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AUTOMATED OBJECTIVE AND SINGLE-WORD ANSWER QUESTIONS MARKING USING HANDWRITTEN TEXT RECOGNITION

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SECV4134-01 Graphics and Multimedia Software Project II | Session 2024/2025 2

Presentation Video: https://youtu.be/LQQbpeWKRio
Demo Video: https://youtu.be/DVBZ6BLH1Ag

Innovating Solutions

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PROBLEM BACKGROUND

- ☑ Manual marking is time-consuming and tiring, leading to delays in student feedback (Rowtula et al., 2019).
- ☑ Poor handwriting or unclear answers can distract educators and lead to marking mistakes (Oche, 2014).
- ☑ Objective and single-word answers are easier to mark than open-ended responses (Süzen et al., 2020).
- ☑ Automating these simple formats helps educators focus on complex parts like essays.
- ☑ Optical Mark Recognition (OMR) can mark objective answers only, but not handwritten words.
- ☑ The SPM English Listening Test includes:
  - Parts 1–3: Multiple choice
  - Part 4: Single-word answers

  OMR alone cannot fully mark this paper.

PROJECT AIM

"Develop an automated objective and single-word answer questions marking mobile application using Handwritten Text Recognition."

PROJECT OBJECTIVES

01

To **identify the requirement** of the SPM English Listening Test assessments marking by secondary school English teachers and tutors.

02

To **design and develop** a marking mobile application that can mark handwritten objective and single-word answer questions for the SPM English Listening Test.

03

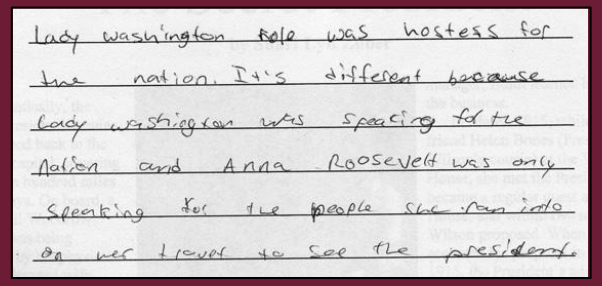
To **evaluate** the usability and perceived effectiveness of the developed marking mobile application using heuristic evaluation with domain experts.

PROJECT SCOPES

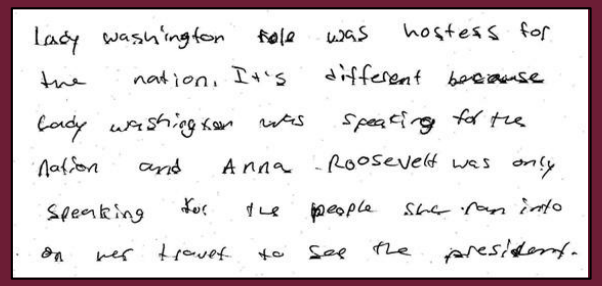
- ☑ The application is single-user based and uses computer vision to recognize handwritten answers to simulate the human marking process.
- ☑ The application is restricted to mark objective and single-word answer questions only.
- ☑ The single-word answer must match the answer scheme provided by the educators.
- ☑ The target users for this application are educators, especially secondary school English teachers and tutors.
- ☑ The application will use the smartphone camera to scan the students' answer sheets and generate marks.

LITERATURE REVIEW

IMAGE PRE-PROCESSING



Scanned Gray-scale Image (Srihari et al., 2008)



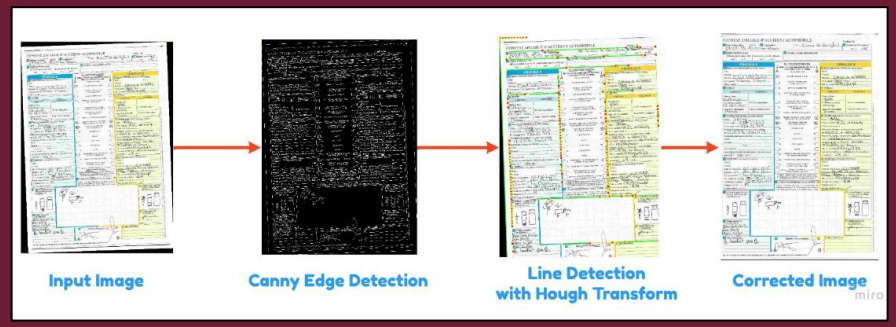
Rule–lines Detected Using the Hough Transform and Removed (Srihari et al., 2008)

01 RULE-LINE REMOVAL

The guidelines on answer sheets are intended to ensure neat handwriting but can hinder text recognition, so need to be removed.

02 DE-SKEW

In some cases, the image acquired might skew slightly. De-skewing is applied to straighten the skewed text lines.



De-skewed Image (Benchekroun, 2022)

03 BINARIZATION

Binarization divides an image into foreground (black) and background (white) pixels, aiding document analysis by simplifying complex backgrounds, varying font colors and sizes, and handling stains and wrinkles.

LITERATURE REVIEW (COMPARISON BETWEEN TEXT DETECTION AND SEGMENTATION METHODS)

Text Detection / Segmentation Models	Strengths	Limitations
Corner Point Detection	Simple step. Accurately locate text regions in documents. Works well with various image conditions. High performance.	Struggle with text in large fonts. Trouble with illustrations with highlighted corners. No layout information like paragraphs and lines.
CNN-based Approach	Works well with multi-oriented handwritten text detection. Precisely locate text regions using bounding box and pixel links. Efficiently segment text into text-lines.	Computational complexity for training.
Projection Profile (✅ Used)	Efficiently segment text into lines, words and characters. Involved pre-processing steps for better enhancement.	More complex than corner point detection. Sensitive to noise. Potential inaccuracy with overlapped and connected characters.

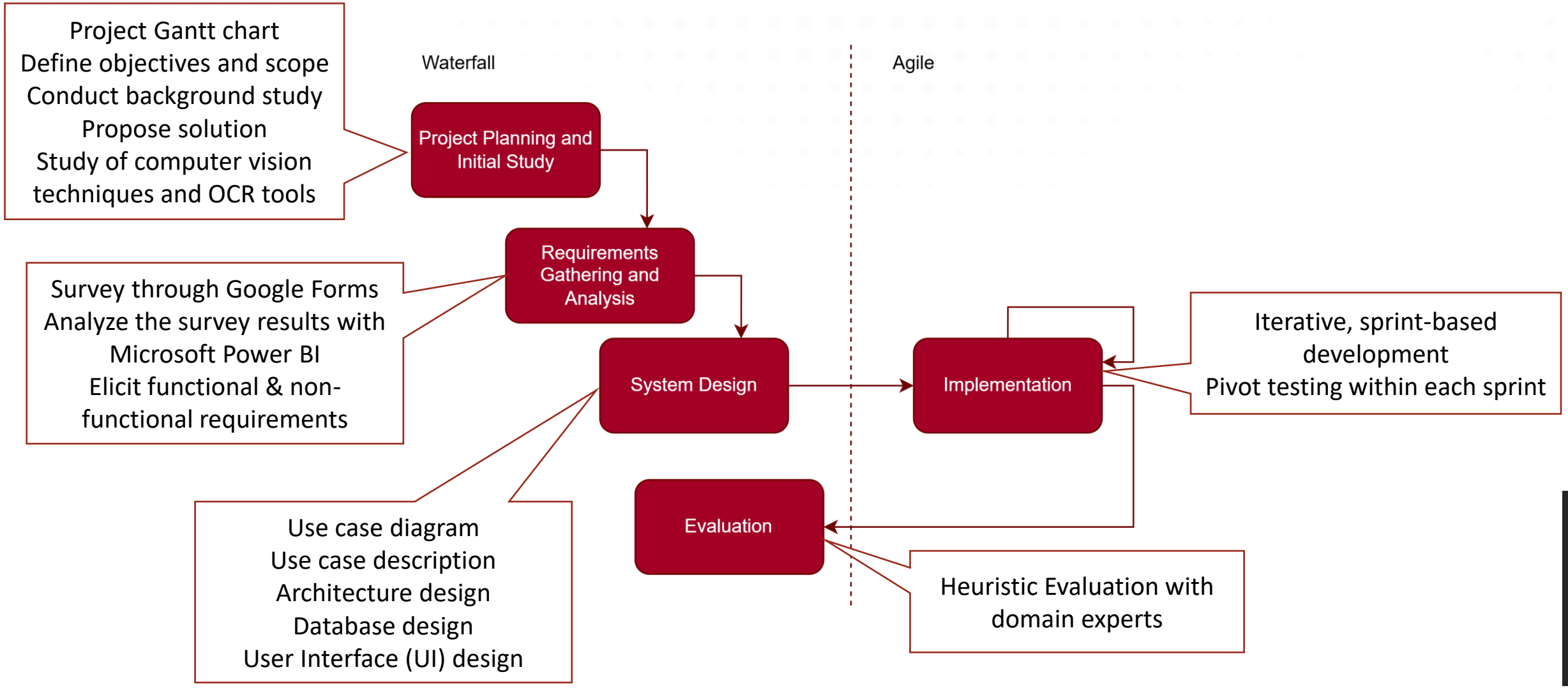
LITERATURE REVIEW (COMPARISON BETWEEN OCR MODELS (Google, n.d.; Gribomont, 2023; Tesseract-Ocr, n.d.; Thammarak et al., 2022))

Features	Google Cloud Vision API (✅ Used)	Tesseract OCR
Advantages	More accurate text recognition. No need extra development or training. Support more programming languages. Support more input format.	Free. More accurate layout detection. Can be used in command-line. Only need to download the software and no initial set up.
Disadvantages	Cost required if exceeds 1000 pages monthly. Layout detection issues. Need to follow a series of steps to set up the project and access API key.	Less accurate text recognition. Support lesser programming languages. Support lesser input format. Need extra development or training for better accuracy.

Google Cloud Vision API

Tesseract OCR

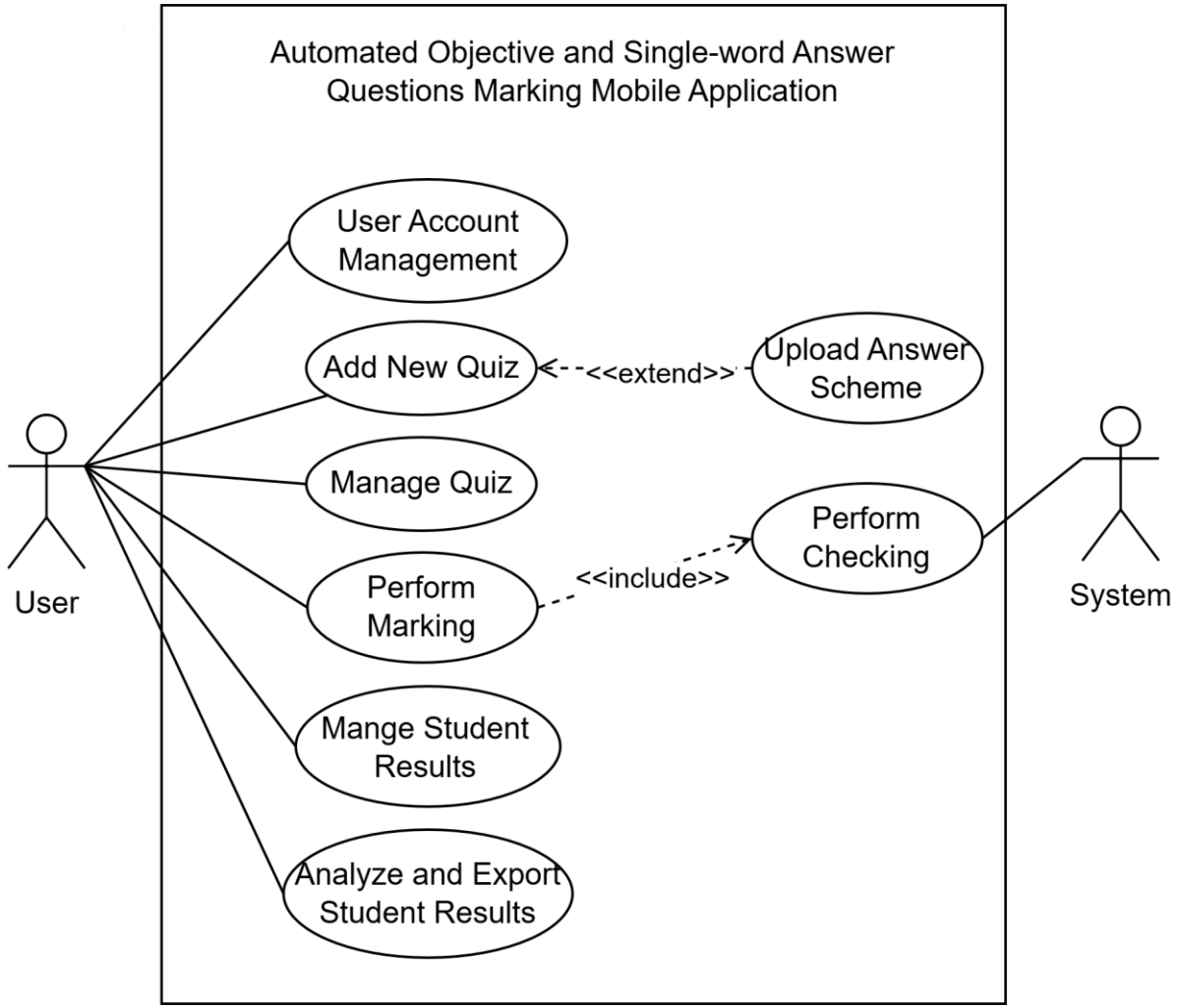
SYSTEM DEVELOPMENT METHODOLOGY



REQUIREMENTS ANALYSIS & DESIGN

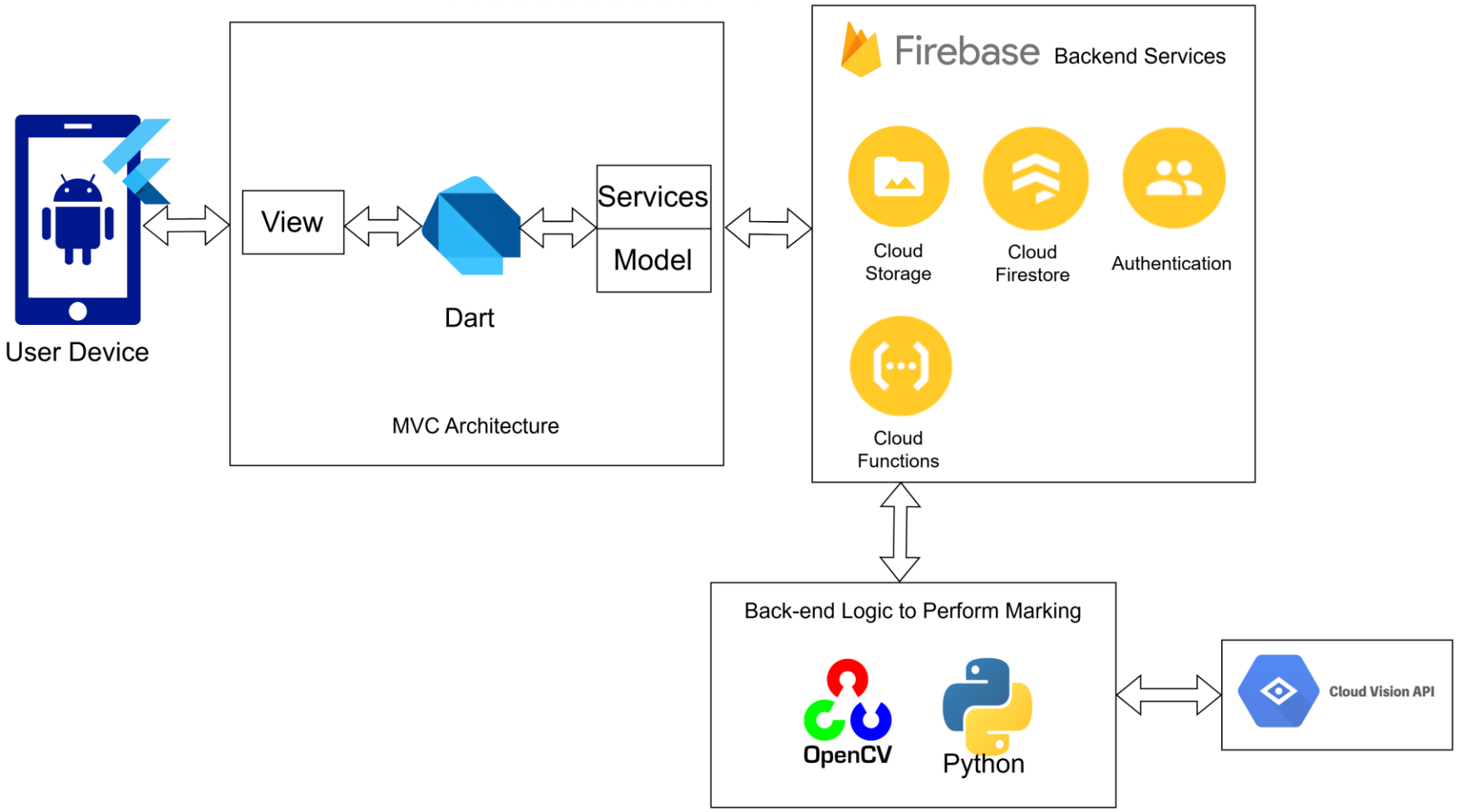
Functional Requirements	Non-functional Requirements
• The user must be able to register, log in, logout, reset passwords, change email or password, update profile, and delete accounts. • The user must be able to create, view, update, or delete quizzes. • The user must be able to upload answer schemes in the required format (.xlsx). • The user must be able to perform marking by capturing or uploading handwritten answer sheet images. • The user must be able to view, update, delete, analyze and export student results. • The application must recognize answers written on blank paper and check them against the uploaded answer scheme. • The application must store the answer sheet details of each student after checking.	• The application shall have an intuitive UI. • The application shall recognize handwritten answers using an integrated OCR engine and check them against the uploaded answer scheme. • The application shall produce consistent results when marking the same answer sheet image.

REQUIREMENTS ANALYSIS & DESIGN



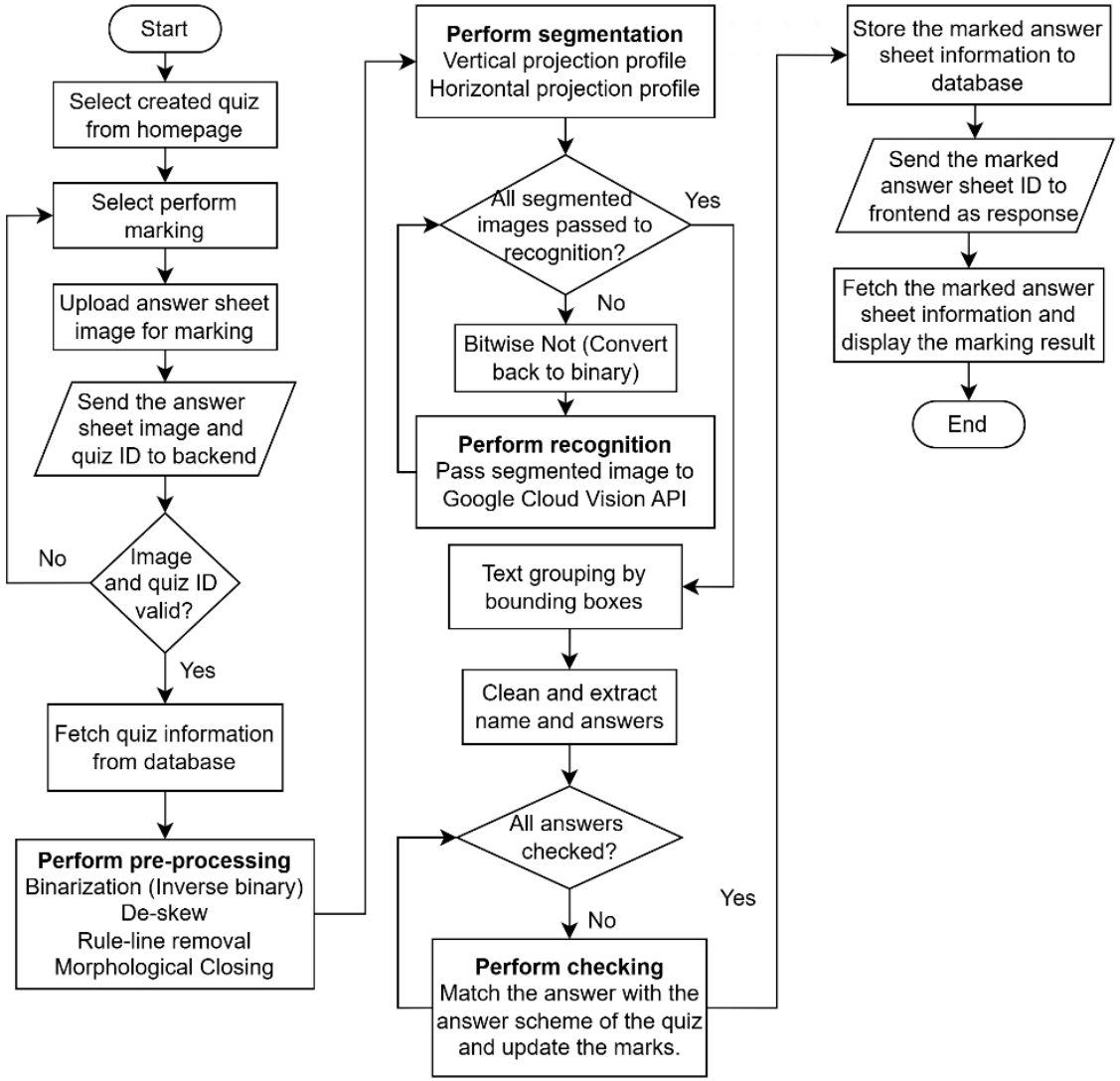
USE CASE DIAGRAM

REQUIREMENTS ANALYSIS & DESIGN

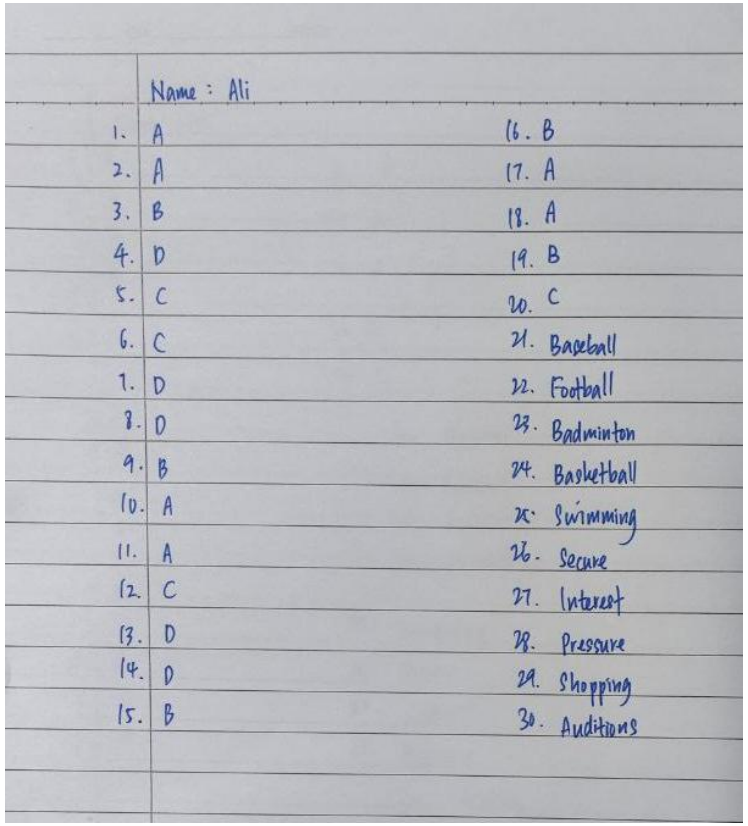


SYSTEM ARCHITECTURE DESIGN

REQUIREMENTS ANALYSIS & DESIGN



SYSTEM FLOW FOR AUTOMATED MARKING & EXAMPLE ANSWER SHEET



Name : Ali

1.	A	16.	B
2.	A	17.	A
3.	B	18.	A
4.	D	19.	B
5.	C	20.	C
6.	C	21.	Baseball
7.	D	22.	Football
8.	D	23.	Badminton
9.	B	24.	Basketball
10.	A	25.	Swimming
11.	A	26.	Secure
12.	C	27.	Interest
13.	D	28.	Pressure
14.	D	29.	Shopping
15.	B	30.	Auditions

REQUIREMENTS ANALYSIS & DESIGN

DATABASE DESIGN

(Firestore - NoSQL)

User Document

```
{
    “fullName”: string,
    “email”: string,
    “createdAt”:
        timestamp
}
```

Quiz Document

```
{
    “quizName”: string,
    “numOfQuestion”: number,
    “createdAt”: timestamp,
    “answerkey”: [
        {
            “ansID”: number,
            “ans”: [string]
        }
    ]
}
```

AnswerSheet Document

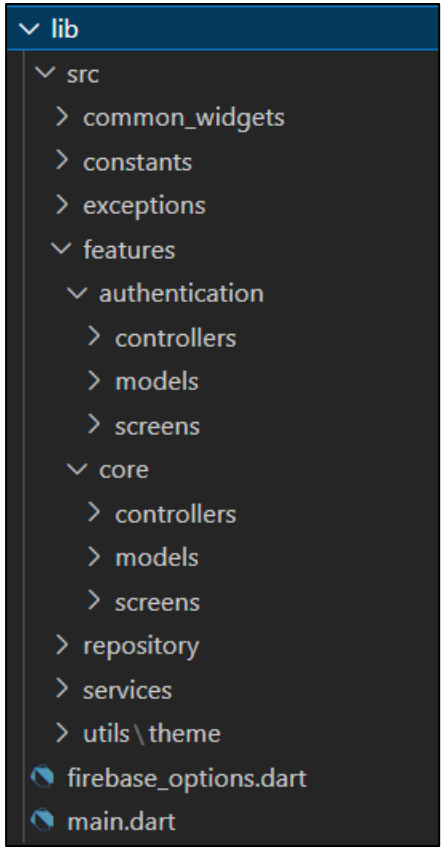
```
{
    “studentName”: string,
    “numOfAnswer”: number,
    “marks”: number,
    “sheetImage”: string,
    “createdAt”: timestamp,
    “answers”: [
        {
            “ansID”: number,
            “ans”: string,
            “bbx”: {
                “bottom”: double,
                “left”: double,
                “right”: double,
                “top”: double,
            },
            “correct”: boolean,
            “forceCorrect”: boolean

        }
    ]
}
```

SYSTEM IMPLEMENTATION

ARCHITECTURE OVERVIEW

- Based on Model-View-Controller (MVC) architecture
- Uses Flutter for frontend, Firebase for backend
- GetX (get package) for routing and reactive state
- Repositories for Firebase logic
- Services for exports, HTTP, file parsing (independent of Firebase)
- Models for quizzes, users, and answer sheets
- Network checks (internet_connection_checker package) to ensure stable operations



SYSTEM IMPLEMENTATION

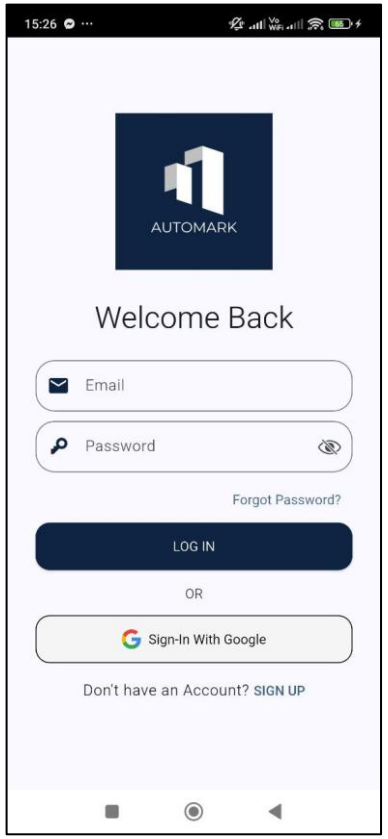
USER ACCOUNT MANAGEMENT

- Firebase Authentication with Firestore
- Supports Email/Password & Google SSO (google_sign_in package)
- Features: Register, Login, Reset Password, Edit Profile, Change Email/Password, Delete Account
- Reauthentication for sensitive actions (Change Email/Password, Delete Account)
- Custom Cloud Function: delete_user_data for full cleanup

