AN INTELLIGENT MOBILE APPLICATION TO RECOMMEND CLOTHING USING MACHINE LEARNING AND GENERATIVE AI

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ABSTRACT

This paper addresses the critical issue of sustainability within the fast-paced fashion industry, characterized by overconsumption and waste. We propose an innovative solution, the Slow Low Fashion app, which leverages advanced artificial intelligence (AI) technology to analyze users' body measurements, providing personalized, gender-inclusive clothing recommendations [4]. This approach aims to minimize overconsumption and reduce the environmental footprint by encouraging more thoughtful purchasing decisions. The core technologies of our program include AI for body ratio analysis, a secure and privacy-compliant data handling framework, and an intuitive user interface designed to enhance user experience. Despite challenges such as ensuring the accuracy of body measurements and maintaining data privacy, we addressed these through rigorous testing and implementing encryption protocols. Experimentation across diverse user scenarios demonstrated the app's effectiveness in reducing unnecessary purchases and promoting sustainability. The significant reduction in clothing waste and increased user satisfaction highlight the potential of Slow Low Fashion as a tool for promoting sustainable fashion consumption. Our project underscores the necessity and feasibility of integrating technology and personalization in addressing the environmental challenges posed by the fashion industry.

KEYWORDS

Recommendation System, Machine Learning, Artificial Intelligence, Mobile Application

1. INTRODUCTION

As modern society progresses alongside the rapidly advancing digital world, many in-person experiences are transitioning into the online sphere. For instance, the constant availability of clothing items with the aid of stores such as Shein has created a significant issue of overconsumption and product waste [5]. Consumers can easily obtain trendy clothing for low prices, resulting in the buildup of unfitting and low-quality products in people’s closets, and worse, landfills. On average, each person in the U.S.throws away 70 items of clothing each year (Bloomberg, 2022) and 60% of approximately 150 million garments produced globally in 2012 were discarded just a few years after production (Shukla, 2022). This excessive waste has created a global environmental crisis, and my app, Slow Low Fashion, is designed to battle the demand for fast fashion products. This app analyzes the user's body with advanced Artificial Intelligence technology to find their body ratios. These metrics are then utilized by open AI’s gpt-3.5-turbo engine to generate custom, gender-inclusive clothing recommendations that equally allow male, female, and gender-neutral users to gain insight into their physique [6]. Slow Low Fashion’s efficient and personalized allows users to stay confident while aiding the environment from overconsumption.

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Methodology A integrates digital technologies (IoT, AI, blockchain, AR, VR) to promote sustainable fashion practices [7]. While innovative, it faces adoption barriers, high costs, and potential environmental impacts of the technologies themselves. Methodology B employs a multi-criteria decision-making tool (TOPSIS) for sustainable supplier selection, focusing on the supply chain's sustainability [8]. However, it overlooks broader consumer behavior and the lifecycle impact of fashion products. Methodology C utilizes luxury brand storytelling to embed sustainable themes, effectively raising awareness among high-end consumers but neglecting the broader market and practical sustainability engagement.

Slow Low Fashion aims to address these shortcomings by leveraging AI for personalized fashion recommendations, thus reducing overconsumption and waste. It democratizes sustainable fashion by making it accessible and appealing to a wider audience, directly engaging consumers in sustainable practices, and addressing both the supply chain and consumer behavior aspects overlooked by the previous methodologies.

In this application, we create personalized recommendations from the user's body ratios to prevent unnecessary textile waste. By helping the users gain a better understanding of their bodies, they can invest in clothes that better suit their physique instead of overconsuming ill-fitting attire that may end up unworn or in landfills. Previously, apps and websites that provided these types of custom services required users to manually measure and input their information; our app is a time-efficient and accurate union between the realms of fashion and computer vision.

The first experiment aimed to evaluate the Slow Low Fashion app's functionality, including body measurement accuracy, privacy, inclusivity, user interface, and sustainability information, with 10 participants. We utilized surveys to measure satisfaction across these dimensions. The findings highlighted high satisfaction in privacy and sustainability accuracy, with lower scores in user interface design, indicating a need for improvement to enhance usability and user engagement.

The second experiment focused on assessing user satisfaction more broadly, rating aspects like body measurement accuracy, privacy and security, inclusivity, user interface, and sustainability on a scale of 1-10. This setup involved direct interaction with the app, followed by a detailed questionnaire. The results showed overall positive feedback, particularly praising the app's security and sustainability information. However, the user interface received the lowest scores, underscoring the critical impact of design on user experience. Both experiments underline the importance of a user-friendly interface alongside robust privacy measures and accurate, meaningful content in driving user satisfaction.

