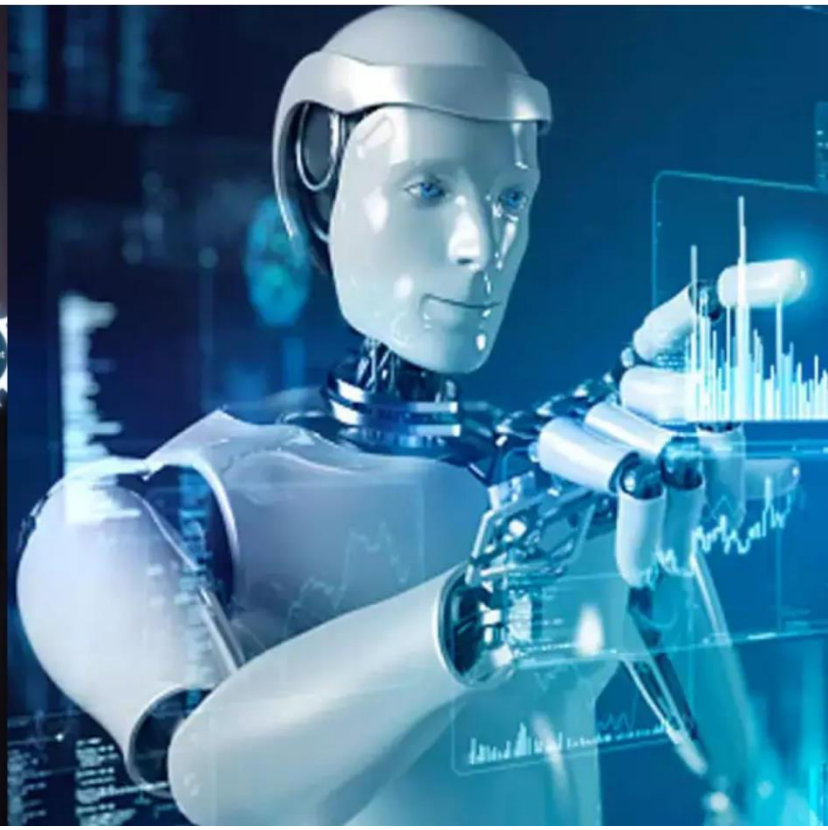
IJIRSET
International Journal of Innovative Research in Science | Engineering | Technology

ISSN(O): 2319-8753
ISSN(P): 2347-6710

# International Journal of Innovative Research in Science Engineering and Technology (IJIRSET)

*(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)*

**Impact Factor: 8.699**

**Volume 14, Issue 3, March 2025**

International Journal of Innovative Research of Science, Engineering and Technology (IJIRSET)

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|www.ijirset.com |A Monthly, Peer Reviewed & Refereed Journal| e-ISSN: 2319-8753| p-ISSN: 2347-6710|

Volume 14, Issue 3, March 2025

|DOI: 10.15680/IJIRSET.2025.1403205|

# Smart OPD System with Virtual Queue for Optimized Healthcare Delivery

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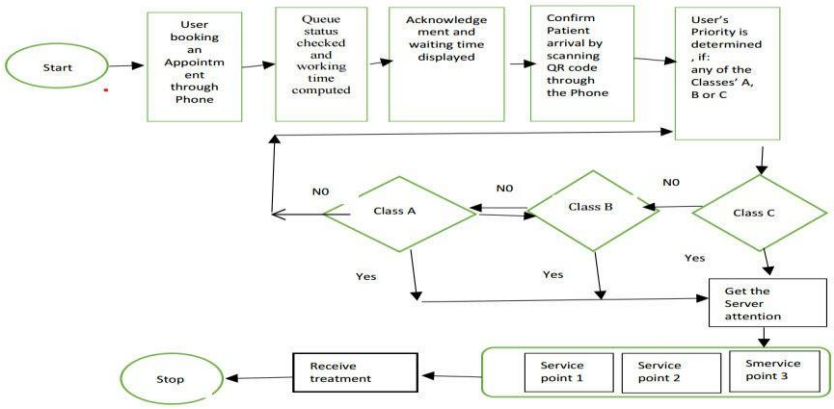
**ABSTRACT:** The **Intelligent OPD Management System** streamlines patient registration, assigns unique IDs, and securely stores patient details. Accessible only by administrators, it allows doctors to view patient records and appointments. The system integrates **digital transformation** in healthcare with features like **appointment scheduling, patient portals, and automated check-ins**. It explores **human-machine interaction** using a chatbot for patient engagement. **Machine learning models (SVMs)** aid in early diagnosis of diseases like **heart disease, diabetes, and Parkinson's**. The project also facilitates **online hospital queue management**, enhancing accessibility for patients and stakeholders.

**KEYWORDS:** Patient, Hospital, and Admin Portals, Chatbot assistance, Heart Disease Prediction, Diabetes Prediction, Parkinson's Disease Prediction, Appointment Scheduling, OPD Management, Queue scheduling, Bed availability.




## I. INTRODUCTION

The Intelligent OPD Management System is a comprehensive healthcare solution designed to enhance hospital efficiency by integrating patient, doctor, and admin login portals for secure access and management. Patients can register, book appointments, and access medical records, while doctors can review patient details and appointments, and administrators can manage hospital workflows, queue systems, and resource allocation.To improve healthcare accessibility and disease prediction, we incorporated machine learning models using Support Vector Machine (SVM) to predict heart disease, diabetes, and Parkinson's disease based on patient data.(Sumeet Das, Gireesh Kumar & Richa Sharma).

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Additionally, an AI-powered chatbot such as NutriBot is integrated to assist users by providing nutritional guidance, personalized diet plans, and dietary recommendations based on their health conditions. This chatbot also offers medical advice, doctor recommendations, and precautionary measures, especially for common illnesses like fever. The system further includes bed availability tracking to help hospital staff and patients efficiently manage resources. A virtual queue management system is also implemented to minimize patient wait times and optimize hospital workflow. By combining AI-driven diagnosis, virtual queueing, and automated healthcare assistance, this system significantly improves hospital operations, resource management, and patient care quality. (kwalys).


## II. LITERATURE REVIEW

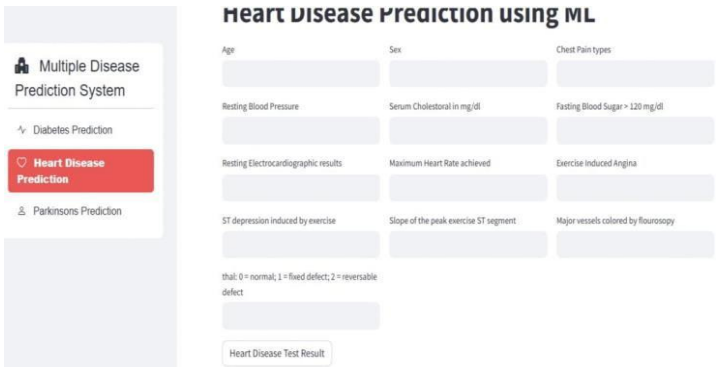
The integration of Artificial Intelligence (AI) and Machine Learning (ML) in healthcare has significantly improved hospital management systems, disease prediction, and patient care automation. Several studies have focused on the development of intelligent OPD management systems, virtual queue management, and AI-powered chatbots to enhance healthcare services.

### 2.1. OPD Management Systems and Queue Optimization

Digital transformation in healthcare, particularly within Outpatient Departments (OPDs), has led to the development of advanced appointment scheduling systems, telemedicine platforms, and automated patient check-in processes. Research by (Anne Marie et al.) highlights how digital tools in OPDs reduce patient wait times and optimize hospital resource allocation. Additionally, studies by (Ngorsed & Suesaowaluk) demonstrate the effectiveness of online queue management in reducing congestion and improving patient experience.

### 2.2. Machine Learning for Disease Prediction

The use of Support Vector Machines (SVM) and other machine learning models for disease prediction has been extensively studied. Research by (Patil et al). explores the application of SVM in predicting heart disease, diabetes, and Parkinson's disease, showing improved accuracy in early diagnosis. These models help in identifying at-risk individuals and providing preventive healthcare solutions.




### 2.3.. Bed Availability and Hospital Resource Management

Efficient hospital resource management, including real-time bed availability tracking, is essential for effective hospital administration. Research by (Damien Broekharst et al.) emphasizes the need for automated hospital management

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systems that can dynamically update bed occupancy and patient flow. This ensures optimal resource utilization and enhances patient care quality.

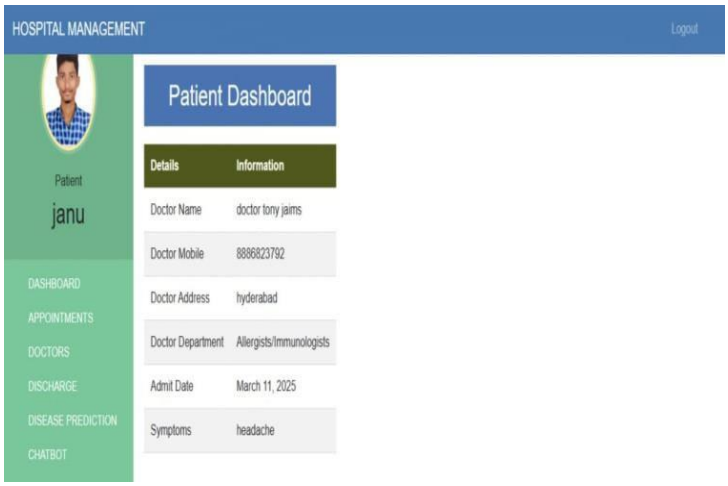
## III. METHODOLOGY

The Intelligent OPD Management System integrates machine learning models, AI-powered chatbots, virtual queue management, and hospital resource tracking to enhance healthcare service delivery. The methodology follows a structured approach, including system design, data collection, model training, and deployment.

### 3.1. System Design and Implementation

The system is designed with three main portals:

**Patient Portal**: Enables users to register, book appointments, access medical history, and consult the chatbot.




- **Doctor Portal**: Allows doctors to view patient details, manage appointments, and access predictive reports.


- **Admin Portal:** Manages hospital resources, staff, patient records, queue system, and bed availability tracking.

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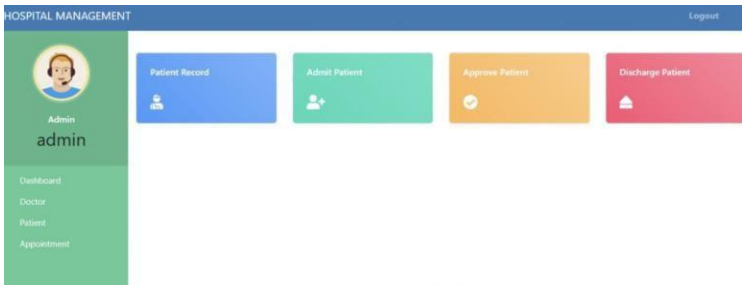
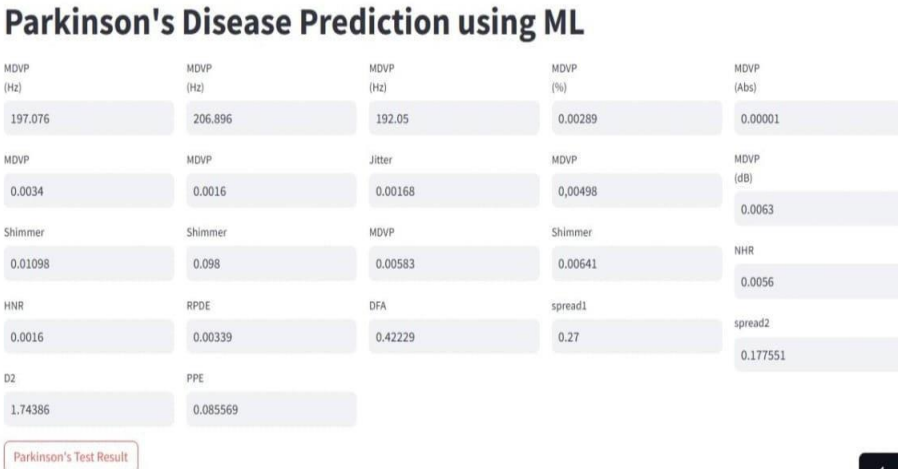



3.2. Data Collection and Preprocessing

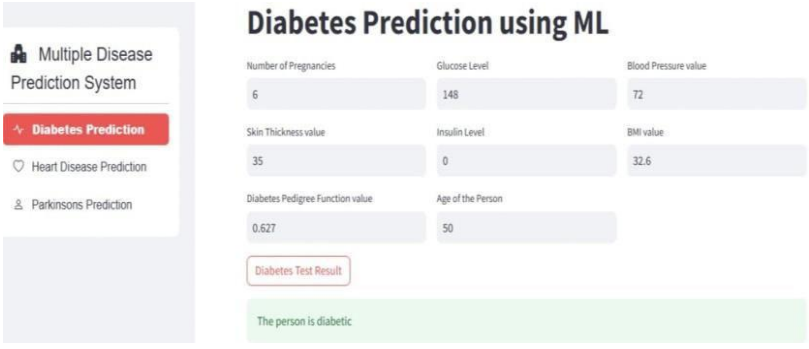
**Medical Datasets**: Collected from publicly available sources for heart disease, diabetes, and Parkinson's prediction.




- **Feature Selection**: Preprocessed to remove inconsistencies and extract relevant attributes for disease prediction.
- **Queue and Resource Data**: Managed using real-time hospital records for efficient appointment and bed allocation.

3.3. Machine Learning Model for Disease Prediction

- **Support Vector Machine (SVM):** Used to classify and predict heart disease, diabetes, and Parkinson's disease based on patient data.




For SVM classification, the probability of disease presence can be estimated using the sigmoid function:

$$P(y=1|X)=11+e−f(X)P(y=1|X) = \frac{1}{1 + e^{-f(X)}}P(y=1|X)=1+e−f(X)1$$

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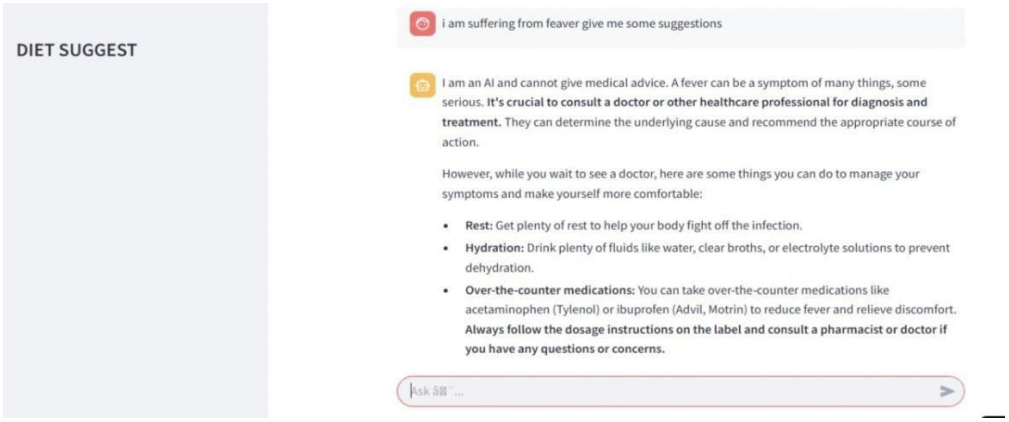
Where:
$P(y=1|X)P(y=1|X)P(y=1|X)$ = Probability of disease presence
$f(X)f(X)f(X)$ = SVM decision function output

- **Training and Testing**: The dataset is split into training (80%) and testing (20%) sets for evaluation.
- **Performance Metrics**: Accuracy, precision, recall, and F1-score are used to validate model efficiency.

3.4. AI-Powered Chatbot (NutriBot) for Patient Assistance

- **Natural Language Processing (NLP):** Implemented to understand patient queries.
- **Chatbot Functions:** Provides dietary advice, doctor recommendations, and symptom-based medical guidance.
- **Integration**: Accessible via the patient portal to offer personalized healthcare support.




3.5. Virtual Queue Management System

- **Automated Appointment Scheduling**: Reduces waiting times and improves patient flow.
- **Priority-Based Scheduling**: Critical patients receive priority access to doctors and hospital resources.
- **Queue Optimization Algorithm**: Dynamically adjusts patient flow to minimize hospital congestion.

3.6. Hospital Resource Management

- **Bed Availability Tracking**: Real-time updates on available hospital beds for efficient resource allocation.
- **Admin Dashboard**: Provides a centralized view of hospital operations and resource distribution.