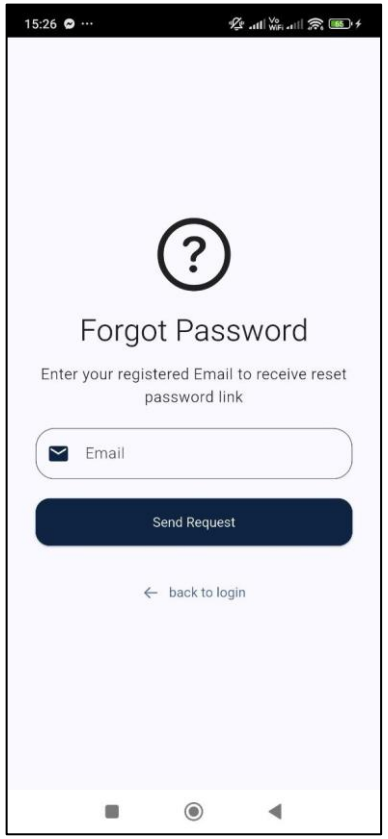
SYSTEM IMPLEMENTATION

USER ACCOUNT MANAGEMENT - FINAL UI

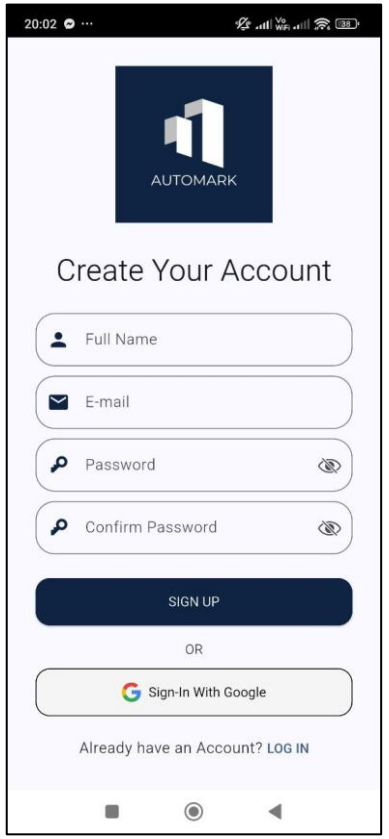
Welcome Page



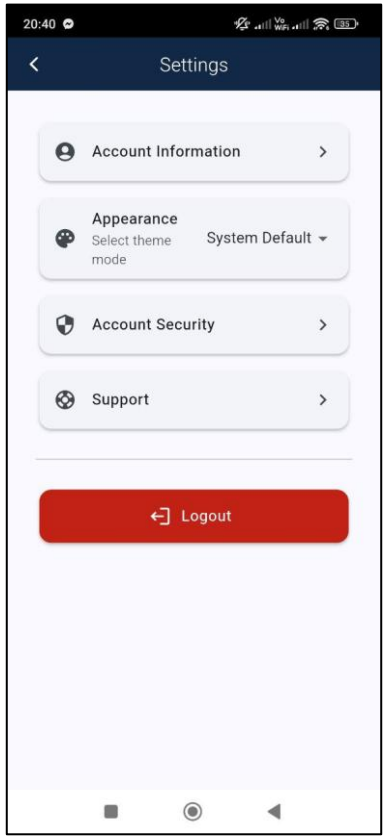
Login Page



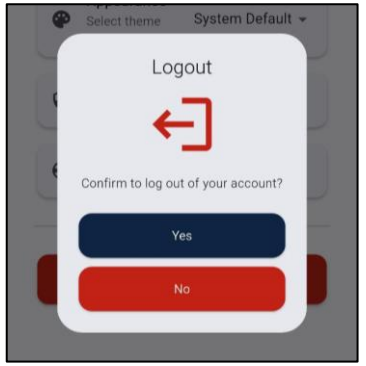
Forgot Password Page



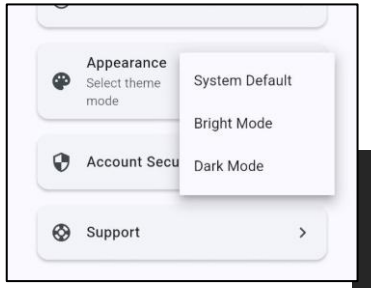
Register Page



Settings Page



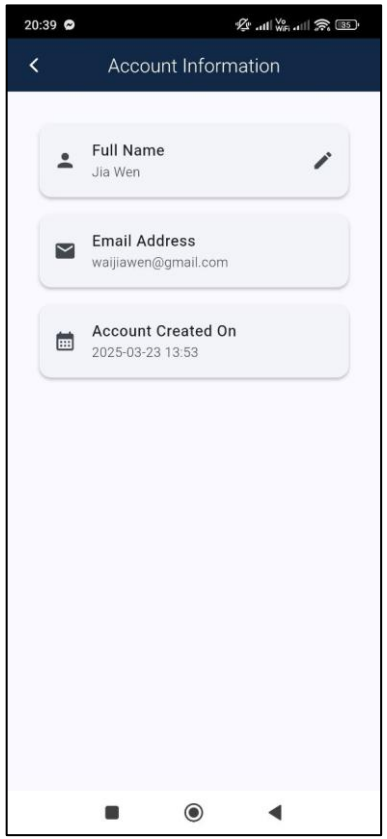
Logout Modal



Application Theme Drop-down Menu

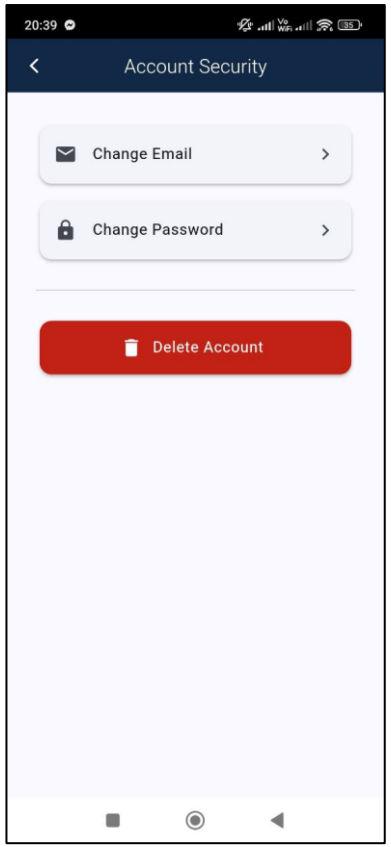
SYSTEM IMPLEMENTATION

USER ACCOUNT MANAGEMENT - FINAL UI

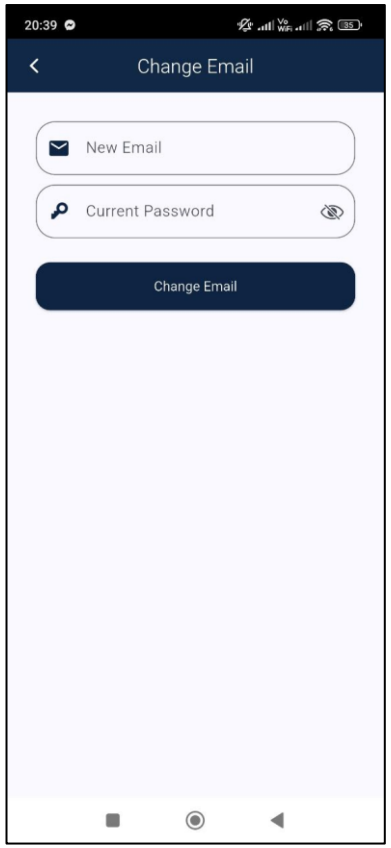


Account Information Page

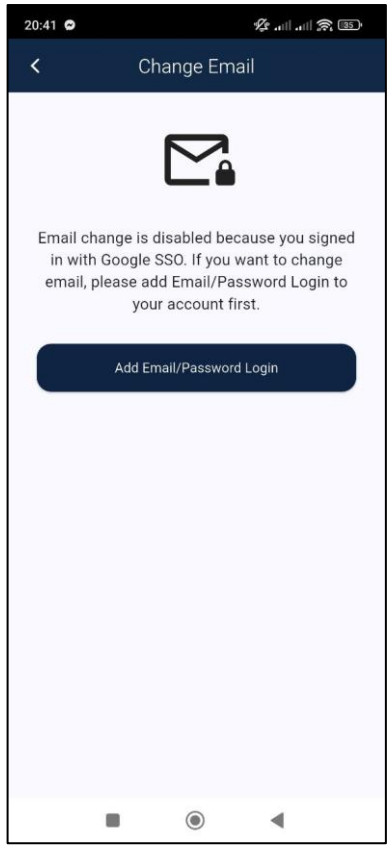
Edit Full Name Modal



Account Security Page

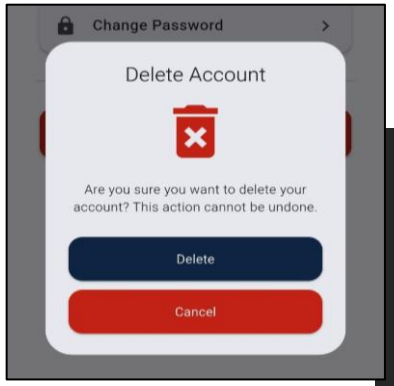


Change Email Page



Change Email Disabled Page

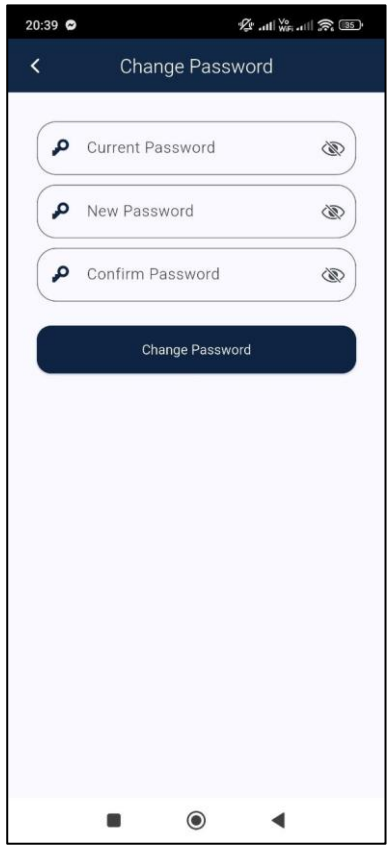
Add Email/Password Login Modal



Delete Account Modal

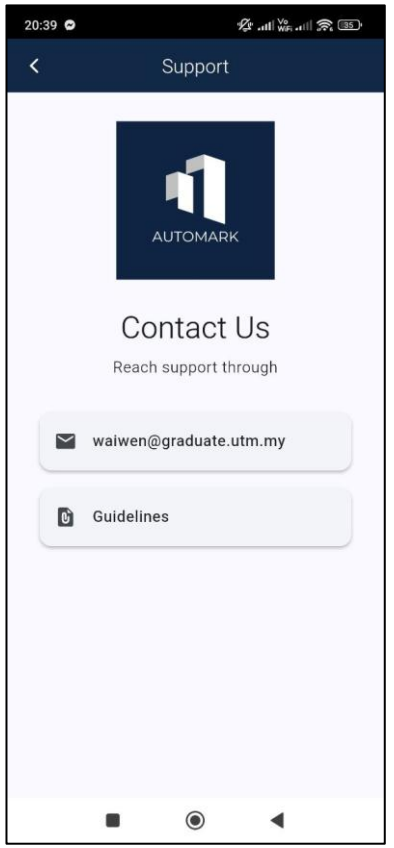
SYSTEM IMPLEMENTATION

USER ACCOUNT MANAGEMENT - FINAL UI



Change Password Page

Change Password Disabled Page



Support Page

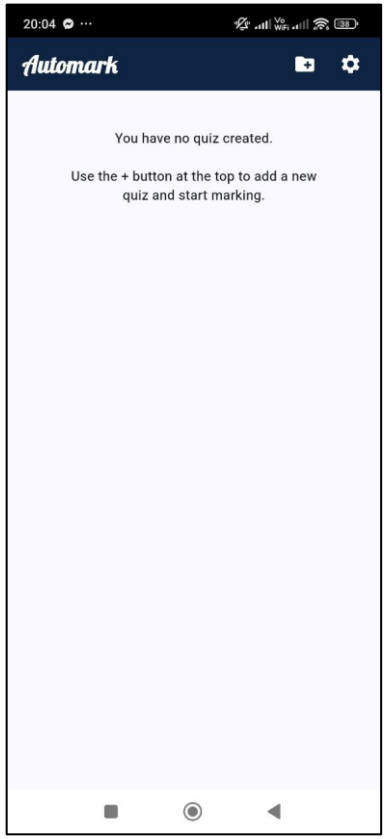
SYSTEM IMPLEMENTATION

QUIZ CREATION AND MANAGEMENT

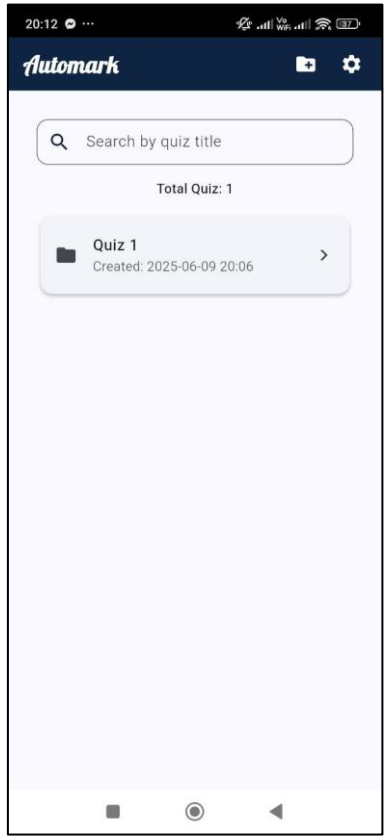
- Form-based quiz creation with validation
- Answer key upload via Excel (.xlsx)
- Parsed using excel package (only Microsoft Excel supported)
- Firebase Firestore for CRUD via QuizRepository
- Custom Cloud Functions:
  - remark_answer_sheet to re-mark answer sheets on key update
  - delete_quiz_data Cloud Function for full quiz deletion

