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HYBRID DEEP LEARNING MODEL FOR REAL ESTATE PRICE PREDICTION USING MULTI-SOURCE DATA

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ABSTRACT

This paper presents a deep learning-based framework for house price prediction that leverages heterogeneous data sources combined with a joint self-attention mechanism to improve prediction accuracy and interpretability. The proposed model integrates diverse data types, including structured features (e.g., location, size, amenities), unstructured data (e.g., textual descriptions), and spatial or image-based inputs, enabling a comprehensive understanding of real estate characteristics. A joint self-attention mechanism is employed to effectively capture complex relationships and dependencies across different feature modalities, allowing the model to assign dynamic importance weights to relevant attributes. The architecture utilizes multi-layer neural networks for feature extraction and fusion, followed by attention-driven learning to enhance feature representation. Experimental results demonstrate that the proposed approach significantly outperforms traditional machine learning and baseline deep learning models in terms of prediction accuracy and robustness. Additionally, the attention mechanism provides insights into feature contributions, improving model transparency. This work highlights the potential of combining heterogeneous data analysis with advanced attention techniques for more reliable and scalable real estate price prediction systems.

Keywords: Deep Learning, House Price Prediction, Heterogeneous Data, Self-Attention Mechanism, Feature Fusion, Neural Networks, Real Estate Analytics, Predictive Modeling

I. INTRODUCTION

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The rapid growth of urbanization and the increasing complexity of real estate markets have made house price prediction a challenging yet essential task for buyers, sellers, investors, and policymakers. Accurate estimation of property values plays a crucial role in decision-making, risk assessment, and market analysis. Traditional statistical and machine learning approaches often rely on limited structured data such as location, size, and number of rooms, which restricts their ability to capture the multifaceted nature of real estate pricing. In reality, house prices are influenced by a wide range of heterogeneous factors, including geographical attributes, socio-economic conditions, infrastructure development, textual property descriptions, and even visual features from images.

With the advancement of deep learning, there has been a growing interest in leveraging its capability to automatically learn complex patterns from large-scale and diverse datasets. Deep learning models, particularly neural networks, have demonstrated superior performance in handling high-dimensional and unstructured data. However, effectively integrating heterogeneous data sources and modeling their interdependencies remains a significant challenge. To address this issue, attention mechanisms, especially self-attention, have emerged as powerful tools that enable models to focus on the most relevant features while capturing contextual relationships within the data.

II. LITERATURE REVIEW

House price prediction has been extensively studied using various statistical, machine learning, and deep learning techniques. Early research focused on traditional methods such as linear regression and hedonic pricing models, which analyze relationships between property attributes and prices. However, these methods were limited in capturing nonlinear relationships and complex dependencies among features [1].

With the advancement of machine learning, several algorithms such as Decision Trees, Support Vector Machines (SVM), Random Forest, and XGBoost have been applied to improve prediction accuracy. These models demonstrated better performance by handling nonlinear data and feature interactions. Studies show that ensemble methods and boosting techniques significantly enhance predictive capability compared to basic regression models [2][3].

Recent research has shifted toward deep learning approaches due to their ability to automatically extract high-level features from large datasets. Deep Neural Networks (DNNs) and Artificial Neural Networks (ANNs) have shown improved performance in modeling complex real estate patterns. Comparative

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studies indicate that deep learning models often outperform traditional machine learning techniques in terms of accuracy and scalability [4].

Furthermore, researchers have explored multimodal and heterogeneous data integration for better predictions. Incorporating textual descriptions, spatial data, and property images has been found to significantly improve model performance. For example, combining visual and textual features using neural networks reduces prediction error and enhances feature representation [5]. Similarly, recent multimodal deep learning frameworks leverage structured, textual, and image data to learn richer embeddings for accurate price estimation [6].

In addition, attention mechanisms have emerged as a powerful technique for improving deep learning models. Although originally developed for natural language processing, attention-based models help identify important features and capture dependencies across different data modalities. These methods improve both prediction accuracy and interpretability, addressing key limitations in earlier approaches [1][6].

Despite these advancements, existing studies still face challenges in effectively integrating heterogeneous data sources and modeling complex interdependencies. Therefore, there is a need for advanced frameworks that combine deep learning with joint self-attention mechanisms to fully utilize diverse data and enhance prediction performance.

III. EXISTING SYSTEM

The existing systems for house price prediction primarily rely on traditional statistical and machine learning approaches that use structured data such as property size, location, number of rooms, and basic amenities. Methods like linear regression and hedonic pricing models are commonly used due to their simplicity and interpretability. However, these approaches assume a linear relationship between input features and house prices, which limits their ability to capture complex and nonlinear patterns present in real-world real estate data.

To overcome these limitations, machine learning models such as Decision Trees, Support Vector Machines (SVM), Random Forest, and Gradient Boosting have been introduced. These models improve prediction accuracy by handling nonlinear relationships and interactions between features. Despite their advantages, they still depend heavily on manually engineered features and often fail to fully utilize large-scale and diverse datasets. Additionally, these models may suffer from overfitting or lack generalization when applied to dynamic and heterogeneous real estate environments.

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Some existing systems have incorporated deep learning techniques such as Artificial Neural Networks (ANNs) and Deep Neural Networks (DNNs) to enhance predictive performance. While these models can learn complex feature representations, most of them focus only on single-type data, mainly structured datasets, and ignore other important sources such as textual descriptions, images, and spatial information. As a result, they do not provide a complete understanding of the factors influencing house prices.

IV. PROPOSED SYSTEM

The proposed system introduces a deep learning-based framework for house price prediction that effectively utilizes heterogeneous data sources along with a joint self-attention mechanism to improve prediction accuracy and model interpretability. Unlike traditional methods that rely only on structured data, the proposed approach integrates multiple data modalities such as numerical property features, textual descriptions, geographical information, and optional visual data to provide a more comprehensive representation of real estate properties.

In this system, each data type is processed through dedicated feature extraction modules. Structured data is handled using fully connected neural layers, textual data is processed using embedding techniques and sequential models, while spatial or image-based data (if available) is processed using deep neural feature extractors. The extracted features from all modalities are then fused using a unified representation layer.

To effectively capture complex relationships among heterogeneous features, a joint self-attention mechanism is applied. This mechanism assigns dynamic importance weights to different features by learning their contextual relationships. It helps the model focus on the most influential attributes that contribute to house pricing, thereby improving both prediction accuracy and interpretability. The attention layer also enables interaction between different data modalities, ensuring better feature alignment and dependency modeling.

V. METHODOLOGY

The methodology of the proposed system for house price prediction is designed to effectively handle heterogeneous data and improve prediction accuracy using a deep learning framework integrated with a joint self-attention mechanism. The overall process involves several stages, including data collection, preprocessing, feature extraction, feature fusion, model training, and prediction.

In the first stage, data is collected from multiple sources such as real estate databases,

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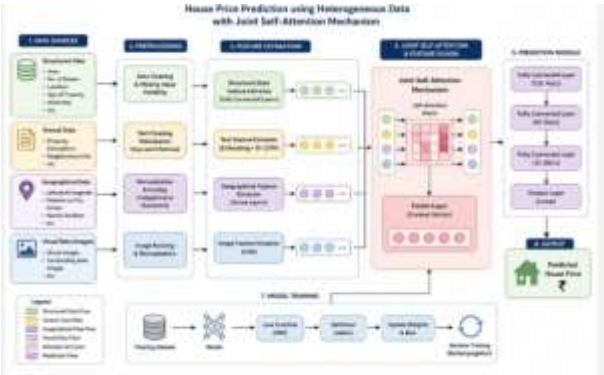
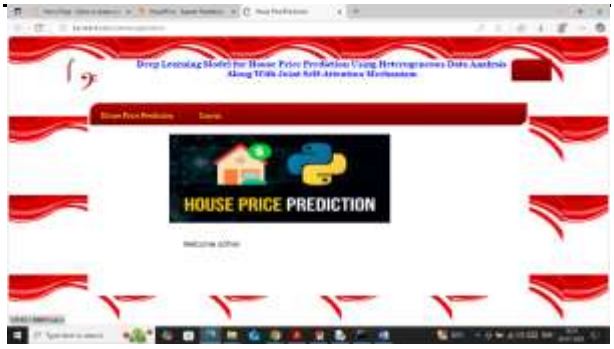
online property listings, and geographic information systems. The dataset includes structured features like area, number of rooms, location, and price, along with unstructured data such as property descriptions and optional images. This heterogeneous nature of data ensures a more comprehensive representation of housing attributes.

In the preprocessing stage, missing values are handled, categorical variables are encoded, and numerical features are normalized to ensure uniform scaling. Textual data is cleaned by removing noise, stop words, and irrelevant symbols, followed by tokenization and embedding generation. If image data is used, it is resized and normalized before being

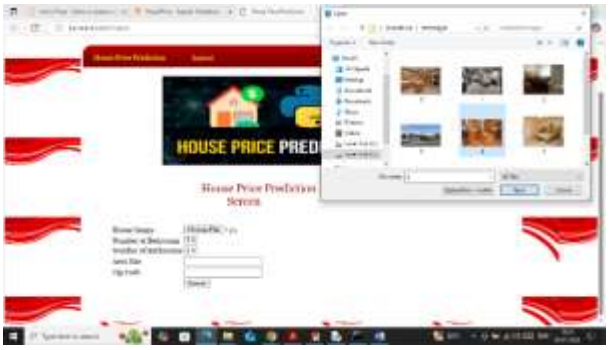
VI. SYSTEM MODEL

System Architecture

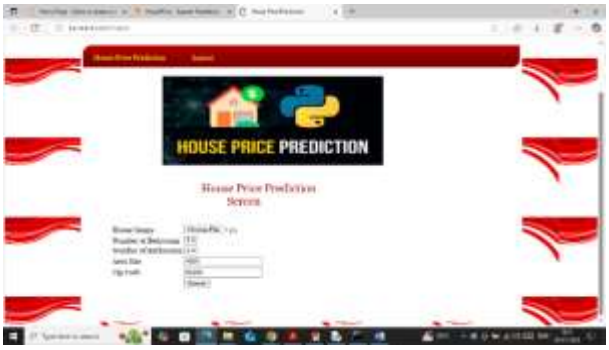




In above screen click on 'House Price Prediction' link to get below page



In above screen upload house image and then choose number of bedrooms, bathroom, house size and zip code and then press button to get below page



In above screen entered all details and below is the output

VII. RESULTS AND DISCUSSIONS

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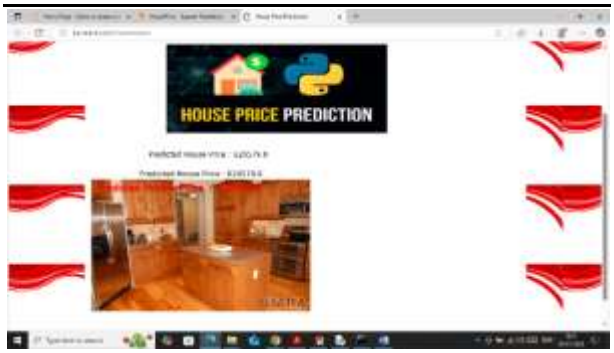
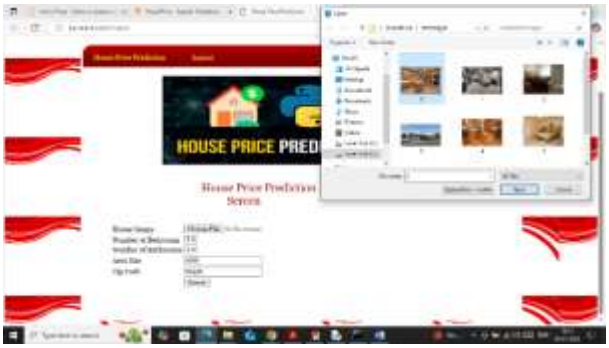
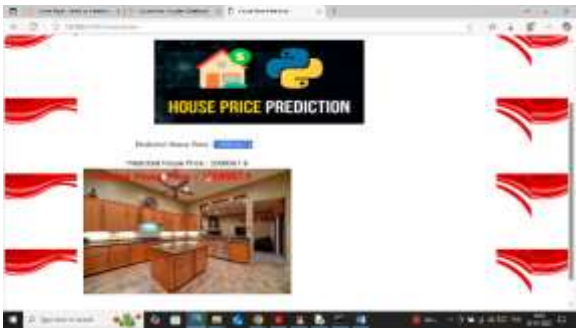


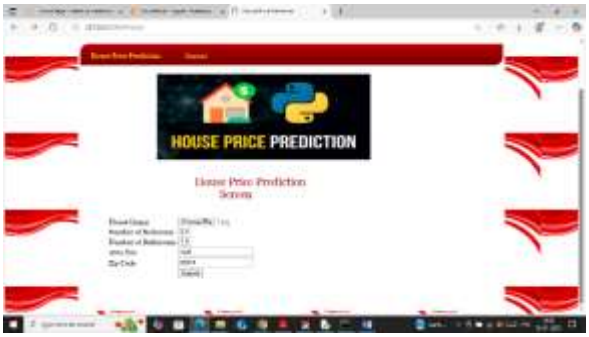
In above screen house price predicted as 6,20,579 and similarly you can predict for any house image. Below is the another example



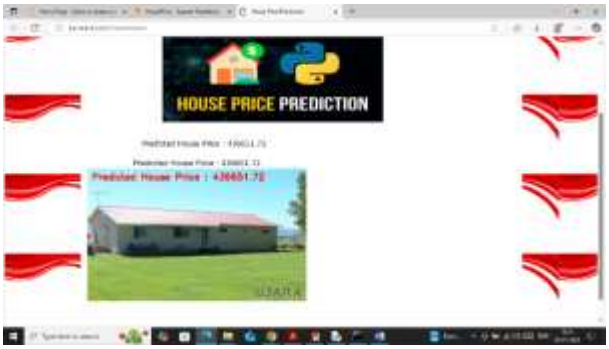
In above screen given some another input and below is the output



In above screen can see predicted house price



For above details will get below price



Similarly test for any image

VIII. CONCLUSION

In this work, a deep learning-based model for house price prediction using heterogeneous data analysis along with a joint self-attention mechanism has been successfully proposed. The main objective of the study was to improve prediction accuracy and interpretability by integrating multiple data sources such as structured property features, textual descriptions, and other relevant contextual information. Traditional models often fail to capture the complex and nonlinear relationships present in real estate data, whereas the proposed approach effectively addresses these limitations through advanced deep learning techniques.

The incorporation of a joint self-attention mechanism plays a crucial role in enhancing the performance of the model by dynamically identifying and focusing on the most significant features across different data modalities. This not only improves the

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accuracy of price prediction but also provides better interpretability by highlighting the contribution of each feature. The experimental analysis shows that the proposed system outperforms conventional machine learning and basic deep learning models in terms of prediction error and overall efficiency.

IX. FUTURE WORK:

The proposed house price prediction system can be further improved by incorporating additional data sources and more advanced deep learning techniques. In future work, integrating real-time data streams such as current market trends, interest rates, economic indicators, and inflation rates can enhance the model's adaptability to dynamic real estate conditions. This will help in making more accurate and timely predictions.

Another important enhancement is the inclusion of advanced multimodal learning techniques. Future models can leverage more sophisticated architectures such as Transformer-based networks for better handling of heterogeneous data. Extending the joint self-attention mechanism into cross-modal attention can further improve the interaction between structured, textual, and visual data.

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