SignPal: An AI-Driven Sign Language Recognition System for Teaching Younger Children Sign Language

Problem Statement:

Communication is key for personal and social development. However, it remains a challenge for those with hearing impairments. Sign language is the most common way in which deaf or hard of hearing individuals communicate, although it can be challenging for younger children to learn sign language. Traditional methods of teaching sign language can be ineffective for younger children as they lack engagement and accessibility.

To address this problem, we are planning to design a software system that converts an inputted video of sign language gestures into digital letters, the goal of this project is to make learning sign language more accessible and engaging for younger children. To do this we are going to use a range of machine learning algorithms and techniques that can recognise certain gestures and convert them into text-based representations. This project aims to make learning sign language simpler and more efficient for younger children.

Our project will tackle a few limitations in the field of sign language recognition and conversion such as the lack of accessibility of resources for younger learners, the inefficiency of traditional methods of learning and the lack of engagement of current learning materials.

Problem Motivation:

The initiative of our project grew as we saw the critical need for more effective systems in the field of sign language learning especially for younger children with no experience of the language. The motivation for this project also came from the challenges faced by the younger children learning sign language such as the accessibility and engagement of the teaching materials as explained above in the problem statement.

During the past few years, the demand for digital learning has grown significantly providing more of a reason to pursue this project as this will improve accessibility as there'll no longer be a need for in person instructors which can greatly limit accessibility for some children.

This project will not only benefit the younger individuals learning the language as it can be used by teachers in classrooms to aid with the teaching, but it can also be used at home by parents to provide a means of communication between parents and their children improving family's quality of life as communication will become easier.

Literature Review:

The use of sign language plays a significant role in the communication for the deaf and hard of hearing community. Traditional methods of teaching sign language to children can be ineffective and inefficient. Recently, machine learning has been used to enhance sign language education through improved accuracy and more accessibility [1]. In this literature review, we will explore the potential

of using sign language recognition systems and sign language to text conversion to create a system for teaching sign language to young children. We will examine the current state of research in this area, including the challenges and limitations that need to be overcome to make this technology more effective and accessible. The goal of this project is to create a tool that can help young children learn sign language in a fun and interactive way.

Sign language teaching methods:

Traditional methods of teaching sign language include in person instruction, learning from books and videos. Whilst these methods can be effective, they have many limitations. For example, in person instruction requires a sign language expert which may not be an accessible option for all young children [2]. Using books and videos doesn't provide an interactive way of teaching younger children sign language which correlates to low engagement hence making this method inefficient in teaching younger children sign language.

Machine learning can address some of the limitations in traditional methods of teaching sign language. For example, real time sign language recognition which can give children instant feedback on their signs, this allows for more engagement and thus leading to more efficient learning. Using machine learning will also allow for more accessibility as sign to text converters provide subtitles under the videos which can help children that are not proficient in the language yet by giving precise feedback quickly.

Furthermore, machine learning can be used to create interactive games and activities for younger children, this can be done by giving children rewards whenever they get a gesture right. This method can further increase engagement contributing to a more effective teaching method as it can help them learn in a more playful way [3].

Sign language recognition technologies:

The first step of building a sign language recognition system is to gather a large dataset of sign language gestures. This includes videos of people performing different gestures of letters, words and phrases. For our system that teaches young children we will look for a dataset containing gestures for different letters and some common words as well. Machine learning comes in play as we will require neural networks to recognise the patterns in the different gestures and features performed in the inputted videos. Recognisable features include hand shape and movement as well as body movement.

Machine learning algorithms are trained on this dataset, this is the procedure in which we can detect different gestures. Neural networks are the most common algorithms used in such systems as they work by mimicking the function of the human brain which allows them to be very accurate and efficient in recognising various signs and gestures.

Once the algorithm is trained, we can then implement it into a system that recognises all the different gestures in real-time, computer vision techniques are typically used to capture the video of the person performing the different gestures then the algorithm recognises them and translates them into whatever format the user may want such as digital text in a document or subtitles under the video.

An Example of a commonly used sign language recognition system:

Sign language to digital text conversion is a method used to translate sign language to written language, advances in digital technologies have allowed us to be able to use such recognition systems from the comfort of our own home using computers, tablets and even on the go using mobile phones, this allows deaf or hard of hearing people from all age groups to communicate effectively.

This system works by capturing the movements of the signer and translating them into meaningful letters, words and sentences. This is done through the machine learning algorithms that have been trained to recognise such movements and gestures.

Using sign language to digital text systems can have significant benefits when it comes to teaching young children sign language. This interactive display that shows the letters directly under the signer is eye-catching for the younger children which in turn increases their engagement and willingness to learn. It's also very effective because when the children perform a wrong sign the system will detect that and give instant feedback allowing room to focus on weaknesses by supervisors.

Additionally, this system can be used by parents and teachers to help and support children through their challenges as they also can follow along with the signs further bridging the communication gap between them and the children [4].

Challenges and Limitations of sign language recognition:

1- **Sign variations:** Just like spoken languages sign language is not universal and people have personal preference on ways to sign certain words which may not be recognised by these systems as they usually are trained using a large dataset with common gestures and not unfamiliar ones that the signer may perform. This illustrates that not all systems will support all types of sign language which may lead to regional inequalities as some people will be able to access the system while others won't.

   To address this challenge, there could be a live instructor that shows children different variations and dialects of signs once they are proficient in the one they are learning so that they're able to communicate in different circumstances.

2- **Technical issues:** Earlier we discussed that these software's are very accessible with advancing technologies such as tablets, computers and mobile phones. However, these types of systems are still under development and the more common sign language recognition systems require special hardware and software to run effectively. This again affects accessibility in areas where this may not be affordable, furthermore these systems are not always made so that they're easy to use and can certainly be a challenge to run in the correct way, this will also limit the use were the parents or teachers must be available with the children to assist them with using the system as they may not be able to run it themselves.

   There are many factors that may affect the accuracy of the system for example lighting and audio if the lighting is poor the system may not be able to detect the signs or may interpret them different to what they are.

   To ensure these issues are minimised you can choose an area where the lighting is most optimal so the system can easily identify the signer, training for use in schools so that when issues with the software or hardware occur someone can fix the problem and so that the

system is used most effectively and most importantly make sure equipment is of the highest quality possible and is always updated and maintained.

3- **Accuracy:** While the software has been designed to recognise a specific set of signs, it may not always be able to recognise signs accurately, which can lead to misunderstandings and frustration for both the teacher and the student.

   The main reason for inaccurate recognition systems when it comes to sign language recognition is the complex hand movements and gestures that the software may not be able to detect, additionally sign variations may not be included in the systems database which may lead to inaccurate translations of certain gestures leading to confusion for young children when learning for the first time.

   There are many other reasons for why the accuracy of the system may decrease from signing speed to hand positioning all which may lead to an ineffective system for teaching young children.

   To overcome these issues, we can use sign language recognition as an important tool for teaching sign language rather than the main method of teaching, where teachers can observe and give feedback to young children immediately to help address their weaknesses more effectively.

Conclusion:

In conclusion, traditional methods of teaching sign language to children can be ineffective and inefficient. However, the use of machine learning has the potential to address some of the limitations of these traditional methods by enhancing accuracy and accessibility. By using real-time sign language recognition systems, children can receive instant feedback on their signs, leading to increased engagement and efficient learning. The use of sign language to text conversion can also have significant benefits for teaching children sign language. However, challenges such as sign variations and technical issues still need to be addressed to make this technology more effective and accessible. Overall, the goal of using sign language conversion to digital letters is to create a tool that can help young children learn sign language in a fun and interactive way. Future research can focus on improving the accuracy and accessibility of these systems and exploring ways to address the challenges and limitations.

Project Statement:

Project Title:

SignPal: An AI-Driven Sign Language Recognition System for Teaching Younger Children Sign Language

Project Overview:

SignPal is an innovative software engineering project that uses machine learning algorithms and computer vision techniques to create a user-friendly sign language learning system for younger children. This interactive system is designed to help children recognise and perform basic sign language gestures and a few common words, making it easier for children with hearing impairments or those who want to learn sign language to communicate more effectively. By leveraging the power of machine learning and natural language processing, SignPal aims to create an effective and engaging learning model that can make a significant impact on the lives of individuals with hearing impairments.

Project Objectives:

To design a machine learning based sign language recognition model
To create an interactive system for young children that increases their engagement
Review and evaluate the system we have created

Project Scope:

In this area will be explained how the project will be carried out and how we hope to reach our goal as a team:

1. **Project Ideation, Solution Design:** Explain the main idea of the project and what the aim of it is and then go on to design a solution that will allow us to achieve our project goal by creating requirements that will be implemented into the system.
2. **Baseline Development**: This is where we will start our project by developing a baseline model for how our system will work I.e., preparing initial dataset and evaluating it. This mission will determine our benchmark and we'll compare our final system to this to see the performance improvement.
3. **Iterative Development:** In this mission we touch on different machine learning models e.g., neural networks which help recognise patterns of hand movement etc., furthermore we'll explore parameter tuning methods that'll help improve predictive performance of our system such as the common grid search method where hyperparameters are defined and all possible combinations are evaluated, and the highest accuracy is selected as the most optimal for the model.
4. **Solution Testing:** Once the iterative development of our system is complete, we'll then test our model extensively according to a specific plan which will include case studies that'll perform certain tests and then report the results back to our back, this mission aims to identify the flaws in our system so that further improvements can be made enhancing the effectiveness of the overall system.
5. **Additional Data, Mathematical Review:** These missions aim to further enhance the effectiveness of our system by integrating in an additional dataset to the iterative development stage that can convert common phrases for younger children to learn once they're proficient in simple gestures. A mathematical review will provide us with a formula for the machine learning algorithms used in the project with justified reasons and references for solutions.
6. **Solution Review:** Here we will review our solution by comparing it to other solutions in the field in a fair way that ensures we are not biased towards our system and that we point out areas that we may be able to improve on in the future.

7. **Project Management:** The role of the project manager will be to manage plans and schedules for team members to ensure each member is assigned equal missions and in a way that maximises efficiency for example assigning certain missions to the person with the best knowledge of that area to improve the overall performance of the system. It is important to also monitor progress throughout the project so that changes can be made if needed.

Conclusion:

In conclusion, our project proposes a novel approach to using sign language recognition systems to teach young children sign language. By leveraging the power of machine learning and natural language processing, the project aims to create an innovative learning model that can help children with hearing impairments or those who want to learn sign language to communicate more effectively. The project's focus on developing a robust and accurate sign language recognition model that allows for more engagement for young learners represents a unique and valuable contribution to the field. Overall, the project's plan and approach have been carefully designed to address a vital need and have the potential to make a significant impact in improving the lives of individuals with hearing impairments.

References:

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