SmartTailor AI

Automated Pattern Generation System — Final Year Project (FYP) Document

1. Project Overview

Fabric cutting is the most critical and challenging skill in traditional tailoring. The modern marketplace heavily relies on expert 'master' tailors to accurately measure, map, and cut solid fabrics to match specific client needs. Errors at the cutting stage inevitably ruin the final garment, leading to significant material and financial losses.

SmartTailor AI is an automated solution designed to revolutionize this workflow. By leveraging geometric algorithms and data-driven pattern drafting, the system converts raw customer body measurements directly into optimized 2D blueprint layouts (pattern sheets). These sheets can be generated according to the garment type (e.g., Sherwani, Lehenga, Shalwar Kameez) and specific fabric specs. Once printed, a layperson or apprentice can simply overlay the blueprint onto the cloth and execute flawless, precise cuts without requiring years of expert training.

2. System Architecture: Modules & Sub-Modules

Module 1: User & Client Management

Handles system authentication and maintains persistent records of client measurement histories, removing the need for manual re-entry.

Sub-Module 1.1: Authentication — Secure sign-up and login protocols tailored for shop owners, independent tailors, or design assistants.

Sub-Module 1.2: Client Profile Management — Digital storage for client records including names, contact details, and overarching size categories.

Sub-Module 1.3: Measurement History Log — Tracks past dimensions, revisions, and garment histories to optimize repeat orders seamlessly.

Module 2: Specification & Input Interface

The centralized configuration dashboard where dynamic data entry forms adjust fields dynamically based on the target garment style.

Sub-Module 2.1: Gender & Category Selection — Segregates drafting algorithms into Men's, Women's, or Kids' apparel categories.

Sub-Module 2.2: Garment Type Selector — Provides intuitive options for complex traditional styles (Sherwani, Lehenga, Kurta, Shalwar Kameez) and western apparel.

Sub-Module 2.3: Dynamic Measurement Form — Fields adapt automatically (e.g., selecting a *Sherwani* prompts for shoulder-to-wrist and collar circumference, while a *Lehenga* asks for high-waist and flare specifications).

Sub-Module 2.4: Fabric Property Input — Collects textile traits (e.g., lawn, cotton, silk, heavy brocade) alongside total fabric width to accurately guide layout constraints.

Module 3: AI Pattern Generation & Optimization Engine

The core computational layer that translates numeric coordinates into structural vector math while aiming to minimize fabric waste.

Sub-Module 3.1: Measurement-to-Geometry Mapping — Mathematical formulas translate linear data into full-scale 2D paths, factoring in standard seam, hem, and ease allowances.

Sub-Module 3.2: Style Alteration Engine — Incorporates rule-based logic or parameters to accommodate specific design fits (e.g., slim fit vs. relaxed comfort cuts, specific neck style lines).

Sub-Module 3.3: Fabric Nesting Optimizer — Implements irregular 2D nesting geometry to tightly fit pattern panels into the virtual fabric boundary, ensuring minimal cloth waste.

Module 4: 2D Visualization & Print Export

Converts geometric patterns into physical or interactive guides for the end user.

Sub-Module 4.1: Interactive 2D Canvas — Provides a browser-based preview of the pattern arrangement directly on a virtual fabric roll before exporting.

Sub-Module 4.2: Scaling & Grid Calibration — Ensures high-fidelity matching where 1 inch in database vectors correlates precisely to 1 physical inch on the printed matrix.

Sub-Module 4.3: Export & Print Manager — Packages layouts into plotter-ready, multi-page tiled formats or scaled high-resolution vector PDFs.

3. Recommended Technology Stack

Layer	Technology Options	Reason for Choice
Frontend (Web / App)	React.js / Next.js / Flutter	Excellent handling for dynamic forms, reactive input bindings, and vector rendering inside an HTML5 Canvas or SVG container.
Backend API	Python (FastAPI / Flask)	High performance and native support for executing mathematical modeling, spatial arrays, and complex nesting code.
Database	PostgreSQL / MongoDB	PostgreSQL provides high integrity for traditional relational accounts; MongoDB provides flexibility for variable, dynamic JSON fields in measurements.
Geometry & Nesting Engine	Shapely / CutGLib / SciPy	Powerful Python open-source tools for computing irregular 2D polygon unions, boundaries, and spatial layout optimizations.
PDF Generation	ReportLab / PDFKit	Creates crisp, highly exact vector-based print media without pixel degradation, ensuring precision down to the millimeter.

4. Execution & Core Workflow

- **Step 1: Input** — The tailor or operator creates a profile, picks a specific design (e.g., Sherwani), and fills the dynamically structured fields along with fabric width boundaries.
- **Step 2: Processing** — The Python backend takes the variables, computes individual component paths (sleeves, back, front panels), and appends structural sewing margins automatically.
- **Step 3: Nesting** — The nesting algorithm fits the shapes tightly onto a simulated representation of the user's raw material layout to maximize resource utility.
- **Step 4: Output** — The system generates a perfectly calibrated blueprint sheet. The final user downloads the vector PDF, prints it, pins it directly to the physical cloth, and cuts following the printed line safely.

> **Important Tip for Project Viva / Defense:**
>
> External examiners often scrutinize scaling reliability. Be prepared to explain how you utilize **Vector Graphics (SVGs/PDFs)** with exact DPI (Dots Per Inch) mapping so that printing files preserve physical dimensional integrity regardless of the user's hardware or printer setup.

5. Additional Project Ideas

The following alternative or extension concepts were also considered as part of the project brainstorming process. Each explores a different angle on modernizing the tailoring and fashion industry through technology.

5.1 Holographic Virtual Fit Avatar

This concept uses holographic or 3D avatar rendering to give clients a realistic preview of how a garment will look before it is ever cut. The client's body measurements and the selected clothing design/fabric are fed into a system that generates a to-scale digital avatar wearing a simulation of the finished outfit. This would let customers visualize fit, drape, and overall look in advance, reducing dissatisfaction and costly alterations after stitching.

5.2 Master & Layman Cutting Sheet Generator

This idea focuses on generating a practical cutting sheet/blueprint derived directly from customer measurements, with two output modes: a detailed version for an experienced master tailor (using traditional pattern-drafting notation and minimal guidance) and a simplified, heavily annotated version for a layman or apprentice with step-by-step visual cutting instructions. This dual-mode approach makes the system usable across different skill levels in a tailoring shop.

5.3 AI-Powered Redesign of Old Clothing (Upcycling)

Inspired by a Harvard alumni initiative, this idea applies generative AI to old or discarded clothes instead of throwing them away. Users would upload images or descriptions of their existing garments, and the system would analyze current fashion trends to propose redesigned, upcycled clothing concepts that repurpose the same fabric into new, on-trend outfits. This promotes sustainability by extending the life of textiles while giving users fresh design options generated by AI.