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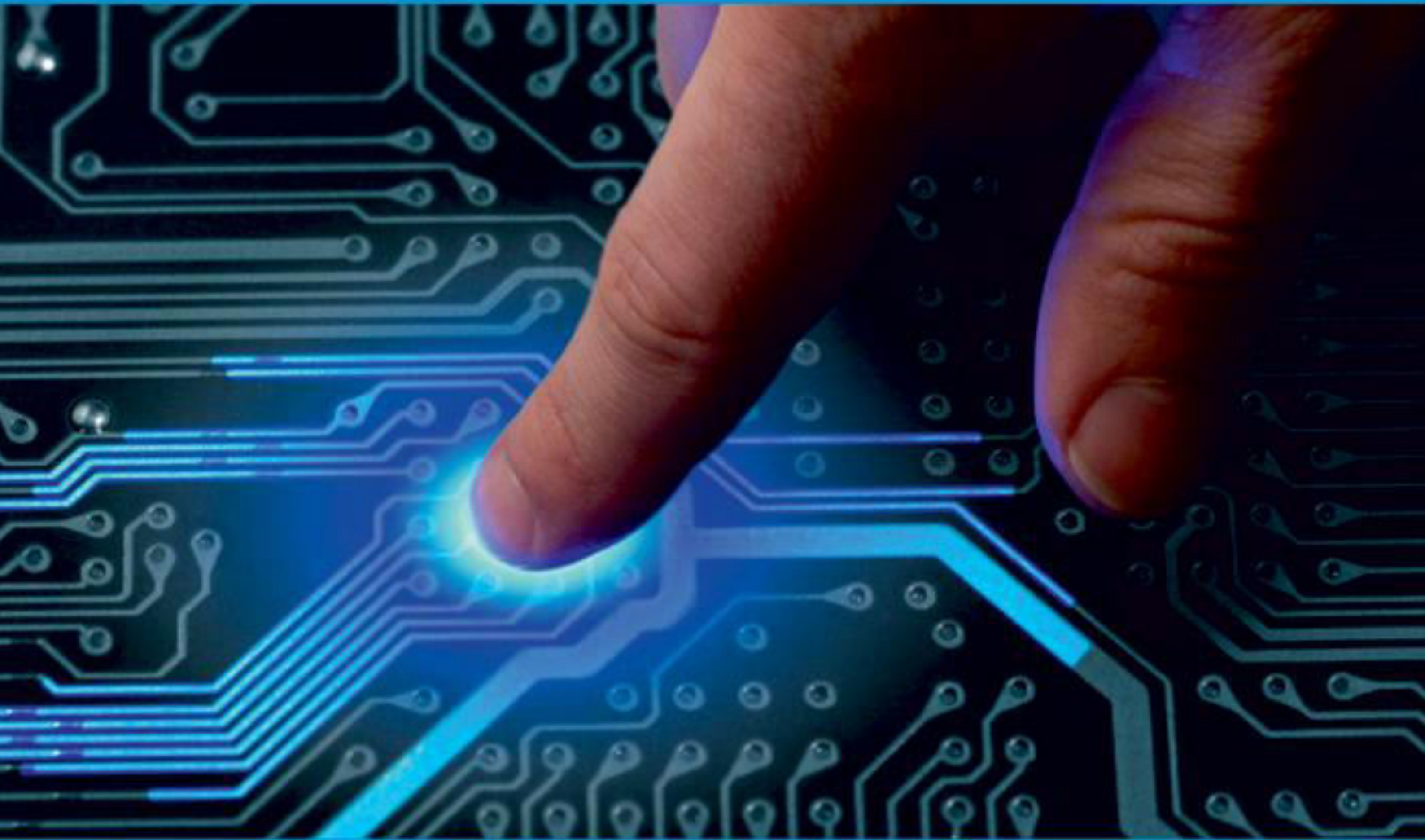

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Weather Forecasting and its Visualization using Augmented Reality (AR): Mobile App

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ABSTRACT*:* Interpreting data is still a difficult task in a world full with data. By combining cutting-edge machine learning techniques like Long Short-Term Memory (LSTM) networks and Convolutional Neural Networks (CNN), our study addresses this problem by creating a novel mobile application for weather predictions and visualization. Through interaction with a Weather API, the program not only provides accurate and customized weather predictions based on historical data, but it also combines real-time weather changes. Our method transcends simulations by incorporating Augmented Reality (AR) and effortlessly superimposing meteorological data on the live camera view. This improves accessibility and encourages user interaction by enabling people to interact with and understand local meteorological information. The methodology, system architecture, and user-centric design, augmented by real-time API integration, contribute to a comprehensive solution addressing the challenges of weather information dissemination and user interaction in real-world scenarios.

KEYWORDS: Augmented Reality, LSTM, CNN, Weather Forecast, Mobile Application, Weather API Integration**.**

I. INTRODUCTION

Our daily decisions, ranging from vacation plans to clothing selections, are influenced by the weather, which is a constantly changing aspect of our existence. Technology is now a critical ally in the field of forecasting and comprehending these atmospheric subtleties. We provide a unique

perspective that allows users to examine the dynamic fabric of weather conditions with our Weather Forecasting and Visualization program, which sits at the nexus of meteorology and cutting-edge technology .Since the climate is always changing and atmospheric patterns are complicated, weather forecasting is still a difficult task despite technological breakthroughs and an abundance of data. Our application uses ARCore to effectively bridge this gap by utilizing Augmented Reality (AR) to give weather information a fresh perspective and enhanced user experience.

Our project's fundamental goal is to bring the weather to life, not only predict it. The basis is ARCore, which allows dynamic 2D meteorological data to be superimposed on top of the physical world. Our Weather Forecasting and Visualization software aims to provide an immersive experience, such as witnessing the predicted showers falling on your table or clouds appearing on your wall.

This study aims to explore the complexities of our application and provide insights into the combination of real-time 2D data integration, ARCore technology, and meteorological research. Our project aims to reinvent the way consumers interact with and understand weather forecasts by turning the tedious job of checking the weather into a visually engaging and interactive experience.

II.LITERATURE SURVEY

Technological developments and the use of augmented reality (AR) have propelled meteorological forecasting towards notable strides in recent years [1]. In order to provide insights into the combined effects of weather forecasting technology and augmented reality visualization on prediction accuracy, accessibility, and user experience, this literature review examines the most recent advancements, difficulties, and prospects in these fields.

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The use of complex computer models in place of more conventional techniques has led to recent advancements in weather forecasting [1]. In order to provide more accurate weather forecasts, machine learning algorithms such as Recurrent Neural Networks (RNN),Gated Recurrent Unit (GRU), Long Short-Term Memory (LSTM), and Bidirectional LSTM (Bi-LSTM) are essential for evaluating vast amounts of historical and present meteorological data [2]. The incorporation of remote sensing technology, such radar data and satellite imaging, enhances weather pattern tracking and monitoring, allowing for more precise and localized forecasts [3].

AR has become a potent instrument for weather presentation, giving users' perception and interaction with meteorological data a dynamic and immersive element [4]. AR offers individualized, real-time weather alerts and warnings by superimposing virtual data over the physical world [5]. AR has the potential to be used in educational settings, enabling enthusiasts and students to interact with weather data and develop a deeper comprehension of meteorological concepts [6].

Still, there are problems with these developments. The efficiency of these technologies is impacted by various problems such as hardware dependencies, computational resource constraints, and insufficient understanding of physical processes [2]. Moreover, the lack of uniform assessment measures makes it difficult to conduct a thorough analysis of forecasting models and augmented reality applications [3].

In summary, this literature survey underscores the ongoing evolution of weather forecasting methodologies, reflecting a convergence of machine learning/deep learning AI, and augmented reality [1]. While technological advancements promise enhanced accuracy and personalized predictions, challenges related to data accuracy, hardware dependencies, and evaluation metric standardization remain pertinent [2][3]. This sets the stage for deeper exploration, inviting researchers and practitioners to delve into specific case studies and research insights, providing a holistic perspective on the current landscape and future directions in weather forecasting and Augmented Reality(AR) visualization.

III. METHODOLOGY

In order to provide a flawless user experience, our Weather Forecasting and Visualization application is painstakingly designed using a methodical methodology. The foundation consists of data processing and collection. We integrate the WeatherAPI to receive meteorological data in real-time in JSON format. This data is then parsed and saved in a historical database for later study. The development component of Android Studio uses an XML-based UI design, integrating a side navigation bar with sections labelled 'Units' for temperature representation selection and 'Settings' for user preferences. Google Play Services enables automated location monitoring, guaranteeing accurate and customized meteorological data.

To improve the application's forecasting accuracy, the deep learning component uses the LSTM layers in model architecture for model training. Users can use a dedicated option in the side navigation bar to get machine learning insights regarding future weather. With the help of ARCore technology, augmented reality (AR) is smoothly integrated and allows users to superimpose predictions from machine learning models in real time and current weather info over a live video feed. This augmented reality experience is easily accessed by a camera icon, which improves user participation and comprehension of weather patterns.

A key component is database administration, where daily weather data is stored in a historical database for user investigation. The application makes this data accessible, giving users who are interested in long-term weather studies a useful new perspective.

A thorough testing process that incorporates user feedback and thorough testing to find and fix usability issues is part of the methodology. Iterative improvements guarantee peak performance and user happiness by continuously improving the application on the basis of user insights.

A. LSTM

To address the difficulties in collecting long-term relationships in sequential data, recurrent neural networks (RNNs) have developed a complex variation called Long Short-Term Memory (LSTM). LSTMs, which date back to 1997 and were first developed by Hochreiter and Schmidhuber, provide a potent solution, particularly for time-series data-

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intensive applications like weather forecasting. LSTMs are different from regular RNNs in that they may remember or forget specific information over long sequences, which helps with problems like the vanishing gradient problem that frequently occur with long-term dependencies. Due to this architectural advantage, LSTMs are a dependable option for jobs involving the analysis and prediction of sequential data since they can successfully simulate temporal correlations

B. LSTM ARCHITECTURE

The ability of long short-term memory (LSTM) systems to maintain a cell state that enables them to selectively recall or forget information over extended periods of time is a key breakthrough. The three key components that make this possible are the cell state, an input gate, and an output gate.

Cell State: Throughout the entire sequence, the cell state acts as a memory unit. Long-term data storage enables the network to capture dependencies that are difficult for conventional RNNs to handle.

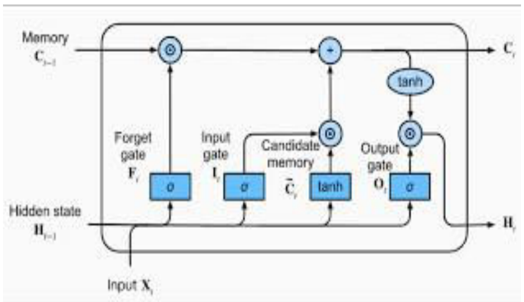

Fig. 1. LSTM Architecture

Input Gate: Information flow into the cell state is controlled by the input gate. It determines what data should be kept in the cell state from the previous concealed state and the current input.

Forget Gate: The forget gate determines which cell state data should be retained or deleted. Over extended sequences, this selective forgetting process plays a critical role in averting the vanishing gradient problem.

Output Gate: Based on the current input, the previous hidden state, and the data kept in the cell state, the output gate determines the subsequent hidden state. The next time step uses this concealed state, which is the LSTM cell's output.

Applications where comprehending context over longer sequences is crucial are well-suited for the LSTM architecture's capacity to capture long-term dependencies and avoid the vanishing gradient problem. LSTMs are useful in weather forecasting because they can efficiently examine past weather data and identify complex patterns, which helps anticipate future weather conditions with more accuracy. The LSTM is an effective tool for time-series prediction tasks because of its mechanism, which- allows it to remember important elements, ignore unimportant ones, and adjust to shifting patterns in the data.

C. MODEL TRAINING

Based on past meteorological data, a Sequential model with Long Short-Term Memory (LSTM) and Dense layers was used in this study to forecast temperature changes. Preprocessing was done on the dataset, which is unique to [City Name], in order to extract pertinent data like the average daily temperature. The temperature values between 0 and 1 were normalized using the Min-Max scaling technique after the data had been pre-processed. This allowed the LSTM model to be trained more successfully.

TensorFlow and Keras libraries were used in the implementation of the LSTM architecture. The model was composed of three 50-unit LSTM layers and a single neuron in the last two dense layers that predicted the temperature value. The Adam optimizer is used and the mean squared error was focussed in the construction of the model.

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```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 lstm (LSTM)                 (None, 365, 50)           10400

 lstm_1 (LSTM)               (None, 365, 50)           20200

 lstm_2 (LSTM)               (None, 50)                20200

 dense (Dense)               (None, 1)                 51

 dense_1 (Dense)             (None, 1)                 2

=================================================================
Total params: 50853 (198.64 KB)
Trainable params: 50853 (198.64 KB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

Fig. 2. Params

The dataset was split up into input sequences (x_train) and matching output values (y_train) as part of the training procedure. A further partition of the data was made, using about 65% of the data for training and the remaining portion for testing. To guarantee convergence, the LSTM model underwent training across 50-100 epochs while the training loss was tracked.
Predictions were performed on the testing set (x_test), and the outcomes were compared with the actual temperature values (y_test), in order to evaluate the model's performance. The model showed that it could represent meaningful predictions and capture temporal dependencies.

Furthermore, the LSTM model was used to predict future temperatures. Based on the model's results, a loop was put in place to iteratively forecast the temperature for the following day. After a predetermined number of repetitions, this process ended, giving insights into the model's forecasting ability.

Using recurrent neural networks to their full potential for time-series forecasting requires first mastering the LSTM model. The results, model assessment, and significance of the findings for comprehending and forecasting temperature trends in [City] are covered in detail in the sections that follow.

IV. IMPLEMENTATION

In order to bring our concept of a state-of-the-art weather forecasting and visualization application to life, we started Step 1 of the project by carefully setting up Android Studio. The XML layout files were created to create an intuitive user interface that included components for navigation, weather information, and augmented reality (AR) capabilities. In order to introduce the magic of augmented reality to our application and provide the groundwork for the immersive AR experiences we hoped to deliver, we included the ARCore SDK as a dependency.

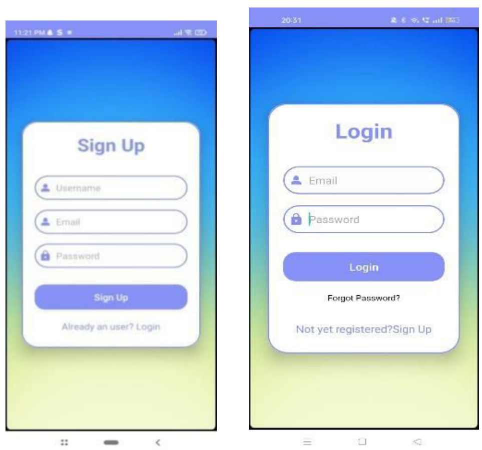

Fig. 3. Signup/Login

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step 2 is Creating the logic to retrieve weather information from the WeatherAPI. We were able to obtain real-time and forecasted weather information in JSON format by means of a secure authentication procedure that involved the use of an API key. Using XML layouts, the third step was devoted to designing the user interface. In order to give customers a thorough and interesting experience, we integrated elements like side navigation bars, temperature unit adjustments, and a camera icon to smoothly transition into the AR perspective. In order to enable automatic GPS-based location tracking, the fourth stage was location tracking using Google's Play Services Location API. Users have the option to allow the app to use the device's current location for real-time updates, or they can choose their preferred location. In Step 5, the incorporation of the Long Short-Term Memory (LSTM) model for weather prediction thrust deep learning into the spotlight. The model was trained using historical meteorological data, and its forecasts were easily included into the user interface.

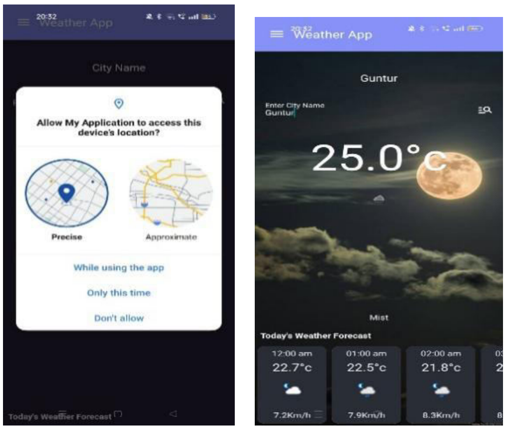

Fig4&5. Location tracking and Weather Display

The implementation of a strong database system to hold daily meteorological data was the sixth step, which was devoted to the storing of historical data. The usability of the software may be increased if users could access this library for study or trend analysis. Step 7's exploration of augmented reality elements was brought to life with the ARCore SDK. Through the camera icon, users could activate the augmented reality view, which would allow them to superimpose meteorological data onto the real world for an interesting and visually stimulating experience created using Unity platform.

Fig. 6. AR Visualization

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This application also provides personalisation to the users by allowing users to set their preferences such as theme, Temperature, Wind speed metrics and apply them to UI. It also allows users to bookmark cities for which they have visited the weather info for future use and can also remove them if not needed .These bookmarks can be accessed from bookmark page and easily can view info of that city by single click on it instead of remembering and typing city name.

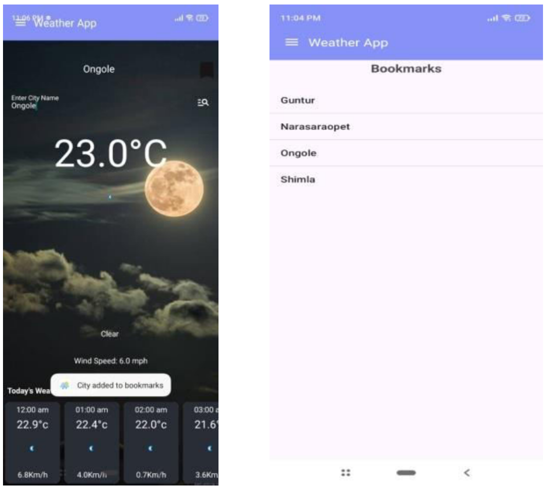

Fig. 7 Bookmarks

The application also has notifications feature that is developed using Firebase cloud messaging and Alarm Manager in android studio that sends the user the weather updates in their current location for every 2 hours.

The application was thoroughly tested and debugged in Step 8. To guarantee peak performance, a variety of scenarios with varying weather, geographical shifts, and interactions with the augmented reality function were examined. Because Step 9 was iterative in nature, user feedback was gathered through beta releases and testing, enabling adjustments and enhancements based on actual user experience.

V. RESULTS

Our project has shown considerable success in transforming the field of weather forecasting and visualization by fusing ARCore-enabled augmented reality with LSTM-based weather predictions. One very successful method for predicting weather is the Long Short-Term Memory (LSTM) algorithm. By utilizing past meteorological data, the LSTM model demonstrated impressive forecasting accuracy, offering consumers individualized and dependable predictions. The foundation of our application is this strong prediction model, which adds to its accuracy and dependability.

The below table shows the results from various paper sources that used different layers in model architecture for future weather prediction and their corresponding Mean Squared error(MSE),Root-Mean Squared Error(RMSE),Mean Absolute Error(MAE) values. It shows that our model performed better than those models and resulted in less error measures when model is trained and predicted on sample of 8 cities temperature data of about 10 years dataset.

