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IT4010 – Research Project - 2024

Topic Assessment Form

Project ID: 24-25J-201

1. Topic (12 words max)

Machine Learning based Automated Construction Planning system for Sri Lanka

2. Research group the project belongs to

Software Systems & Technologies (SST)

3. Research area the project belongs to

ICT for Development (ICTD)

4. If a continuation of a previous project:

Project ID	-
Year	-

5. Brief description of the research problem including references (200 – 500 words max) – references not included in word count.

The traditional architectural design process is often time-consuming and expensive, requiring extensive consultations between architects and clients. This project aims to address this challenge by developing a machine learning (ML) based system for automatic architecture planning[1] [5].

Current Limitations

• Manual and Iterative Process: The initial stages of architectural design involve manual exploration of ideas through sketches and models. This iterative process relies heavily on the architect's experience and can be time-consuming for clients.

• Limited Accessibility: Architectural design services can be expensive, making it difficult for some individuals to access professional design expertise, especially during the initial brainstorming phase.

Proposed Solution

This project proposes an ML-powered system that assists with the initial stages of architectural design. The system will leverage a machine learning model trained on a comprehensive dataset of architectural plans, images, and relevant data points [3] [4]. Users will be able to interact with the system by:

• Specifying their preferences (style, number of rooms, budget).

• Uploading an image of the land area.

The system will then

• Analyze the uploaded image using image processing techniques to extract features like land size, shape, and sun orientation [6].

• Generate initial architectural design ideas based on the user's preferences and the processed land data [2].

• Provide rough estimates for construction costs and potential solar panel efficiency based on the generated plan.

• By analyzing the land image and sun orientation, the system estimates the potential efficiency of solar panels on the proposed design. This empowers users to explore sustainable energy options early in the planning process [7] [8] [9] [10].

Benefits

• Improved Efficiency: The system can streamline the initial design exploration stage, saving time and resources for both architects and clients.

• Enhanced Accessibility: By offering an automated design assistant tool, the system can potentially make architectural design concepts more accessible to a wider audience.

• Data-Driven Approach: The ML model can learn from a vast amount of data, potentially leading to more innovative and efficient design solutions.

References

[1] R. Babakhan, "Automatic Generation of Architectural Plans with Machine Learning," *Technology Architecture + Design,* vol. 7, no. 7.2, pp. 183-191, 16 11 2023.

[2] S. Giacomelli, "Infrared enhancement of supersymmetry in four dimensions," *arXiv,* vol. 2, p. 24, 21 08 2018.

[3] Sergio Jiménez, Tomas De la Rosa, Fernando Fernández and Susana Fernandez, "A review of machine learning for automated planning," *Research gate,* vol. 04, p. 27, 2012.

[4] S. Abreu, "Automated Architecture Design for Deep Neural Networks," *arXiv,* vol. 01, 22 08 2019.

[5] Peyman Jafary, Davood Shojaei, Abbas Rajabifard and Tuan Ngo, "Automated land valuation models: A comparative study of four machine learning and deep learning methods based on a comprehensive range of influential factors," *Elsevier,* vol. 151, 15 05 2024.

[6] José Maria Codosero Rodas, José Manuel Naranjo Gómez , Rui Alexandre Castanho and José Cabezas, "Land Valuation Sustainable Model of Urban Planning Development: A Case Study in Badajoz, Spain," *mdpi,* vol. 10, no. 05, 07 05 2018.

[7] Thisara Manupriya Sathkumara, Anuradha Samarajeewa Waidyasekara and Hasith Chathuranga Victar, "The feasibility of transparent solar panels for high-rise building façade in Sri Lanka," *Emerald Insights,* p. 95, 13 11 2023.

[8] H. S. Choi, "Architectural Experiment Design of Solar Energy Harvesting: A Kinetic Façade System for Educational Facilities," *MDPI,* vol. 12, p. 5853, 2022.

[9] Ceylin Şirin, Jamie Goggins and Magdalena Hajdukiewicz, "A review on building-integrated photovoltaic/thermal systems for green buildings," *Elsevier,* vol. 229, 25 05 2023.

[10] Wei Liu, Yedan Shen, Pasura Aungkulanon, Mohammad Ghalandari, Binh Nguyen Le, Aníbal Alviz-Meza and Yulineth Cárdenas-Escrocia, "Machine learning applications for photovoltaic system optimization in zero green energy buildings," *Elsevier,* vol. 9, pp. 2787-2796, 06 02 2023.

6. Brief description of the nature of the solution including a conceptual diagram (250 words max)

This project proposes a web-based system utilizing a machine learning model to assist with initial architectural planning. Here's a breakdown:

Components:

• Machine Learning Model: Trained on architectural plans, images, and data points like land characteristics, building codes, and cost estimations.

• Image Processing Module: Analyzes uploaded land images, extracting features like size, shape, slope, and sun orientation.

• User Interface (UI): Allows users to input preferences (style, budget) and upload land images.

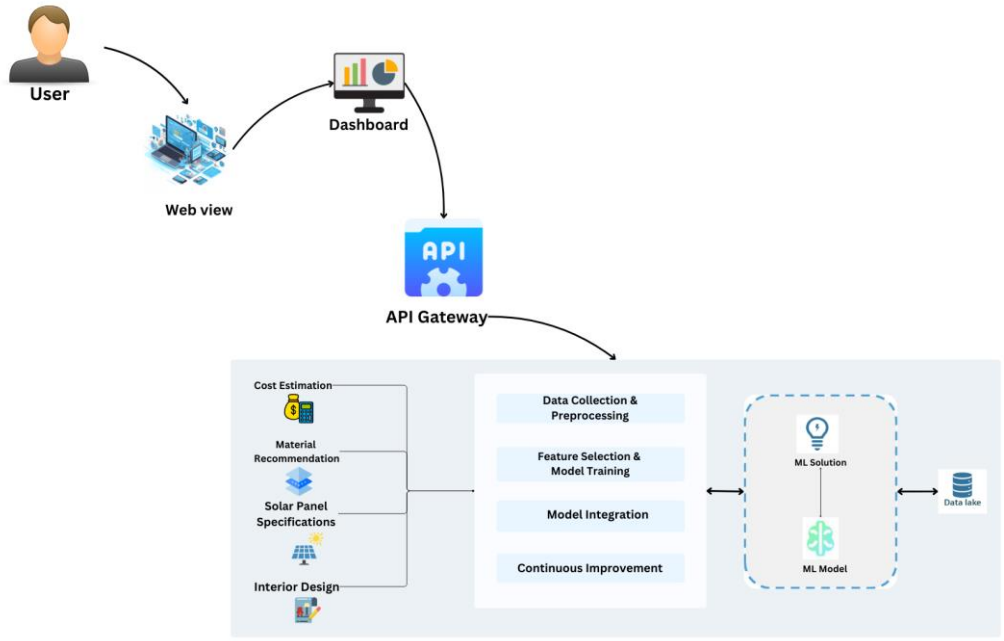
Nature of the Solution

The system acts as an intermediary between the user and the complex world of architectural design. The user provides input, and the ML model, informed by the analyzed land image and vast training data, generates initial design ideas and estimations. User feedback can be incorporated to further refine the model over time.

Benefits

This approach offers an accessible and efficient tool for exploring initial design concepts, potentially democratizing access to architectural design.

conceptual diagram



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7. Brief description of specialized domain expertise, knowledge, and data requirements (300 words max)

This project necessitates expertise across several domains to ensure successful development and implementation. Here's a breakdown of the key requirements:

1. **Machine Learning Expertise:**

• A solid understanding of machine learning algorithms, particularly supervised learning for tasks like image classification and regression for cost estimation.

• Experience in data preprocessing, model training, and evaluation techniques to ensure the accuracy and generalizability of the ML model.

• Knowledge of cloud computing platforms like Google Cloud AI Platform or Amazon SageMaker for potential model deployment.

2. **Architectural Knowledge:**

• Understanding of architectural design principles, building codes, and regulations to ensure the generated plans adhere to safety standards.

• Familiarity with different architectural styles and their suitability based on user preferences and land characteristics.

• Knowledge of construction materials and their cost implications to inform the cost estimation aspect of the system.

3. **Data Science Expertise:**

• Skills in data acquisition, cleaning, and wrangling to prepare a comprehensive dataset for model training. This may involve collaborating with architects to access plans and data.

• Knowledge of data visualization techniques to effectively communicate the generated design ideas and cost estimates to the user.

• Experience in working with geospatial data, potentially including satellite imagery or drone footage of land areas.

