**1. Problem Statement**

Online fashion retail suffers from high return rates (up to 40 % for apparel) largely because shoppers cannot visualize how garments will look on **their own body shape, skin tone, or pose**. Standard studio photos use professional models who represent <1 % of real shoppers, creating a “fit & feel” uncertainty that depresses conversion and inflates logistics costs.

An AI-powered visualization tool can:

* Generate **hyper-realistic images** of garments on **any customer** within seconds.
* Show **draping, shadows, wrinkles, and fabric stretch** that respect the user’s morphology.
* Provide **360° views, mix-and-match styling, and size-to-fit simulation** to reduce bracketing returns.

**2. MVP Scope**

**Table**

| **Phase** | **Deliverable** |
| --- | --- |
| **0. Data Acquisition** | 50 k high-resolution studio pairs (flat-lay + on-model) plus 5 k body-scanned avatars (anonymous). |
| **1. Model Training** | Conditional GAN / Diffusion pipeline that transfers a garment from flat lay → target person image. |
| **2. Web Demo** | Upload user photo + choose garment → receive 3 generated visuals (front, side, back). |
| **3. Feedback Loop** | Thumbs-up/down & optional text prompt; stored for re-training & A/B analytics. |
| **4. Performance KPI** | ≤5 s generation on GPU, ≥65 % “looks like me” user rating, ≤1 % NSFW artifacts. |

**3. Core Features**

**Table**

| **Feature** | **Description** |
| --- | --- |
| **Data Pipeline** | Automated background removal, pose normalization, skin-tone clustering, and tokenized meta-data (fabric, print, sleeve, neckline). |
| **AI Try-On Engine** | Diffusion-based inpainting conditioned on: (a) garment mask, (b) target body pose map, (c) skin tone embedding, (d) text prompt for style. |
| **Explainable UI** | Slider to **morph body shape ±20 %** and see real-time garment strain heat-map (red = tight, blue = loose). |
| **Real-Time Gen** | 512×512 px image in 3-5 s on single A10G; 1024×1024 <10 s. |
| **Dashboard** | Retailer portal listing most tried-on SKUs, conversion uplift per SKU, and return-rate delta vs. control group. |
| **Ethics & Safety** | Built-in NSFW filter, age & gender bias monitor, DIGITS-compliant data deletion. |

**4. Expected Impact**

**Table**

| **Stakeholder** | **Benefit** |
| --- | --- |
| **Shoppers** | 30 % drop in size-related returns, 2× increase in confidence score, inclusive representation. |
| **Retailers** | +8 % net conversion, –15 % logistics cost, richer 1st-party data (body stats & style prefs). |
| **Sustainability** | Fewer shipments → lower CO₂; unsold inventory reduced via better demand prediction. |
| **Marketing** | Viral share-worthy try-on images drive organic traffic & UGC. |

**5. Technology Stack (Proposed)**

**Table**

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| **Layer** | **Tech** |
| --- | --- |
| **Data Engineering** | Python, Dagster, Pillow, OpenCV, Trimesh (for 3-D body scan cleaning). |
| **AI / ML** | PyTorch, Diffusers library, ControlNet, LoRA fine-tuning, CLIP for semantic alignment. |
| **Deployment** | FastAPI micro-service, Docker, Kubernetes, NVIDIA Triton Inference Server. |
| **Front-End** | React + Three.js for 3-D avatar, WebGL acceleration, PWA for mobile. |
| **Storage** | PostgreSQL (metadata), S3 (images), Redis (session cache), MinIO (on-prem option). |
| **MLOps** | Weights & Biases experiment tracking, DVC for data versioning, Prometheus + Grafana monitoring. |

**6. Future Extensions**

* **Video Try-On**: 15 s 360° catwalk clip from single photo + garment.
* **Multi-Person & Group**: Family outfit coordination visualization.
* **AI Stylist**: LLM suggests accessories & color matches based on closet history.
* **Virtual Influencer Suite**: Auto-generate model photos for social-media campaigns without physical photo shoots.
* **Size-to-Manufacturing API**: Send aggregated body stats to suppliers for better grading rules.

**7. Model Architecture Suggestions (MVP → Scale)**

**Table**

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| **Layer** | **MVP** | **Scale** |
| --- | --- | --- |
| **Descriptive** | Classic CV metrics (SSIM, LPIPS) + human rating. | Real-time perceptual study dashboard. |
| **Generative Core** | Fine-tuned Stable Diffusion 1.5 + ControlNet pose. | In-house diffusion stack with <1 s latency via distillation & TensorRT. |
| **Explainability** | Pose heat-map & garment mask overlay. | Interactive “what-if” body-parameter saliency maps. |
| **Integration** | Shopify & WooCommerce plug-ins. | Full headless API for metaverse, AR mirrors, and SDK for app developers. |
| **LLM Reporting** | Auto-generated SKU description: “This midi dress drapes beautifully on pear-shaped bodies…”. | Personalized newsletters with “You may also like” visuals created on-the-fly. |

**8. Indicative Timeline & Team**

**Table**

| **Sprint** | **Weeks** | **Milestone** |
| --- | --- | --- |
| **0** | 1 | Data licensing & legal sign-off. |
| **1-2** | 2 | Baseline model (pix2pixHD) + metric scripts. |
| **3-4** | 2 | Diffusion upgrade, alpha UI, 100 internal testers. |
| **5-6** | 2 | NSFW & bias filters, retailer pilot onboarding. |
| **7-8** | 2 | KPI evaluation, bug-fix, marketing assets. |

**Core Roles**: 1 Product Mgr, 2 ML engineers, 1 CV/3-D researcher, 1 Full-stack dev, 1 UX/UI, 1 QA, 1 Ethics advisor (part-time).

**9. Risk Register (Abridged)**

**Table**

| **Risk** | **Mitigation** |
| --- | --- |
| **Dataset bias (thin, young models)** | Active sampling augmentation; partner with body-positive NGOs for diverse scans. |
| **IP infringement (garment prints)** | Accept only retailer-supplied imagery; implement hash-based counterfeit detection. |
| **Deep-fake abuse** | Mandatory user photo consent + encrypted watermark; rate-limit & log API. |
| **GPU cost spikes** | Spot-instance fallback, model-pruning, and edge-cache for repeat requests. |

**10. Success Criteria (MVP Exit)**

* ≥10 k unique try-ons within first 30 days of pilot.
* “Looks like me” rating ≥4/5 averaged across ≥1 k feedbacks.
* Return rate for visualized SKUs down ≥10 % vs. matched control.
* p95 latency <5 s, uptime ≥99 %.
* Zero critical security or ethics violations.