SYSTEM IMPLEMENTATION

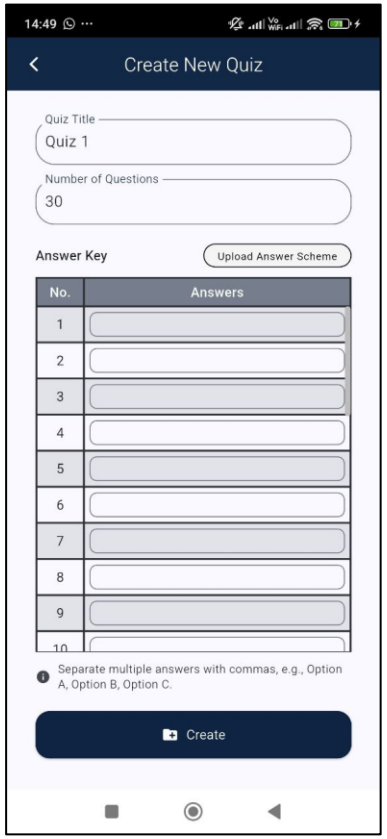
QUIZ CREATION AND MANAGEMENT - FINAL UI



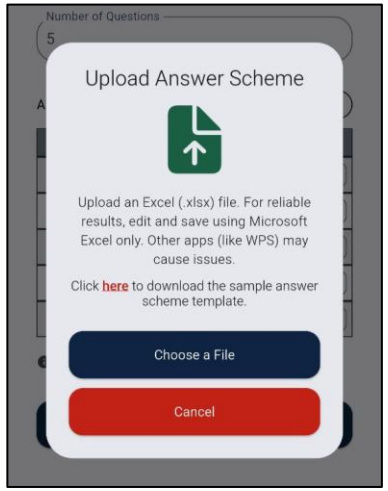
Homepage (No Created Quiz)



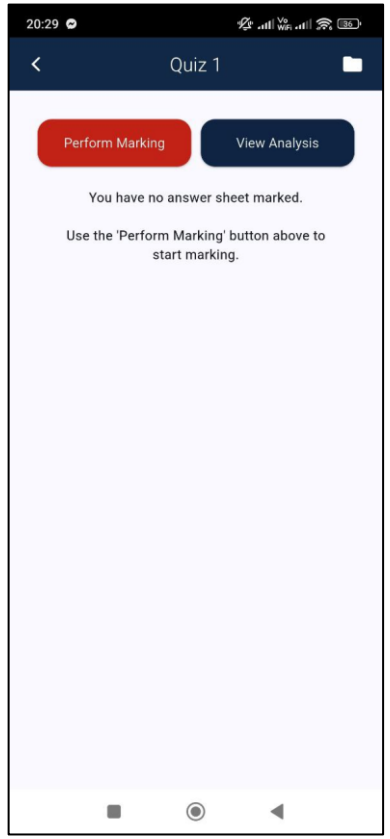
Homepage (With Created Quiz)



Create New Quiz Page



Upload Answer Scheme Modal

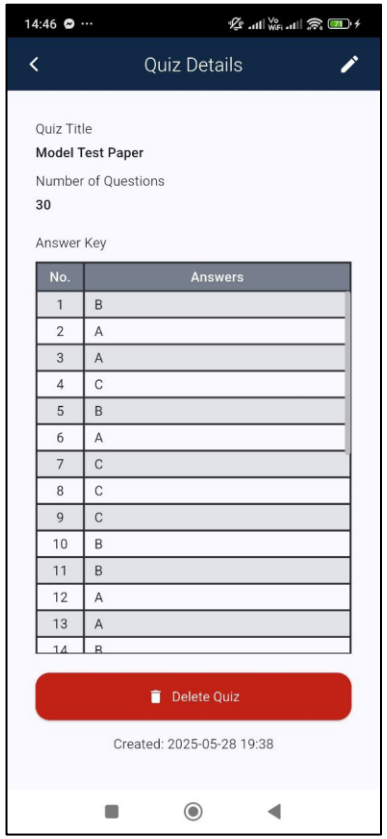


Created Quiz Page (No Marked Answer Sheet)

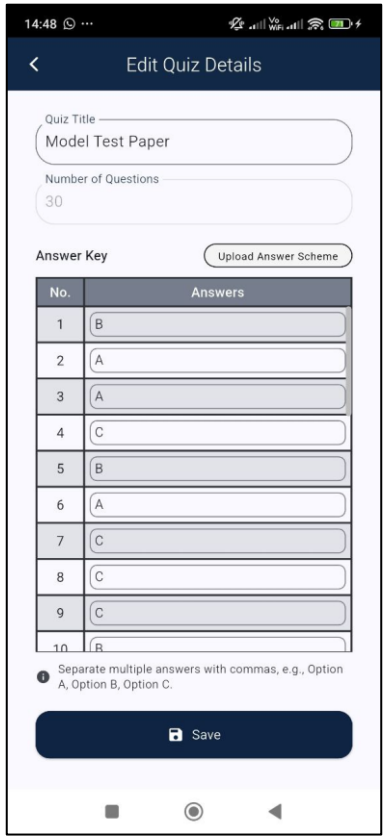
Created Quiz Page (With Marked Answer Sheet)

SYSTEM IMPLEMENTATION

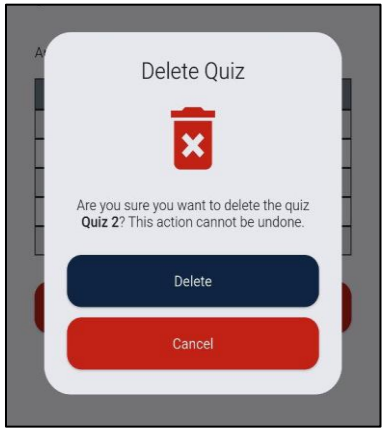
QUIZ CREATION AND MANAGEMENT - FINAL UI



Quiz Details Page



Edit Quiz Details Page



Delete Quiz Modal

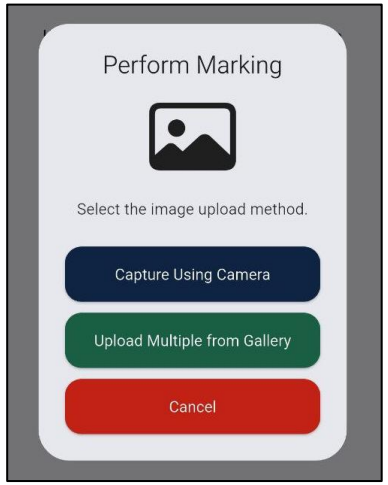
SYSTEM IMPLEMENTATION

PERFORM MARKING

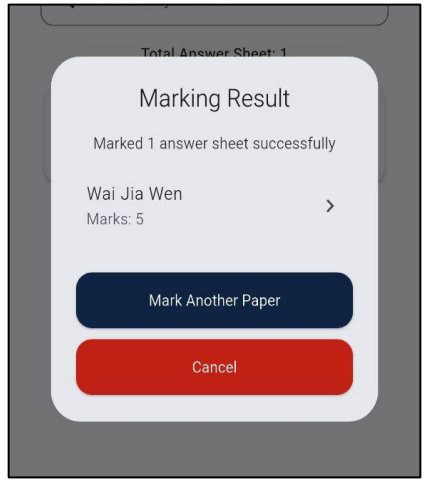
- Upload image from camera or gallery (image_picker package)
- Supports batch upload for upload from gallery with parallel processing (pool package)
- Compresses images before upload for better recognition results
- Custom Cloud Function: perform_marking using OpenCV, Python, Vision API
- Saves answer sheet in Firestore and Firebase Storage

SYSTEM IMPLEMENTATION

PERFORM MARKING - FINAL UI



Perform Marking Modal



Marking Result Modal

SYSTEM IMPLEMENTATION

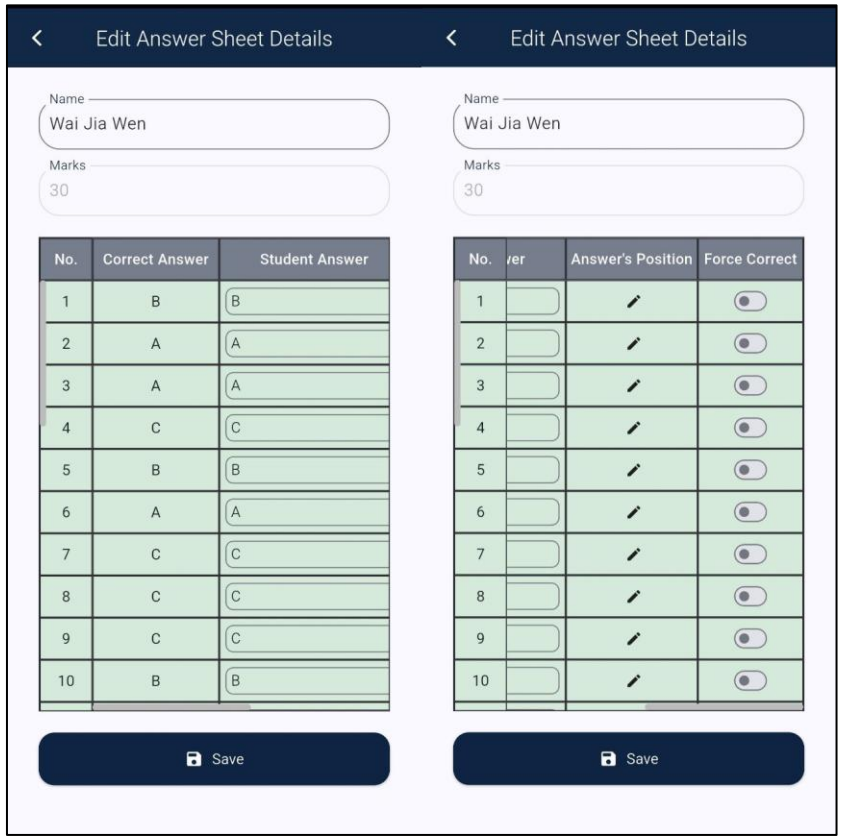
MANAGE RESULTS & EXPORT REPORTS

- View and edit answer sheets (zoom, bounding boxes)
- Edit student name, answers, or override correctness
- fl_chart package used for analysis (accuracy, mark distribution)
- Export PDF (pdf package) & Excel (excel package) reports
- Preview and open files using open_file package