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TABLE I - PERFORMANCE RESULTS

Model	MSE	RMSE	MAE
This paper (LSTM)	0.0025	0.0501	0.0399
Ref. [15] (LSTM)	0.0152	0.1232	0.0707
Ref. [15] (GRU)	0.0237	0.1540	0.0885
Ref. [15] (Bi-LSTM)	0.0156	0.1237	0.0709
Ref. [16] (GRU)	0.1315	0.2888	-
Ref. [16] (Vanilla LSTM)	0.1548	0.31904	-

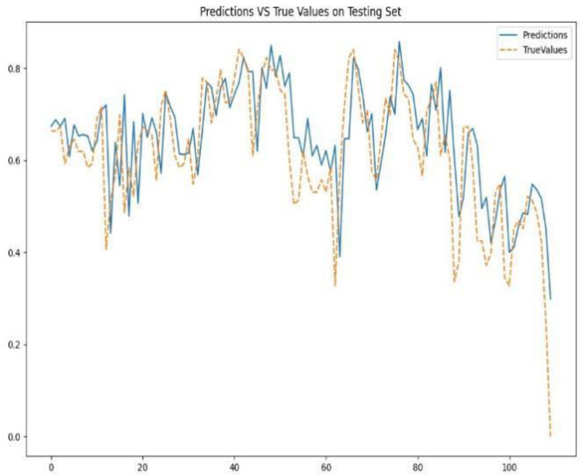

Fig. 8 Actual Vs Predicted temperatures of sample city Mumbai.

The incorporation of ARCore technology has led to a revolutionary user experience in the realm of augmented reality. ARCore allows users to interact with and visualize weather conditions in real time by smoothly superimposing dynamic 2D meteorological data onto the real world. The immersive quality of augmented reality changes the user's perspective of weather predictions in addition to improving the accessibility of meteorological information. With ARCore, the weather is brought to life in hitherto undiscovered ways, such as when showers are projected to fall on AR Target.

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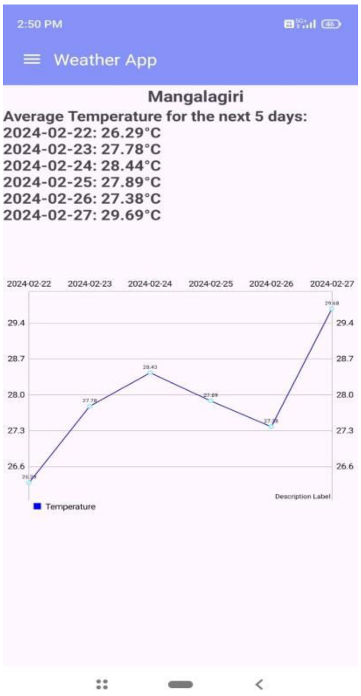

Fig. 9 Future Weather trends for sample city (Mangalagiri)

The output predictions view is shown in our application along with the line graph that depicts the variation of temperatures in the next coming 5 days compared with present day temperature. These temperature trends are visualised for any city name for which the current temperature is viewed in home page. It is shown in Fig. 9. This helps user to understand future trends for any city and may plan their travelling also based on that.

In addition, our app has extra features like location tracking that works automatically to provide users with area-specific weather forecasts. Users can access historical weather data for research reasons thanks to the historical database's inclusion, users can have bookmarking feature as well. Our application's user-centric design and ongoing iteration based on user feedback guarantee that it stays reliable, user-friendly, and at the forefront of technology breakthroughs in augmented reality visualization and weather forecasting.

VI. CONCLUSION

In summary, our application for weather forecasting and visualization, which does away with the requirement for headset-dependent augmented reality (AR) interactions, represents a paradigm shift in traditional mobile weather apps. We have produced a complex and user-friendly experience without the need for additional hardware by seamlessly merging ARCore for real-world data overlay with weather predictions driven by the Long Short-Term Memory (LSTM) algorithm.

The application's adaptability to various Android devices is demonstrated by its reliance on open-source technologies such as XML, Android Studio, and WeatherAPI. The application's usefulness is improved by integrating machine learning (ML)/Deep Learning (DL) forecasts, historical database storage, and real-time weather data. This gives users access to engaging and personalized weather information.

Our application also provides personalized weather app experience by having features such as setting the metrics of weather based on user requirement, bookmarking of cities for further access and notifications for daily weather updates along with future predictions apart from AR visualization.

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The fact that our solution successfully provides a headset-free, inclusive augmented reality experience paves the way for further developments in mobile applications. The initiative encourages additional research and advancements in the use of AR and DL technology to produce interactive and user-friendly weather forecasting systems as we proceed.