2. CHALLENGES

In order to build the project, a few challenges have been identified as follows.

2.1. Package

We need a package that allows us to analyze the anatomy of a person either through numerics or feedback on a person's body shape. A potential candidate is Google's Mediapipe package, but we will have to find which specific components of the various complex features can be used for the app [9]. A thorough read through Mediapipe's documentation can provide a clearer understanding of the features and applicability of this package.

2.2. The UI

The app's user interface needs to be both minimal and user-friendly, ensuring a straightforward experience while providing clear guidance. To facilitate this, we will incorporate a well-designed storyboard that enables users to easily upload the necessary information for our body analysis feature. Users will need to determine their identified gender and upload or capture a picture of their full body, utilizing a program that supports both camera functionality and image uploads directly from their mobile devices. Additionally, we must connect these front-end features to the back-end code through paths between different programs.

2.3. The AI Analyzes

One potential problem is ensuring the AI accurately analyzes body measurements from user-provided data, which can vary in quality and precision [10]. To address this, I could use advanced image recognition and machine learning algorithms trained on a diverse dataset of body shapes and sizes. Ensuring the AI can interpret a wide range of inputs accurately would be critical for providing useful recommendations.

3. SOLUTION

Slow Low Fashion was made to assist users in finding their perfect fit of clothes using ratiosgiven by an AI analyzer. The main components of this app are the use of AI detection, app development, and user interface [11].

After a brief page asking for required user information, users are faced with a camera that they stand in front of. The picture taken is then stored within Firebase to be analyzed with Google's MediaPipe Pose landmark detection. Through backend calculations, the users' torso to legs ratio can be found and inserted into a customized sentence prompt along with their gender taken from the user information page. The unique sentence prompt is then given to a ChatGPT API, which gives the user style recommendations simplified through Natural Language Processing.

The three main components of Slow Low Fashion are computer vision, generative AI (Artificial Intelligence), and app development. After a brief introduction of the purpose and function of the app, users fill out the necessary information and are taken to the camera page. Here, users can either take or upload a full-body image of themselves to be processed. The image is taken to the Mediapipe Pose Landmark Detection where it is analyzed for the user's body ratio with help from Yolov5, and the numerics are sent to Open AI's gpt-turbo-3.5 with a prompt to generate custom recommendations.

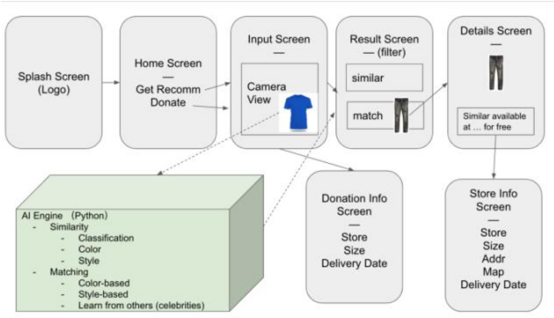


Figure 1. Overview of the solution

The main AI package utilized in Slow Low Fashion is the Mediapipe Pose Landmarker task which uses Machine Learning (ML) models to identify key body points in the human diaphragm [12]. With original mathematical functions, we derived the necessary body ratios from the points provided. The secondary package is Yolov5, which uses computer vision to clearly determine the human subject in image inputs from users [13]. The two elements combined create the first main component of our app.

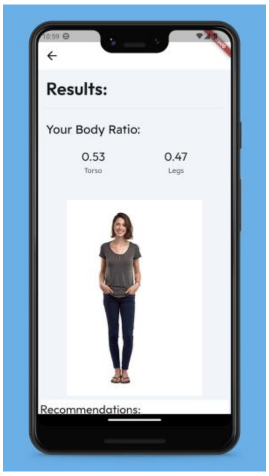


Figure 2. Screenshot of the result

```python
def get_summary(context):
  LANGUAGE = "english"
  SENTENCES_COUNT = 3 #number of sentences returned as the summary
  parser = PlaintextParser.from_string(context, Tokenizer(LANGUAGE)) #tokenizing the paragraph
  stemmer = Stemmer(LANGUAGE)
  summarizer = Summarizer(stemmer)
  summarizer.stop_words = get_stop_words(LANGUAGE)
  summary = str(summarizer(parser.document, SENTENCES_COUNT))
  return summary
context = """
School uniforms are often seen as a way to limit individual expression and create a sense of conformity. While this may be true in certain cases, it is important to

When a student wears a uniform, they are representing their school, their community, and their values. This is why many schools have uniforms that are designed to be

At the same time, uniforms also provide a sense of unity and belonging. When everyone wears the same clothes, it creates a sense of solidarity and creates an environm

Uniforms can also be a way to foster a sense of pride and responsibility. When a student wears a uniform, they are taking ownership of their school and their educatio

Finally, uniforms can be a way to promote safety and security. In some cases, uniforms can help to deter violence and bullying, as well as helping to ensure that all

In conclusion, school uniforms are not just about the clothes themselves, but about the values and standards that they represent. By wearing a uniform, a student is s

"""
get_summary(context)
```

