on teaching such individuals to initiate functional communication using photographs and symbols. PECS has proven effective in improving communication skills in children with ASD, allowing them to express their needs,

preferences, and emotions more effectively. In this project, we leverage the principles of PECS to promote emotion representation and object-aware learning in gamified web applications.

1. Basic Principles of Exchange - Exchange pictures or pictures to get the things or activities that the child wants.
2. Increase Distance and Persistence - Helping children to exchange photos or pictures to get the things or activities they want.
3. Differentiate picture selection - Allows children to choose from a variety of pictures depending on the object or activity they want.
4. Introduction of sentence structure - Helps children create sentences by combining words to request objects or activities they want.
5. Respond - Allow children to respond to other people's questions using pictures or pictures.
6. Comment - Help children leave comments about their surroundings.

PECS helps improve children's communication skills, which helps them adapt more to social situations and participate more effectively in learning environments. For this reason, PECS is widely used in educational programs for children with autism spectrum disorders.

4.2 ABA

ABA is a treatment approach based on learning theory and behavior modification principles, aimed at improving socially important behavior in individuals with ASD. This method breaks down complex tasks into smaller, teachable units, and enhances desired behavior through a system of rewards and outcomes. ABA has been widely recognized as an effective intervention for children with ASD, helping them acquire new skills and reduce unnecessary behavior. In this project, we will combine ABA with computer vision technology to develop web applications to help children with ASD improve their emotional and language skills.

4.3 AI-based background : YOLOv8

Emotional and Language Development Education Program for Autistic Children Using YOLOv8 We propose a real-time screen recognition children's emotional and language development program using YOLOv8. The program includes:

- YOLOv8 for dataset training (SW)
- Dataset collection and processing using Roboflow site (SW)
- Real-time detection of facial expressions and other objects of autistic children using OpenCV (SW)
- Implementation of a compensation system for successful missions of autistic children (SW)