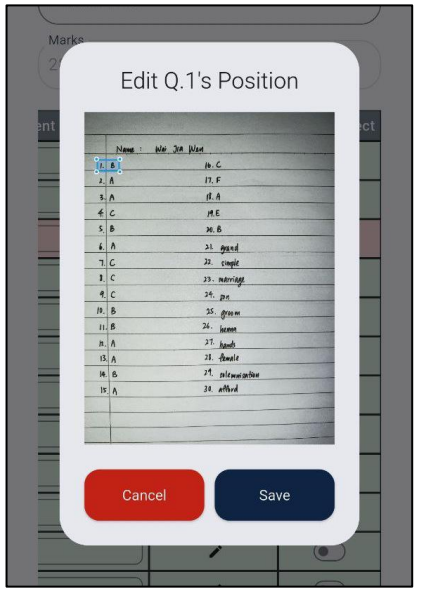
SYSTEM IMPLEMENTATION

MANAGE RESULTS & EXPORT REPORTS - FINAL UI

Answer Sheet Details Page



Edit Answer Sheet Details Page

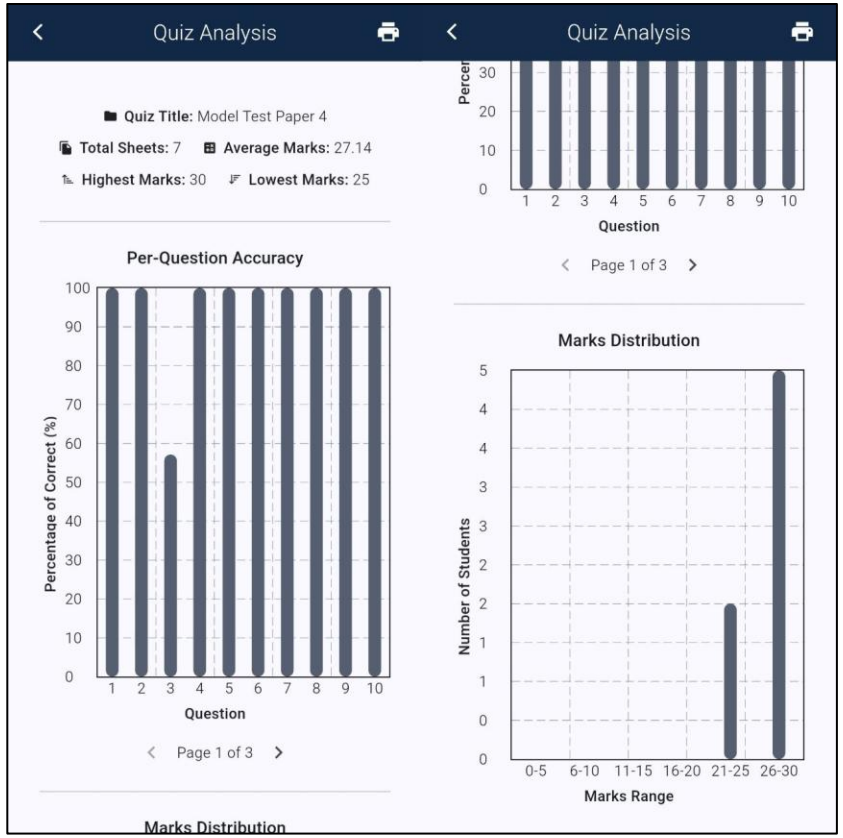


Edit Answer Position Modal

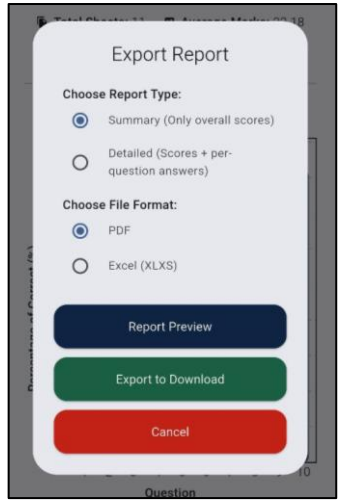
Delete Answer Sheet Modal

SYSTEM IMPLEMENTATION

MANAGE RESULTS & EXPORT REPORTS - FINAL UI



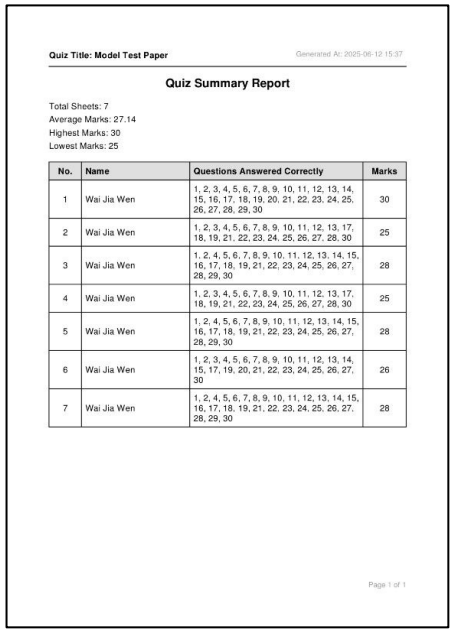
Quiz Analysis Page



Export Student Results Modal

SYSTEM IMPLEMENTATION

MANAGE RESULTS & EXPORT REPORTS - EXAMPLE REPORT OUTPUT



Quiz Title: Model Test Paper

Generated At: 2025-06-12 15:37

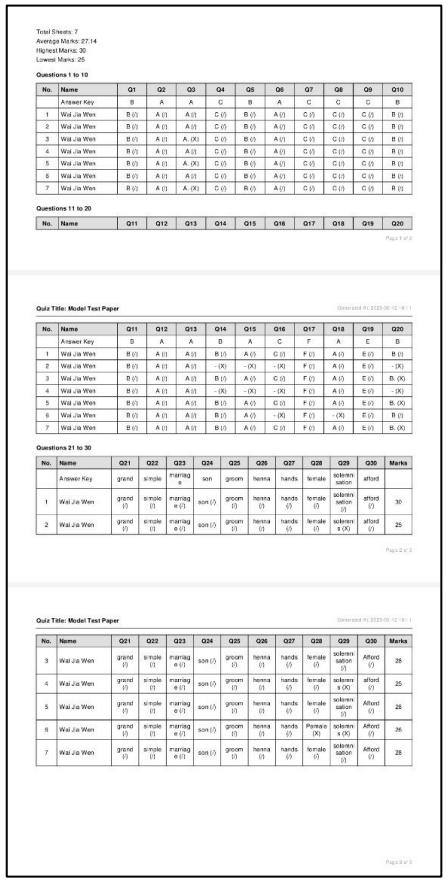
Quiz Summary Report

Total Sheets: 7
Average Marks: 27.14
Highest Marks: 30
Lowest Marks: 25

No.	Name	Questions Answered Correctly	Marks
1	Wai Jia Wen	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30	30
2	Wai Jia Wen	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 17, 18, 19, 21, 22, 23, 24, 25, 26, 27, 28, 30	25
3	Wai Jia Wen	1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30	28
4	Wai Jia Wen	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 17, 18, 19, 21, 22, 23, 24, 25, 26, 27, 28, 30	25
5	Wai Jia Wen	1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30	28
6	Wai Jia Wen	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 19, 20, 21, 22, 23, 24, 25, 26, 27, 30	26
7	Wai Jia Wen	1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30	28

Page 1 of 1

Example of Summary PDF Report



Total Sheets: 7
Average Marks: 27.14
Highest Marks: 30
Lowest Marks: 25

Questions 1 to 10

No.	Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
	Answer Key	B	A	A	C	B	A	C	C	C	B
1	Wai Jia Wen	B (/)	A (/)	A (/)	C (/)	B (/)	A (/)	C (/)	C (/)	C (/)	B (/)
2	Wai Jia Wen	B (/)	A (/)	A (/)	C (/)	B (/)	A (/)	C (/)	C (/)	C (/)	B (/)
3	Wai Jia Wen	B (/)	A (/)	A. (X)	C (/)	B (/)	A (/)	C (/)	C (/)	C (/)	B (/)
4	Wai Jia Wen	B (/)	A (/)	A (/)	C (/)	B (/)	A (/)	C (/)	C (/)	C (/)	B (/)
5	Wai Jia Wen	B (/)	A (/)	A. (X)	C (/)	B (/)	A (/)	C (/)	C (/)	C (/)	B (/)
6	Wai Jia Wen	B (/)	A (/)	A (/)	C (/)	B (/)	A (/)	C (/)	C (/)	C (/)	B (/)
7	Wai Jia Wen	B (/)	A (/)	A. (X)	C (/)	B (/)	A (/)	C (/)	C (/)	C (/)	B (/)

Questions 11 to 20

No.	Name	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20

Page 1 of 3

Quiz Title: Model Test Paper

No.	Name	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
	Answer Key	B	A	A	B	A	C	F	A	E	B
1	Wai Jia Wen	B (/)	A (/)	A (/)	B (/)	A (/)	C (/)	F (/)	A (/)	E (/)	B (/)
2	Wai Jia Wen	B (/)	A (/)	A (/)	- (X)	- (X)	- (X)	F (/)	A (/)	E (/)	- (X)
3	Wai Jia Wen	B (/)	A (/)	A (/)	B (/)	A (/)	C (/)	F (/)	A (/)	E (/)	B. (X)
4	Wai Jia Wen	B (/)	A (/)	A (/)	- (X)	- (X)	- (X)	F (/)	A (/)	E (/)	- (X)
5	Wai Jia Wen	B (/)	A (/)	A (/)	B (/)	A (/)	C (/)	F (/)	A (/)	E (/)	B. (X)
6	Wai Jia Wen	B (/)	A (/)	A (/)	B (/)	A (/)	- (X)	F (/)	- (X)	E (/)	B (/)
7	Wai Jia Wen	B (/)	A (/)	A (/)	B (/)	A (/)	C (/)	F (/)	A (/)	E (/)	B. (X)

Questions 21 to 30

No.	Name	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Marks
	Answer Key	grand	simple	marriag e	son	groom	henna	hands	female	solemn sation	afford	
1	Wai Jia Wen	grand (/)	simple (/)	marriag e (/)	son (/)	groom (/)	henna (/)	hands (/)	female (/)	solemn sation (/)	afford (/)	30
2	Wai Jia Wen	grand (/)	simple (/)	marriag e (/)	son (/)	groom (/)	henna (/)	hands (/)	female (/)	solemn s (X)	afford (/)	25

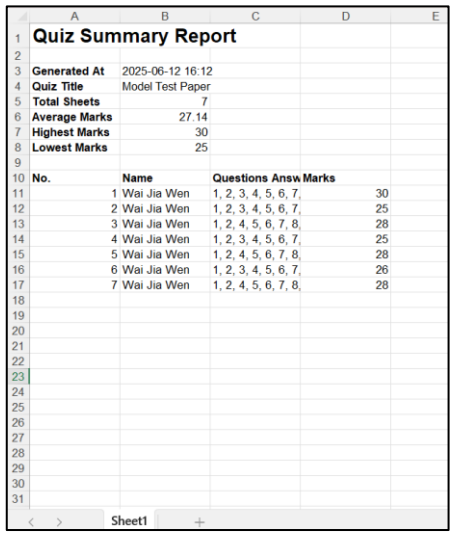
Page 2 of 3

Quiz Title: Model Test Paper

No.	Name	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Marks
3	Wai Jia Wen	grand (/)	simple (/)	marriag e (/)	son (/)	groom (/)	henna (/)	hands (/)	female (/)	solemn sation (/)	Afford (/)	28
4	Wai Jia Wen	grand (/)	simple (/)	marriag e (/)	son (/)	groom (/)	henna (/)	hands (/)	female (/)	solemn s (X)	afford (/)	25
5	Wai Jia Wen	grand (/)	simple (/)	marriag e (/)	son (/)	groom (/)	henna (/)	hands (/)	female (/)	solemn sation (/)	Afford (/)	28
6	Wai Jia Wen	grand (/)	simple (/)	marriag e (/)	son (/)	groom (/)	henna (/)	hands (/)	Female (X)	solemn s (X)	Afford (/)	26
7	Wai Jia Wen	grand (/)	simple (/)	marriag e (/)	son (/)	groom (/)	henna (/)	hands (/)	female (/)	solemn sation (/)	Afford (/)	28

Page 3 of 3

Example of Detailed PDF Report



	A	B	C	D
1	**Quiz Summary Report**			
2				
3	**Generated At**	2025-06-12 16:12		
4	**Quiz Title**	Model Test Paper		
5	**Total Sheets**	7		
6	**Average Marks**	27.14		
7	**Highest Marks**	30		
8	**Lowest Marks**	25		
9				
10	**No.**	**Name**	**Questions Answ**	**Marks**
11	1	Wai Jia Wen	1, 2, 3, 4, 5, 6, 7,	30
12	2	Wai Jia Wen	1, 2, 3, 4, 5, 6, 7,	25
13	3	Wai Jia Wen	1, 2, 4, 5, 6, 7, 8,	28
14	4	Wai Jia Wen	1, 2, 3, 4, 5, 6, 7,	25
15	5	Wai Jia Wen	1, 2, 4, 5, 6, 7, 8,	28
16	6	Wai Jia Wen	1, 2, 3, 4, 5, 6, 7,	26
17	7	Wai Jia Wen	1, 2, 4, 5, 6, 7, 8,	28
18				
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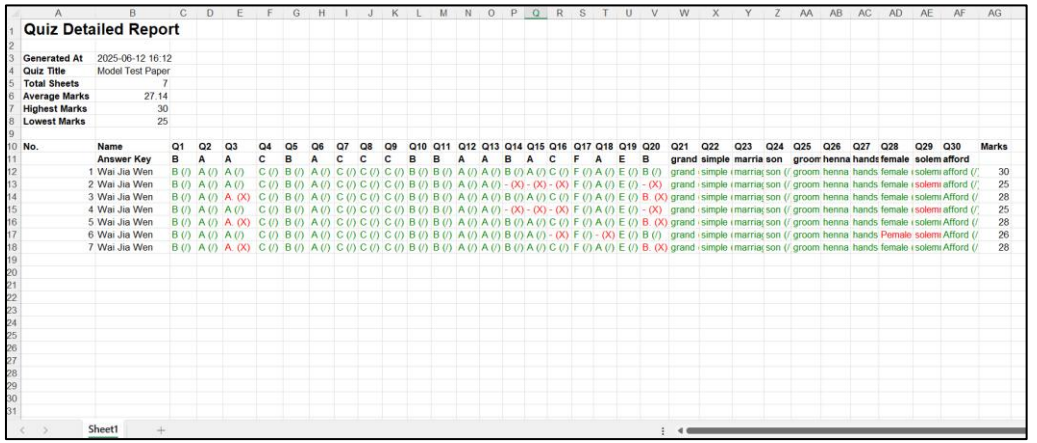
31				

Sheet1

Example of Summary Excel Report



Quiz Detailed Report

Generated At	2025-06-12 16:12
Quiz Title	Model Test Paper
Total Sheets	7
Average Marks	27.14
Highest Marks	30
Lowest Marks	25

No.	Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Marks
	Answer Key	B	A	A	C	B	A	C	C	B	B	A	A	B	A	C	F	A	E	B	grand	simple	marria	son	groom	henna	hands	female	solem	afford		
1	Wai Jia Wen	B (/)	A (/)	A (/)	C (/)	B (/)	A (/)	C (/)	C (/)	B (/)	B (/)	A (/)	A (/)	B (/)	A (/)	C (/)	F (/)	A (/)	E (/)	B (/)	grand	simple	marria	son	groom	henna	hands	female	solem	afford		30
2	Wai Jia Wen	B (/)	A (/)	A (/)	C (/)	B (/)	A (/)	C (/)	C (/)	C (/)	B (/)	B (/)	A (/)	A (/)	- (X)	- (X)	- (X)	F (/)	A (/)	E (/)	- (X)	grand	simple	marria	son	groom	henna	hands	female	solem	afford		25
3	Wai Jia Wen	B (/)	A (/)	A. (X)	C (/)	B (/)	A (/)	C (/)	C (/)	C (/)	B (/)	B (/)	A (/)	A (/)	B (/)	A (/)	C (/)	F (/)	A (/)	E (/)	B. (X)	grand	simple	marria	son	groom	henna	hands	female	solem	Afford		28
4	Wai Jia Wen	B (/)	A (/)	A (/)	C (/)	B (/)	A (/)	C (/)	C (/)	C (/)	B (/)	B (/)	A (/)	A (/)	- (X)	- (X)	- (X)	F (/)	A (/)	E (/)	- (X)	grand	simple	marria	son	groom	henna	hands	female	solem	afford		25
5	Wai Jia Wen	B (/)	A (/)	A. (X)	C (/)	B (/)	A (/)	C (/)	C (/)	C (/)	B (/)	B (/)	A (/)	A (/)	B (/)	A (/)	C (/)	F (/)	A (/)	E (/)	B. (X)	grand	simple	marria	son	groom	henna	hands	female	solem	Afford		28
6	Wai Jia Wen	B (/)	A (/)	A (/)	C (/)	B (/)	A (/)	C (/)	C (/)	C (/)	B (/)	B (/)	A (/)	A (/)	B (/)	A (/)	- (X)	F (/)	- (X)	E (/)	B (/)	grand	simple	marria	son	groom	henna	hands	Female	solem	Afford		26
7	Wai Jia Wen	B (/)	A (/)	A. (X)	C (/)	B (/)	A (/)	C (/)	C (/)	C (/)	B (/)	B (/)	A (/)	A (/)	B (/)	A (/)	C (/)	F (/)	A (/)	E (/)	B. (X)	grand	simple	marria	son	groom	henna	hands	female	solem	Afford		28

Sheet1

Example of Detailed Excel Report

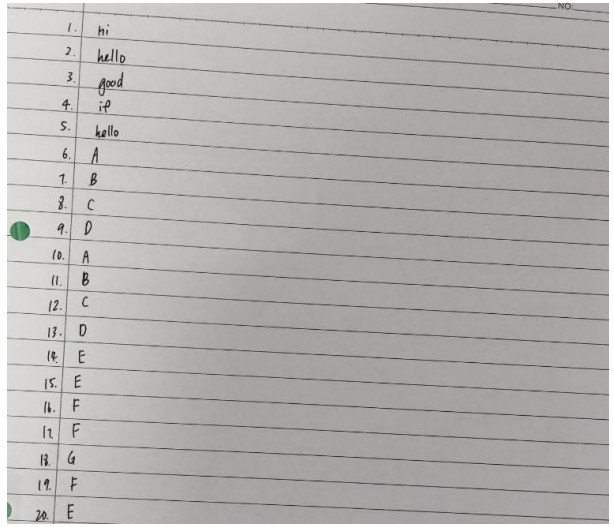
SYSTEM IMPLEMENTATION

PERFROM CHECKING (BACKEND MARKING LOGIC)

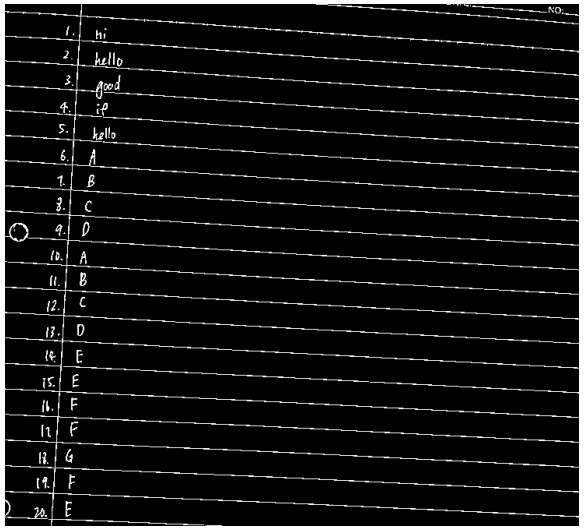
- Deployed as perform_marking Cloud Function (Python, OpenCV)
- Steps:
    1. Inverse Binarization – enhance contrast, suppress noise
    2. De-skew – correct tilt
    3. Rule-line Removal – remove printed lines
    4. Morphological Closing – restore broken characters
    5. Segmentation – vertical & horizontal projection profiles
    6. Re-invert to Binary – prep for OCR
    7. OCR – Google Cloud Vision API
    8. Custom Logic – group & clean text, extract answers
    9. Scoring – match to Firestore key, save results
    10. Return Result – send back document ID to app

SYSTEM IMPLEMENTATION

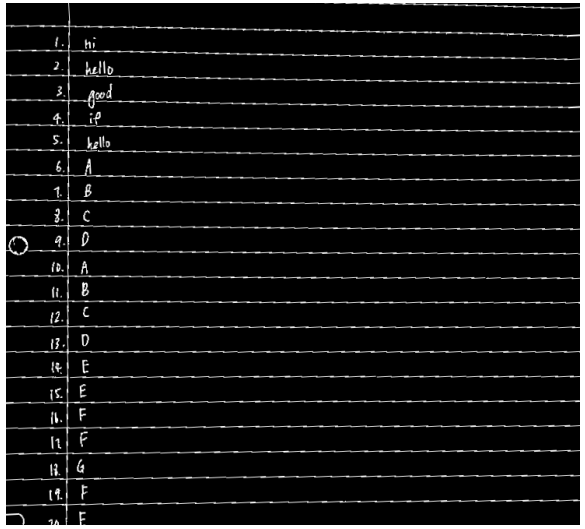
PERFROM CHECKING (BACKEND MARKING LOGIC) - DEBUG OUTPUT



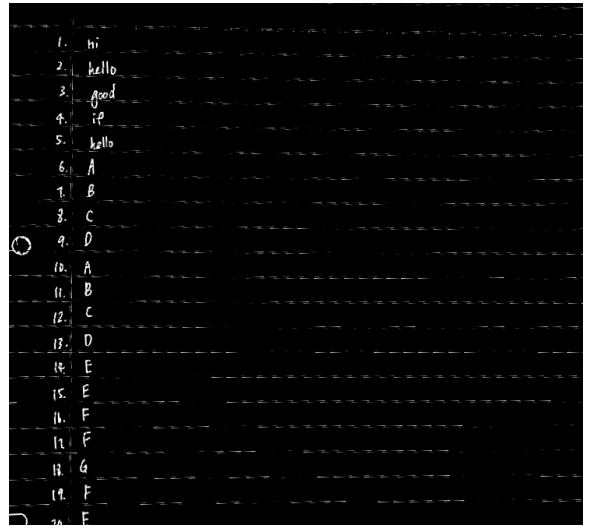
Input Image



Inverse Binary Image



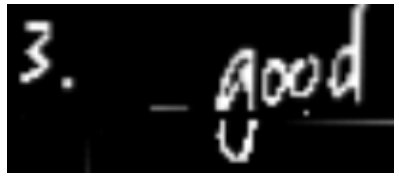
De-skewed Image



Rule-line Removed Image

SYSTEM IMPLEMENTATION

PERFROM CHECKING (BACKEND MARKING LOGIC) - DEBUG OUTPUT



Before Morphological Closing (Zoomed View)

After Morphological Closing (Zoomed View)

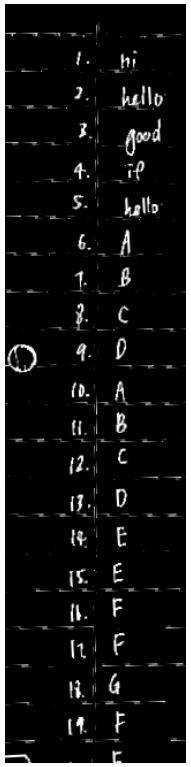


Image Segmented Using Vertical Projection Profiling

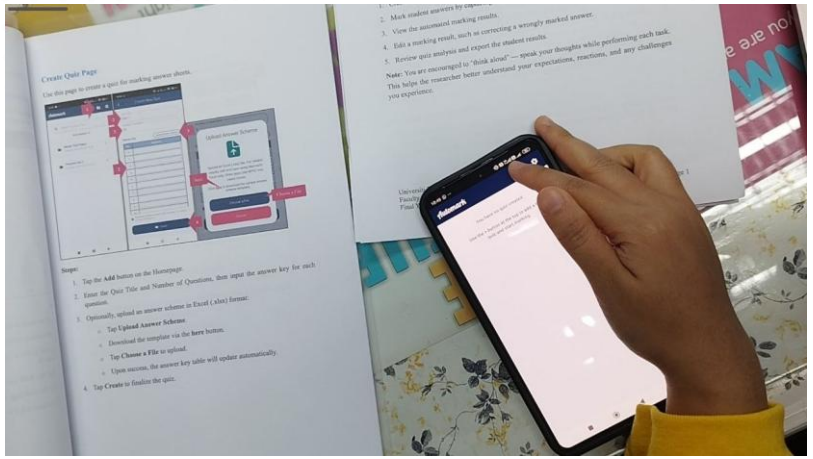
A Line Segment Segmented Using Horizontal Projection Profiling

Binary Image (After Bitwise NOT) Before Sending to OCR

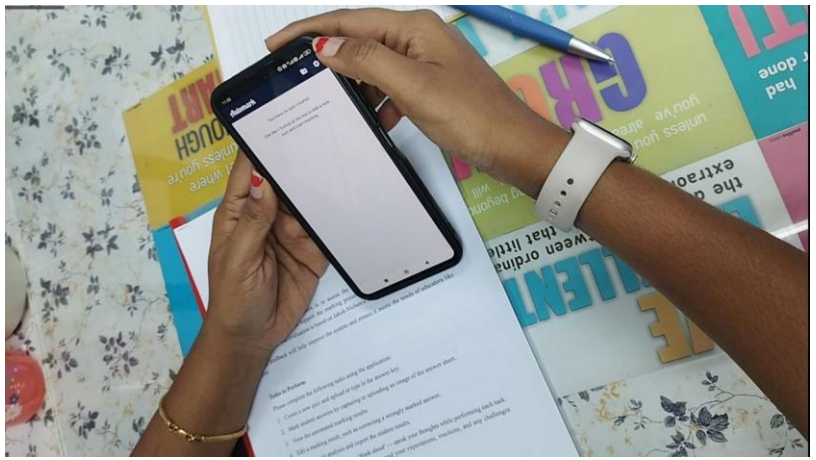
SYSTEM EVALUATION

HEURISTIC EVALUATION
(Nielsen's 10 heuristic principles)

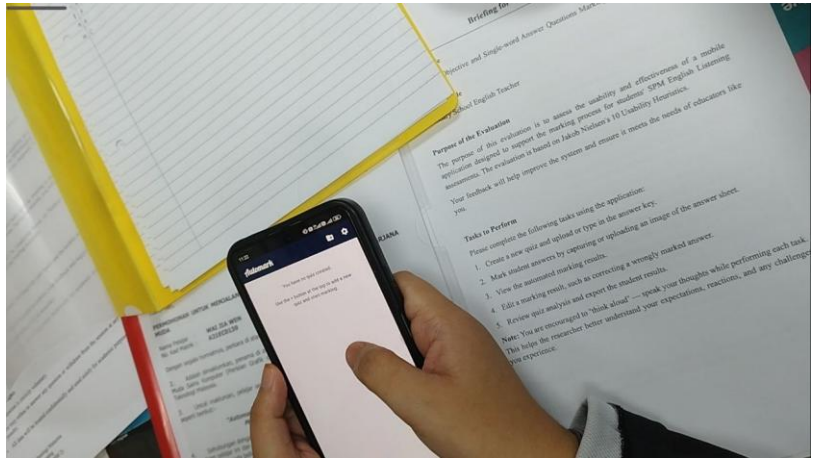
No.	Key Tasks
1	Create a new quiz and upload or type in the answer key.
2	Mark student answers by capturing or uploading an image of the answer sheet.
3	View the automated marking results.
4	Edit a marking result, such as correcting a wrongly marked answer.
5	Review quiz analysis and export the student results.



Evaluator 1



Evaluator 3



Evaluator 2

SYSTEM EVALUATION (Compiled Heuristic Evaluation Results)

No.	Issue Description	Heuristic Violated	Severity (0-4)	Suggested Improvement
1	Teacher who captured images did not realize multiple answer sheets could be uploaded from the gallery and asked for clarification.	Recognition Rather Than Recall	2	Clarify the label to “Upload Multiple from Gallery”.
2	Font size felt small for one teacher.	Aesthetic & Minimalist Design	1	Rather than follow the device’s display settings size, maybe can offer in-app font scaling option.
3	“Show Answers” toggle was hard to tap and the teacher only succeeded after multiple tries.	Aesthetic & Minimalist Design	2	Make toggle larger or ensure both toggle and label are clickable.
4	Report layout did not follow the section format of the English listening paper.	Aesthetic & Minimalist Design	3	Collect quiz section information during creation and organize the report accordingly.
5	One teacher relied heavily on the manual to complete tasks as a first-time user.	Help and Documentation	1	Add an onboarding walkthrough or quick-start tips for new users.
6	Teacher asked if the app is mobile-only and suggested desktop would ease analysis and reporting.	Flexibility and Efficiency of Use	0	Consider future expansion to desktop or web platform for better viewing or reporting.

CONCLUSION

Project Achievements

- Requirements identified through teacher survey & background research.
- Designed and developed the mobile app for marking handwritten objective/single-word answers.
- Usability and effectiveness evaluated with domain experts using Nielsen's heuristics.

Project Constraints

- Conventional image processing struggles with handwriting variations & poor scans.
- OCR needs multiple API calls, slower processing.
- Report format lacks section-based structure like SPM English Listening format answers.

Future Work

- Adopt machine learning for better handwriting recognition.
- Optimize speed with on-device/backend improvements.
- Redesign report layout to follow SPM structure.
- Add desktop/web support.
- Support phrase/sentence answers in future.

THANK YOU

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