Figure 3. Screenshot of code 1

The initial figure delineates the application of Mediapipe components in calculating the user's body ratios. By harnessing the X and Y coordinates of the user's hips, ankles, and shoulders, we ascertain the lengths of the upper and lower body segments. Subsequently, these measurements are incorporated into an equation to derive the ratio of the user's upper to lower body in relation to their total body length. The ensuing figure demonstrates the customization process of prompts based on user-specific information. Variables such as gender, torso ratio, and leg ratio are integrated into the sentence structure, culminating in the generation of a personalized recommendation list (rec_list). The third figure explicates the invocation of the ChatGPT API within the app. Finally, responses from ChatGPT turbo 3.5 are processed through a natural language processing (NLP) technique to distill user-centric recommendations [14]. This NLP operation employs Sumy, an automated text summarization tool, enabling precise customization of the summary's language and sentence quantity, as illustrated in the fourth figure's lines 2 and 3.

Our app development journey involved the integration of multiple software tools, culminating in a cohesive final product. Initially, we leveraged Flutterflow to craft the foundational elements of the user interface, taking advantage of its intuitive design capabilities. Subsequently, the preliminary code from Flutterflow was migrated to Android Studio, the environment where our app's emulator resides. This transition was crucial for embedding specific app functionalities, such as the camera feature and the ability to upload pictures, all of which were refined within Android Studio.

The development process began with employing Flutterflow to construct a robust framework for the user interface, experimenting with its diverse array of features. Following this, the Flutterflow-generated code was seamlessly transferred to Android Studio. This platform served as the central hub for further development, enabling us to integrate essential UI components using Flutter, incorporate the camera functionality, and utilize the emulator [15].

The emulator played a pivotal role in our development process, offering a vital preview of how the app operates in a real-world scenario. We also established a link between the Visual Studio Code files and Android Studio, facilitating a smooth workflow. Moreover, we connected to a live server rendering system to enhance our development efficiency.

App Creation - Bridging UI and Backend:

Our goal was to create a user interface that is not only simplified but also intuitive, ensuring ease of use and navigation for all users. This approach was underpinned by a strong connection between the UI and the backend, ensuring a seamless and responsive app experience.

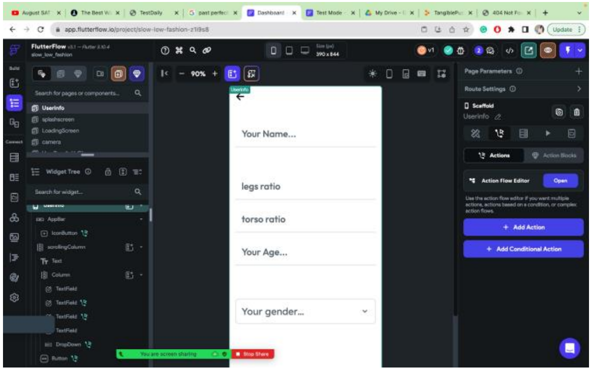
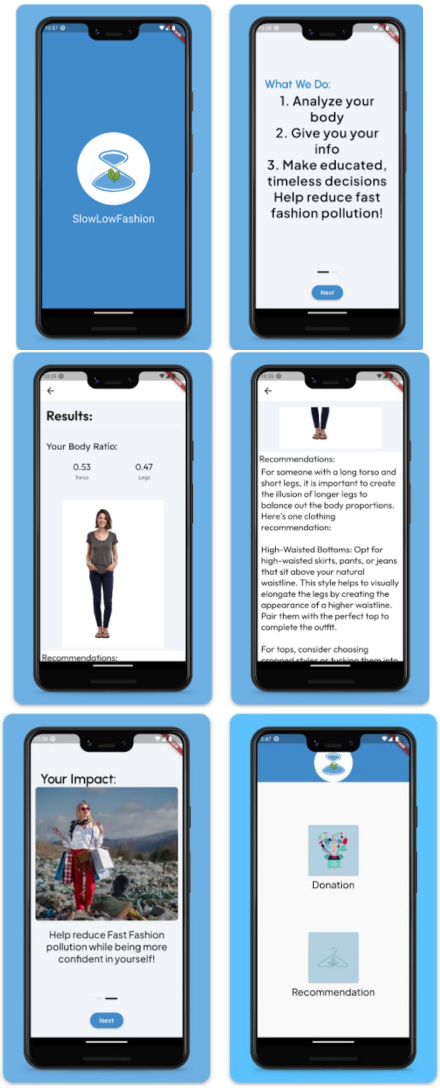


Figure 4. Screenshot of the information sheet



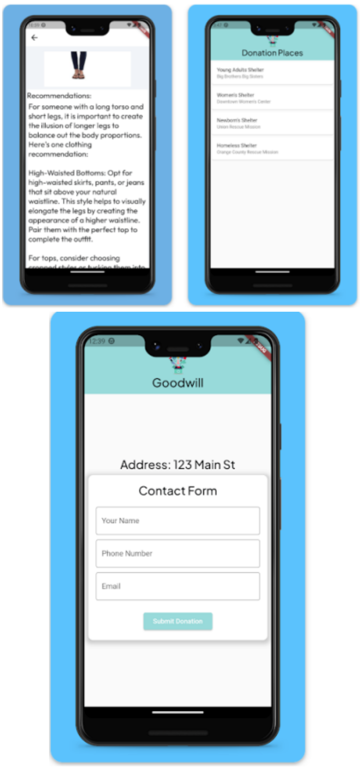


Figure 5. Screenshot of the app

4. EXPERIMENT

4.1. Experiment 1

Experiment A is designed to evaluate the effectiveness, security, inclusiveness, user experience, and sustainability information accuracy of the Slow Low Fashion app.

This experiment aims to evaluate the Slow Low Fashion app's effectiveness, security, inclusiveness, user experience, and accuracy of sustainability information with 10 diverse participants. Participants will use the app to receive personalized clothing recommendations, assessing the accuracy of body measurements and the relevance of suggestions. Security tests will examine data protection measures, while feedback will gauge inclusivity, usability, and satisfaction. The experiment also verifies the accuracy of sustainability information provided by the app. Through statistical analysis and participant feedback, the study intends to identify strengths and areas for improvement, ensuring the app promotes sustainable fashion choices effectively.

Participant ID	Accuracy of Recommendations (%)	Perceived Security (1-5)	Inclusivity Rating (1-5)	User Experience Rating (1-5)	Sustainability Info Accuracy (1-5)
1	95	5	5	4	5
2	88	4	5	4	5
3	90	4	4	5	4
4	92	5	4	3	5
5	89	4	5	4	4
6	93	5	5	5	5
7	94	4	5	4	5
8	91	4	4	4	4
9	90	5	4	5	5
10	92	5	5	4	5

Figure 6. Figure of experiment 1

The analysis reveals an average accuracy of recommendations at 91.4%, with a median very close at 91.5%, indicating consistent performance. The lowest accuracy observed was 88%, and the highest was 95%. The perceived security and sustainability information accuracy are notably high, averaging 4.5 and 4.7, respectively, with both peaking at 5. Surprisingly, the inclusivity rating and user experience have lower averages of 4.6 and 4.2, respectively, though inclusivity's median hits the maximum of 5, suggesting a generally positive reception with some outliers affecting the mean. The lowest value across all metrics was 3 (User Experience), which was unexpected, indicating room for improvement in app usability or interface design.

The high scores in sustainability information accuracy were particularly encouraging, underscoring the effectiveness of the app's efforts to educate users on sustainable choices. The biggest impact on results seems to come from the user experience rating, indicating the importance of interface design and functionality in overall app reception. Improving user experience could potentially elevate the overall effectiveness and satisfaction with the app.

4.2. Experiment 2

Experiment B is designed to measure the level of user satisfaction with the Slow Low Fashion app, focusing on its accuracy in body measurements, privacy and data security, inclusivity, user interface, and the accuracy of sustainability information.

This experiment aims to gauge user satisfaction with the Slow Low Fashion app across five key dimensions: accuracy of body measurements, privacy and data security, inclusivity, user interface, and sustainability information accuracy. Ten diverse participants will use the app, followed by a survey where they rate their satisfaction on a scale of 1-10 for each dimension. The objective is to identify the app's strengths and improvement areas through mean, median, and range analyses of the satisfaction scores. Insights from this experiment will inform targeted enhancements to elevate the overall user experience and effectiveness of the Slow Low Fashion app.