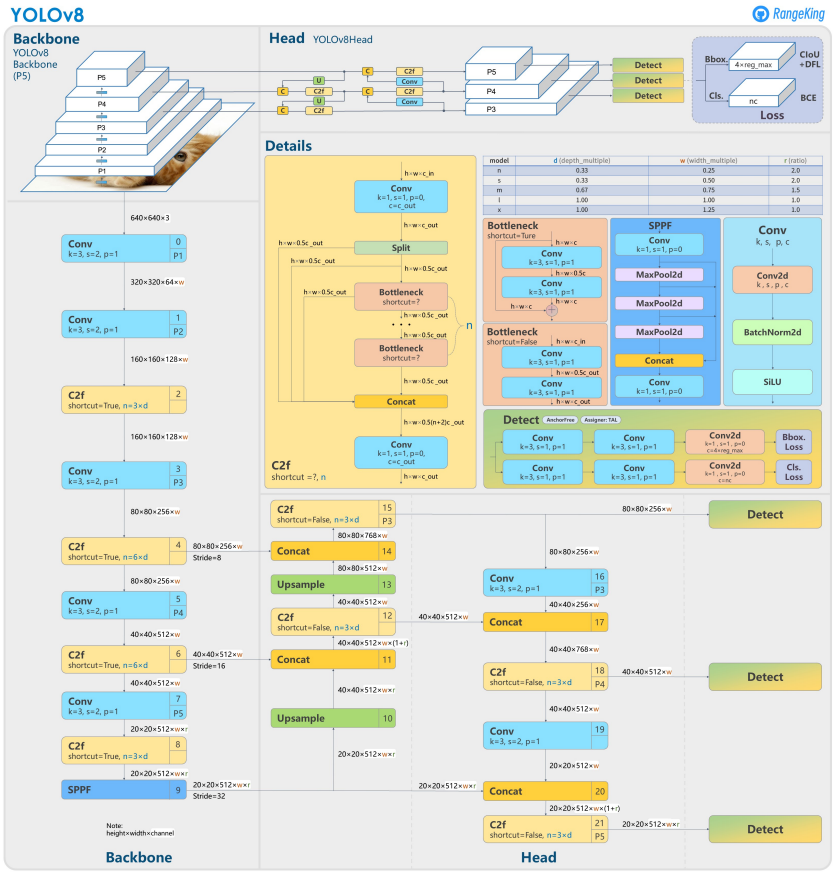

Fig. 1. YOLOv8 Architecture Model

Development of SW using YOLOv8 YOLOv8 is the latest YOLO model available for object detection, image classification, and instance partitioning operations. It reflects numerous architectural changes and improvements over traditional YOLOv5, such as:

- Anchor-free detection
- New convolution
- Closing the mosaic augmentation

Performance Comparison YOLOv8 achieves higher accuracy than YOLOv5 in COCO. The intermediate model, the YOLOv8m model, achieves 50.2% mAP when measured at COCO. It also improves RF100 accuracy over previous versions. Compared to YOLOv5, the YOLOv8 model achieves similar results on each dataset or shows better average mAP numbers overall.

▼ Detection

Model	size (pixels)	mAP^{val} 50-95	Speed CPU (ms)	Speed T4 GPU (ms)	params (M)	FLOPs (B)
YOLOv8n	640	37.3	-	-	3.2	8.7
YOLOv8s	640	44.9	-	-	11.2	28.6
YOLOv8m	640	50.2	-	-	25.9	78.9
YOLOv8l	640	52.9	-	-	43.7	165.2
YOLOv8x	640	53.9	-	-	68.2	257.8

- **mAP^{val}** values are for single-model single-scale on COCO val2017 dataset.
  Reproduce by `yolo mode=val task=detect data=coco.yaml device=0`
- **Speed** averaged over COCO val images using an Amazon EC2 P4d instance.
  Reproduce by `yolo mode=val task=detect data=coco128.yaml batch=1 device=0/cpu`

Fig. 2. YOLOv8 COCO evaluation

New Tracking Functionality Previously, the tracking function had to be used to analyze images using an external tracking tool such as bitetrack or depsort. However, YOLOv8 recently updated its own tracking model. The tracking algorithms provided are botsort.yaml and bytetrack.yaml, and the default tracker is botsort.

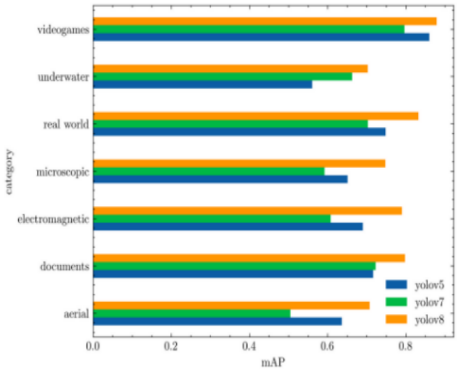

Fig. 3. Average mAP for RF100 category

Training Results Compared to YOLOv5, the YOLOv8 model produces similar results on each dataset or shows better average mAP numbers overall.

5 Planning in detail

5.1 Task assignment

This project is largely divided into two tasks: AI and web development. We decided tasks based on the interest and competence of individual team members. In addition to the designated tasks of members, we will divide the additional tasks as needed flexibly.

Table 1. Main tasks of individual team members.

Name	Task
Choi Nayoung	**data collecting, labeling, model training, HI**
Kim Seyeon	**data collecting, labeling, model training**
Kim Yongtaek	**model performance measurement, program performance improvement**
Kim Jiwon	**web development, data collecting, labeling**
Lee Jongwoo	**web development, data collecting, labeling**

5.2 Project schedule

Based on the tasks that we divided above, we set the project schedule briefly. The schedule can be modified depending on the situation.

Table 2. Project schedule.

March	April	May	June
Topic selection, data collection	Labeling and model training	Program development	Program development model/program

6 References

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