LetterBuddy’s Detailed Requirements

Stakeholders:

Children and adults who guide them in their handwriting learning process (such as parents, teachers, and therapists).

Functional Requirements:

1. User Registration:
    - Adults can register by providing their name, email, username, and password.
    - Adults can register their children by providing their name, username, and password. Once they register them, they are assigned to the adult who added them, and they are able to view their progress.

2. User Authentication:
    - Both children and adults can log in to their accounts using their username and password.

3. User Authorization(roles and permissions):
    - Children can access handwriting exercises and GIFs of how to write letters correctly. They are forbidden from viewing their progression tracking, the content about correct handwriting, or managing other accounts.
    - Although the adults don't have access to handwriting exercises, they are able to access detailed progress tracking, including graphs and each of the children’s submissions, content about correct handwriting, and management of their children’s accounts.

4. Handwriting Guidance:
    - During exercises, animated GIFs are available for each letter in the child’s language to guide proper handwriting.
    - Provides content about correct handwriting for adults to help them guide the children.

5. Handwriting Exercises:
    - The system generates exercises based on the child’s past performance and their current level, as determined by the OCR and VLM evaluations.
    - The children are prompted with 3 types of exercises based on their current level: letters, words, and category-based (e.g., "Write a word from the category animal") to write.

6. Handwriting recognition:
    - Children can upload or capture their handwriting (on a blank page) using the device's camera or gallery.

- The system uses a combination of an OCR and VLM model to detect and evaluate handwriting directly from those images.

7. AI-based submission evaluation:
   - The OCR model gives a confidence score for each character detected in the child's handwriting, and the VLM provides its reading of the image. Combined, an evaluation of the submitted image is created, scoring each of the exercise's letters and the exercise as a whole.

   - Provide the child with simple and mostly positive feedback on their handwriting based on the evaluation. Focusing on what the child got right rather than what they got wrong, to encourage them to continue exercising.

8. Data stored in the database:
   - The users of the system are saved in it, each with their own role. For the child, we are also saving the ID of the parent who is guiding him.
   - After a handwriting exercise has been practiced, we save in the database: the practiced word, the expected one(if there is one), its category, and its score. In addition, we save each letter submitted in the exercise, along with the expected letter and its confidence score. To be able to detect easily confused letters and provide statistics for each letter.

9. Progression tracking:
   - Adults guiding each child can view their progression, displaying the information saved in the database in several ways:
     - Each child's submissions table - to view each one of his submissions, with an option to view the score given for the exercise, the score for each letter, the submitted image, and a textual analysis of the handwriting quality by the VLM - in a similar form that teachers and professionals often provide.
     - Visual representation of the child's progression in the form of graphs, including: average score for each letter in their alphabet, which allows spotting difficulties the child encounters with specific letters, average score in each level, daily average score showing the progression of the child over time, and letters that the child often confuses between so the adult could work on them with him.

Non-Functional Requirements:

1. Security:
    - The user's authentication process is done under a secure protocol.
    - The user's information is saved in a secure database.
2. Performance:
    - The content the child is requested to write will be generated in 3 seconds or less, at least 95% of the time.
    - The handwritten capture submitted by the child will be analyzed in 10 seconds or less, at least 90% of the time.
3. Portability:
    - Support popular browsers such as Chrome, Safari, and Edge
    - Responsive design for Android, iOS, and PC resolutions.
4. Accessibility:
    - Clear, understandable UI with large buttons and minimal text, thus easy to learn and use by children ages 5-12.
    - Ensure adults can easily access and interpret progress tracking data.
5. Safety:
    - The word generator won't generate any harmful or inappropriate words that the children are requested to write.

Use Case: Exercise Handwriting

Goal in context:
A child practices handwriting by uploading handwritten input and receiving feedback.
Scope: Handwriting practice app.
Level: Primary task.
Pre-conditions:
The child has logged into the application.
Success end condition:
The child has scanned the written and received suitable feedback; his handwriting data (scores, progression tracking, image) is updated on the DB.
Failed end condition:
The child scans the written input but does not receive feedback,
and his handwriting data is not updated.
Primary actor: The child.
Trigger: The child enters his homepage, where he can exercise.

Main success scenario:
1. The system displays an exercise for the child according to his current level, and asks him to write it on a blank page and upload it.
2. The child writes on a blank piece of paper and uploads a photo of it.
3. The system evaluates the writing using an ensemble of OCR and VLM models.
4. The system updates the child's data in the database, an exercise entity with the results is updated, and the image submitted is saved in Cloudinary(its URL is saved in the exercise entity in the database).
5. The system provides suitable feedback based on the evaluation.

Sub-variations:
1. a. The system may display a letter to write a couple of times.
1 .b. The system may display words for practice.
1 .c. The system may display a category of words to write from(like fruits, etc.).
2. a. The child uploads his handwriting by taking a photo of it using the device's camera.
2 .b. The child decides to skip the current exercise and goes back to 1.

Use-case diagram: