AI-BASED HOSPITAL BED OCCUPANCY PREDICTION SYSTEM

PRESENTED BY

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PROBLEM STATEMENT

During seasonal flu outbreaks, pandemics, or local health crises, hospitals often experience sudden surges in patient admissions, leading to bed shortages. This affects emergency preparedness, delays treatment, and overwhelms hospital resources.

Currently, most hospitals rely on manual estimates or static systems that do not account for trends like local outbreaks, weather changes, or seasonal patterns. As a result, they lack accurate short-term forecasting of bed occupancy, making it difficult to plan staff, equipment, and space effectively.

There is a growing need for a data-driven, AI-based system that can predict bed demand in the next 24–48 hours to support better planning and faster response.

PROPOSED SOLUTION

- The proposed system aims to address the challenge of predicting hospital bed occupancy over the next 24 to 48 hours to improve resource allocation, staff scheduling, and emergency preparedness. This invol leveraging machine learning and time-series forecasting techniques to accurately estimate short-term demand based on historical and real-time data. The solution will consist of the following components:

- Data Collection:
  - Gather historical data on bike rentals, including time, date, location, and other relevant factors.
  - Use external data such as weather, holidays, and disease trends to improve prediction ac

- Data Preprocessing:
  - Clean and preprocess the collected data to handle missing values, outliers, and inconsistencies.
  - Perform Feature engineering (e.g.,dayof the week,past admision count).

- Machine Learning Algorithm:
  - Use models like LSTM, Prophet, or XGBoost to forecast future bed demand.
  - Incorporate seasonal trends and external factors into model training.

- Deployment:
  - Build a Streamlit or Flask dashboard to display predictions.
  - Allow hospital staff to view bed forecasts and plan accordingly.

- Evaluation:
  - Evaluate model accuracy using MAE, RMSE, and R^2 Score.
  - Continuously improve the model using feedback and new data.

- Result:
  - Accurate predictions of bed needs for the next 1–2 days.
  - Helps hospitals improve emergency preparedness and resource allocation.

SYSTEM APPROACH

->Programming Language: Python

->Libraries Used: Pandas, NumPy, Matplotlib, Scikit-learn, TensorFlow/Keras, Streamlit

->Data Sources: Historical hospital admission records, weather data, local disease reports

->System Stack:

Data preprocessing & feature engineering

Time-series modeling (LSTM, Prophet, or XGBoost)

Web-based dashboard using Streamlit or Flask

ALGORITHM & DEPLOYMENT

- In the Algorithm section, describe the machine learning algorithm chosen for predicting bike counts. Here's an example structure for this section:
- **Algorithm Selection:**
  - The system uses LSTM, Prophet, and XGBoost for predicting hospital bed occupancy. LSTM is used for capturing time-dependent patterns, Prophet handles seasonality and holidays, while XGBoost processes structured features. Input data includes historical bed occupancy, day of the week, holidays, weather conditions, and local disease trends. The models are trained using past data with techniques like cross-validation and hyperparameter tuning. Once trained, they forecast bed demand for the next 24–48 hours, and the results are displayed through a simple dashboard built using Streamlit or Flask for easy access by hospital staff.
- **Data Input:**
  - Specify the input features used by the algorithm, such as historical bike rental data, weather conditions, day of the week, and any other relevant factors.
- **Training Process:**
  - Explain how the algorithm is trained using historical data. Highlight any specific considerations or techniques employed, such as cross-validation or hyperparameter tuning.
- **Prediction Process:**
  - Detail how the trained algorithm makes predictions for future bike counts. Discuss any real-time data inputs considered during the prediction phase.

RESULT

The machine learning models produce short-term bed occupancy forecasts that help hospital staff anticipate demand. The output is visualized through graphs comparing predicted and actual values. Performance is evaluated using metrics like Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and R^2 Score. These predictions assist in optimizing staff scheduling, allocating medical resources, and improving emergency readiness, especially during high-demand periods.

CONCLUSION

The AI-based hospital bed prediction system provides a reliable and efficient way to forecast short-term bed demand using past admission trends and external factors. It improves decision-making for hospital administrators, reduces operational stress during emergencies, and enhances patient care. The system demonstrates the potential of machine learning in solving real-world healthcare management problems.

FUTURE SCOPE

Future improvements to the system could include expanding the model to predict specific resource needs such as ICU beds, oxygen cylinders, or ventilators. Integration with hospital databases and live outbreak feeds could enhance real-time responsiveness and accuracy. The system can also be scaled to cover multiple hospitals or regions, enabling better coordination across healthcare networks. Additionally, edge computing could be explored for faster, on-site predictions without relying on central servers. We can also enhance the system to track the availability of doctors and their specializations, allowing hospitals to plan not just bed capacity but also ensure the right medical expertise is available during peak demand periods.

REFERENCES

This project draws on credible research and official data sources to support the development of an AI-based hospital bed occupancy prediction system. The World Health Organization's publication Managing Epidemics highlights how disease outbreaks lead to sudden surges in hospital admissions, straining bed availability. The Indian Ministry of Health and Family Welfare (MoHFW) and NITI Aayog provide detailed reports on hospital infrastructure and the shortage of specialist doctors across urban and rural areas. CDC's COVID-NET data illustrates real-time hospital utilization trends during pandemics. To forecast occupancy, the project uses time-series techniques such as LSTM, guided by Chris Olah's foundational blog on understanding LSTM networks. Facebook Prophet, selected for trend and seasonality handling, is supported by its official documentation. For the system interface, Streamlit is used to create interactive dashboards, based on its comprehensive development documentation. Additionally, the IEEE paper titled AI-based Hospital Bed and Staff Forecasting during COVID-19 validates the use of machine learning in real-world hospital resource planning.

GitHub Link:Link

Thank you