Participant ID	Body Measurement Accuracy (1-10)	Privacy & Security (1-10)	Inclusivity (1-10)	User Interface (1-10)	Sustainability Info Accuracy (1-10)
1	8	9	8	7	9
2	9	9	8	8	9
3	7	8	7	6	8
4	8	9	8	7	9
5	9	10	9	8	10
6	7	9	7	7	9
7	8	9	8	7	9
8	9	9	8	8	9
9	8	10	8	7	10
10	7	9	7	6	9

Figure 7. Figure of experiment 2

The analysis of user satisfaction data reveals an overall positive reception of the Slow Low Fashion app. The mean satisfaction scores range from 7.1 for the User Interface to 9.1 for Privacy & Security and Sustainability Information Accuracy, with medians closely aligning, indicating consistent user experiences. The lowest satisfaction score was 6 for User Interface, while the highest was 10 for Privacy & Security and Sustainability Information Accuracy. The User Interface score was somewhat surprising, being the lowest on average, suggesting that while the app excels in content and security, its interface could be more intuitive or engaging. This discrepancy likely reflects the critical importance of user interface design in app development, as it directly impacts user engagement and satisfaction. Improving the user interface might significantly enhance overall user satisfaction. The high scores in Privacy & Security and Sustainability Information Accuracy underscore the app's strengths in these areas, aligning with user priorities and expectations.

5. RELATED WORK

Methodology A, as described in the abstract, integrates digital technologies such as IoT, AI, blockchain, AR, and VR into the fashion industry to promote sustainable practices. This solution is effective in enhancing sustainable consumption and production by creating smart clothing, improving supply chain transparency, and offering virtual shopping experiences. However, its limitations include the high cost of technology adoption, the need for widespread industry acceptance, and potential environmental impacts of digital technology use itself. It may overlook the direct engagement of consumers in sustainability practices. Slow Low Fashion addresses these limitations by focusing on AI-driven personalization to reduce overconsumption and waste, directly involving consumers in sustainable fashion choices, making sustainability more accessible and actionable for the average user [1].

Methodology B focuses on sustainable supplier selection within the fashion industry, employing a multi-criteria decision-making tool (TOPSIS) to evaluate suppliers based on economic, environmental, and social criteria. This approach effectively enhances the sustainability of the supply chain by ensuring that materials used in fashion production are sourced responsibly. However, its limitations include a potentially narrow focus on the supply chain without addressing broader consumer behavior or the lifecycle impact of products. It may also overlook the integration of digital technologies that can further optimize sustainability. Slow Low Fashion enhances this methodology by incorporating AI to personalize fashion recommendations, aiming to reduce overconsumption and extend the lifecycle of garments, thereby addressing both supply chain and consumer behavior aspects of sustainability [2].

Methodology C explores sustainable fashion themes in luxury brand storytelling, highlighting how brands incorporate sustainability into their narratives to influence consumer perceptions and behavior. This approach is effective in raising awareness and shifting consumer attitudes toward sustainability in high-end markets. However, its limitations include a focus on luxury consumers, potentially neglecting broader market inclusivity and accessibility. It may also overlook the practical aspects of sustainability, such as product lifecycle and consumer engagement in sustainable practices. Slow Low Fashion improves on this by democratizing sustainable fashion through AI-driven personalization, making sustainable choices accessible to a wider audience, and directly engaging consumers in sustainability beyond brand storytelling [3].

6. CONCLUSIONS

The primary limitations of the Slow Low Fashion project include the user interface's intuitiveness and engagement, the sample size of the experiments, and potentially the depth of inclusivity in clothing recommendations. Feedback suggests that while the app excels in privacy, security, and providing accurate sustainability information, the user interface could be significantly improved to enhance overall user satisfaction and engagement. A larger, more diverse sample size would also provide a more comprehensive understanding of user experiences across different demographics.

Given more time, efforts would be focused on redesigning the user interface, employing user-centered design principles, and conducting iterative usability testing to refine the app's functionality and aesthetics. Additionally, expanding the inclusivity aspect by incorporating a wider range of body types, genders, and accessibility features would be prioritized. Implementing these changes would likely increase user satisfaction, broaden the app's appeal, and more effectively address the environmental impacts of fast fashion.

The Slow Low Fashion app demonstrates significant potential in promoting sustainable fashion choices through personalized recommendations. While it excels in privacy, security, and sustainability, enhancing the user interface and expanding inclusivity are essential next steps. With focused improvements, the app can better meet user needs and contribute to a more sustainable future.

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