Data Requirements:

• A large dataset of architectural plans encompassing various styles, sizes, and complexities.

• Corresponding images of the land plots associated with these plans for land characteristic analysis.

• Data on construction material costs, labor costs, and local building codes.

• Solar panel efficiency data based on location and roof orientation (potentially from solar company stations).

Addressing the Challenge:

The success of this project hinges on acquiring a high-quality dataset. Collaboration with architectural firms, access to public building code databases, and leveraging existing datasets on construction costs and solar panel efficiency will be crucial.

8. Objectives and Novelty

Main Objective This project aims to develop a web-based architectural design assistant powered by machine learning to streamline initial planning with automated ideas, cost estimations, and solar panel potential.			
Member Name	Sub Objective	Tasks	Novelty
R A AHAMED	To Develop an interactive Construction Cost and material estimations using machine learning, based on built-up area and approximate cost per square foot, featuring detailed material and cost breakdowns.	• Develop and train a machine learning model to estimate construction costs. • Design a user-friendly form to input built-up area and cost per square foot • Gather historical data on construction costs, material usage, and project timelines • Integrate the trained machine learning model into the backend logic	• The machine learning model adapts to new data, continuously improving its estimation accuracy over time. • The model adapts to materials cost and calculate the total cost and by change the material type can get the different cost

Sathurjan.K	To Develop a basic machine learning model that recommends the most suitable building materials based on building plan and weather details. This model can help engineers and customers make informed decisions about material choices.	• Develop algorithms to analyze the generated projects data materials and building types and sustainability goals Example Data: - Building Type: Residential - Climate: Tropical - Material: Bamboo - Properties: Renewable, low cost • Integrate the user interface to allow material selection based on climate	• System recommends the suitable materials based the climate to the places • System recommends the materials and recommends places to build the architecture based on architecture type and materials
Linganathan J	To Recommend solar panel specifications and price. with estimated energy consumption for the location and cost to the solar panels and inverter.	• Train object detection/segmentation model. Develop algorithm to calculate land area. • Develop method to gather user input or access data (e.g., bills, location data). • Design algorithm to estimate power demand. • Develop model to select appropriate number and type of panels based on land area and power demand.	• Integrate cost consumption estimation, using **Linear Regression** and **Clustering Algorithms** to find the best cost price for high-quality solar panels.

Silva A A I	To Enhance client-architect communication and optimize design efficiency by solving the problem of clients' inability to effectively convey their design ideas due to a lack of technical knowledge, which leads to delays, repeated work, and reduced productivity.	• Develop an interactive design dashboard with text, image • Implement a multimodal communication hub for clear summaries. • Develop a scalable backend for real-time data processing. • Create an ML-powered recommendation system for personalized design suggestions	• Real-time multimodal inputs for immediate updates. • AI-driven summarization and transcription. • Secure, scalable backend architecture. • Analyzing client preferences for tailored recommendations. • Real-time progress tracking and compliance

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9. Supervisor checklist

a) Does the chosen research topic possess a comprehensive scope suitable for a final-year project?

Yes	✓	No	

b) Does the proposed topic exhibit novelty?

Yes	✓	No	

c) Do you believe they have the capability to successfully execute the proposed project?

Yes	✓	No	

d) Do the proposed sub-objectives reflect the students' areas of specialization?

Yes	✓	No	

e) Supervisor's Evaluation and Recommendation for the Research topic:

10. Supervisor details

	Title	First Name	Last Name	Signature
Supervisor	Ms	Ravi	Supunya	Ravi
Co-Supervisor	Mr	Dharshana	kasthurirathna	
External Supervisor				
Summary of external supervisor's (if any) experience and expertise				

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Topic Assessment Form

<u>This part is to be filled by the Topic Screening Panel members.</u>

Acceptable: Mark/Select as necessary

Topic Assessment Accepted	
Topic Assessment Accepted with minor changes (should be followed up by the supervisor)*	
Topic Assessment to be Resubmitted with major changes*	
Topic Assessment Rejected. Topic must be changed	

* Detailed comments given below

Comments

The Review Panel Details

Member's Name	Signature

*__Important__:

1. According to the comments given by the panel, make the necessary modifications and get the approval by the **Supervisor** or the **Same Panel**.
2. If the project topic is rejected, identify a new topic, and follow the same procedure until the topic is approved by the assessment panel.