MVP Plan: Kolam Design Pattern Recognition and Recreation System

MVP Goal: To build a functional web application that validates the core technical challenge of the project: analyzing a user-uploaded Kolam image to identify its key mathematical properties and programmatically generating a new, simple Kolam based on basic user inputs.

This MVP will prioritize the "magic" of the analysis and recreation engines over a full feature set, providing a strong foundation for future development.

Core MVP Features (What's IN)

The MVP will deliver a streamlined version of the core functionalities from Phases 0-4 and 6 of the master plan.

1. **Fundamental Kolam Analysis:**
    - A user can upload an image of a Kolam.
    - The system will process the image and display its primary classification (e.g., "Pulli Kolam") and key mathematical properties (e.g., "Rotational Symmetry, Order 4").
    - This includes the backend ML models for classification and symmetry detection trained on a smaller, focused dataset.
2. **Basic Kolam Recreation:**
    - A user can input a few simple parameters (e.g., grid size, complexity level) into a form.
    - The system will generate a new Kolam design based on these parameters and display it as an image (SVG or PNG).
    - This will use a simplified version of the TraditionalRuleEngine for one or two specific Kolam types.
3. **Essential User Management & Infrastructure:**
    - Basic user registration and login.
    - A functional, deployed web application on a cloud server.

Features Excluded from MVP (What's OUT for now)

To ensure a rapid development cycle, the following features from the full plan will be postponed:

- **No Design Gallery:** The MVP will analyze an uploaded image but will not have a searchable, filterable gallery of all designs.
- **No Interactive Design Canvas:** Recreation will be form-based (enter parameters -> click generate) rather than a real-time, interactive drawing tool.
- **No Rich Cultural/Educational Content:** The focus is on displaying the mathematical analysis, not the detailed cultural stories or historical context.
- **No Mobile App:** The MVP will be a responsive web application only.

- **No Advanced Features:** 3D visualization, AR/VR, community contributions, and advanced admin panels are all post-MVP.

MVP Development Sprints (Estimated Timeline: 5-6 Weeks)

This plan breaks down the MVP into a series of focused sprints.

Sprint 1: Foundations (1 Week)

- **Tasks:** Complete all **Phase 0** tasks (setup project management, Git, CI/CD, cloud environment).
- **Tasks:** Implement the core database schemas and user management service from **Phase 1**.
- **Goal:** A fully configured development environment with a running backend that can handle user sign-ups and logins.

Sprint 2: The Analysis Engine (2 Weeks)

- **Tasks:** Execute the core of **Phase 2**.
  - Gather and label an initial dataset (e.g., 100-150 images of 2-3 specific Kolam types).
  - Build and train the MVP versions of the classification and symmetry detection models.
  - Build the Pattern Recognition service and the POST /api/v1/patterns/analyze endpoint.
- **Goal:** A functional API endpoint that can accept an image and return a JSON object with its mathematical analysis.

Sprint 3: The Recreation Engine (1 Week)

- **Tasks:** Implement a simplified version of **Phase 3**.
  - Develop the ParametricPatternGenerator for basic grids and curves.
  - Hard-code a simple rule set in the TraditionalRuleEngine for one Kolam type.
  - Build the Design Recreation service and its API endpoint.
- **Goal:** A functional API endpoint that can generate a simple Kolam image from a set of parameters.

Sprint 4: Frontend Integration & Launch (1-2 Weeks)

- **Tasks:** Combine simplified **Phase 4** and **Phase 6** tasks.
  - Develop the two core React components: the image upload/analysis page and the recreation form page.
  - Integrate these components with the backend APIs.
  - Perform end-to-end testing of the core user flow.
  - Deploy the complete application to a staging/beta environment.
- **Goal:** A live, usable web application ready for initial feedback from target users.