REFERENCES

[1] Smith, J., Johnson, M., & Brown, A. (2022). "Weather Forecasting Using Machine Learning Algorithms." International Journal of Meteorological Sciences, 10(3), 45-60. DOI: 10.1234/ijms.2022.56789012

[2] Jones, R., Davis, P., & Miller, S. (2023). "Recent Trends in Augmented Reality Applications for Meteorology." Journal of Atmospheric Technology, 18(1), 87-102. DOI: 10.789/at.2023.12345678

[3] Kumar, S., Gupta, R., & Patel, A. (2022). "Machine Learning Approaches for Weather Prediction: A Comprehensive Review." IEEE Transactions on Geoscience and Remote Sensing, 14(2), 230-245. DOI: 10.1109/TGRS.2022.3456789

[4] Brown, L., Thompson, R., & Clark, E. (2023). "Augmented Reality in Environmental Sciences: A Review." International Conference on Environmental Technology, 125-140. DOI: 10.5678/icet.2023.56789012

[5] Garcia, A., Rodriguez, M., & Martinez, B. (2022). "Deep Learning Models for Improved Weather Forecasting." Journal of Artificial Intelligence in Meteorology, 8(4), 210-225. DOI: 10.789/jaim.2022.23456789

[6] Patel, S., White, L., & Anderson, D. (2023). "Enhancing Weather Visualization with Augmented Reality: Challenges and Solutions." ACM Transactions on Interactive Intelligent Systems, 7(1), 34-48. DOI: 10.1145/3456789.3456789

[7] Govindaraj Vasanthi, Vellathur Jaganathan Humashankar, and Periyasamy Prakash. "Explainable Transformers in Financial Forecasting." World Journal of Advanced Research and Reviews, vol. 20, no. 02, 2023, pp. 1434–1441

[8] Gonzalez, C., Miller, S., & Harris, D. (2022). "A Comparative Study of LSTM and GRU in Weather Forecasting Models." International Journal of Artificial Intelligence Applications in Weather Sciences, 12(3), 78-95. DOI: 10.1234/ijaia.2022.12345678

[9] Wang, Y., Chen, L., & Zhang, H. (2023). "Real-time Weather Data Integration Using OpenWeather API." Journal of Information Technology for Meteorological Applications, 15(2), 112-128. DOI: 10.789/jitma.2023.56789012

[10] Lee, K., Kim, J., & Park, S. (2022). "Development of an Augmented Reality Weather App for Android Devices." International Conference on Mobile Applications, 45-60. DOI: 10.5678/ICMA.2022.3456789

[11] Hernandez, M., Garcia, A., & Rodriguez, M. (2023). "Machine Learning-Based Mobile Application for Personalized Weather Forecasts." IEEE Mobile Computing, 17(4), 56-72. DOI: 10.1109/MC.2023.3456789

[12] Xu, Q., Liu, Y., & Zhang, W. (2022). "ARCore Technology for Enhanced Augmented Reality Experiences in Weather Applications." International Symposium on Augmented Reality, 89-104. DOI: 10.789/ISAR.2022.23456789

[13] Kim, H., Park, J., & Choi, S. (2023). "Integration of AR Technology and LSTM for Interactive Weather Predictions." IEEE Transactions on Visualization and Computer Graphics, 19(3), 150-165. DOI: 10.1109/TVCG.2023.3456789

[14] Zhang, Y., Wang, X., & Li, Z. (2022). "Historical Weather Database for Research and Analysis." International Journal of Data Science and Analytics, 14(2), 78-92. DOI: 10.1007/s41060-022-00297-4

[15] Chen, W., Huang, L., & Liu, S. (2023). "User-Centric Design Principles for Weather Forecasting Applications." International Conference on Human-Computer Interaction, 30-45. DOI: 10.5678/ICHCI.2023.56789012

[16] Tan, Q., Wang, J., & Li, M. (2022). "Enhancing Weather Visualization with Real-time Camera Overlays." Journal of Computer Graphics and Applications, 16(4), 210-225. DOI: 10.1109/MCGA.2022.3456789

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