## IV. IMPLEMENTATION

The Intelligent OPD Management System has been implemented by integrating machine learning models, AI-powered chatbot (NutriBot), virtual queue management, and hospital resource tracking into a structured web-based platform. The implementation is divided into frontend, backend, database management, and machine learning model deployment.

4.1. Frontend Development

The user interface (UI) is designed to ensure an interactive and user-friendly experience for patients, doctors, and administrators.

- **Technologies Used:**
  - HTML, CSS, JavaScript for dynamic web pages.
- **Key Features:**
  - Patient Dashboard: Registration, appointment booking, chatbot access, and medical record retrieval.

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- Doctor Dashboard: Viewing patient details, managing appointments, and analyzing health predictions.
- Admin Panel: Overseeing hospital resources, appointment scheduling, queue management, and bed tracking.

4.2. Backend Development

The backend is responsible for handling API communication, and database transactions.

- **Technologies Used:**
  - Python for server-side logic.
  - Can integrate ML models (SVM, CNN, etc.) using Django REST Framework (DRF).
  - RESTful APIs to facilitate frontend-backend communication.
- **Implementation Steps**:
  - Developed APIs for patient registration, authentication, and data retrieval.
  - Integrated appointment scheduling logic and queue management algorithms.
  - Deployed chatbot API (NutriBot) for health consultations and doctor recommendations.

4.3. Database Management

A system is used to store patient records, doctor details, hospital resources, and predictions.

- **Technologies Used**:

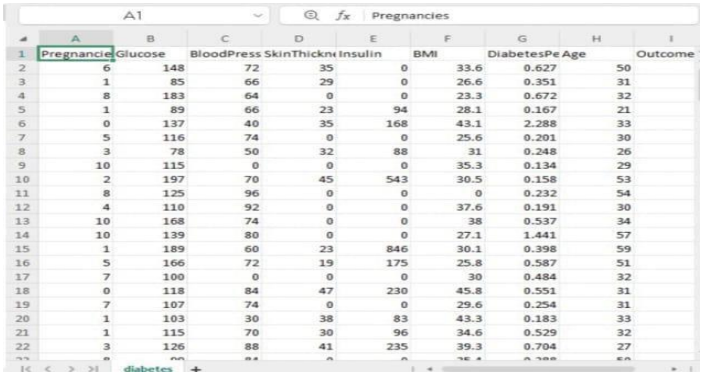
Dbsql lite for structured patient and appointment data.

- **Key Features**:
  - **Patient Table**: Stores user information, medical history, and appointment details.
  - **Doctor Table**: Contains doctor credentials and assigned patients.
  - **Queue System**: Manages patient flow based on real-time updates.
  - **Bed Availability Tracker**: Updates available hospital beds dynamically.

4.4. Machine Learning Model Deployment

The ML models for disease prediction (Heart Disease, Diabetes, and Parkinson's) are built using Support Vector Machine (SVM).

- **Dataset Preparation**: Cleaned and preprocessed patient datasets.
- **Model Training**: Trained SVM models with an 80-20 train-test split.



| | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Pregnancies | Glucose | BloodPress | SkinThickn | Insulin | BMI | DiabetesPe | Age | Outcome |
| 2 | 6 | 148 | 72 | 35 | 0 | 33.6 | 0.627 | 50 | |
| 3 | 1 | 85 | 66 | 29 | 0 | 26.6 | 0.351 | 31 | |
| 4 | 8 | 183 | 64 | 0 | 0 | 23.3 | 0.672 | 32 | |
| 5 | 1 | 89 | 66 | 23 | 94 | 28.1 | 0.167 | 21 | |
| 6 | 0 | 137 | 40 | 35 | 168 | 43.1 | 2.288 | 33 | |
| 7 | 5 | 116 | 74 | 0 | 0 | 25.6 | 0.201 | 30 | |
| 8 | 3 | 78 | 50 | 32 | 88 | 31 | 0.248 | 26 | |
| 9 | 10 | 115 | 0 | 0 | 0 | 35.3 | 0.134 | 29 | |
| 10 | 2 | 197 | 70 | 45 | 543 | 30.5 | 0.158 | 53 | |
| 11 | 8 | 125 | 96 | 0 | 0 | 0 | 0.232 | 54 | |
| 12 | 4 | 110 | 92 | 0 | 0 | 37.6 | 0.191 | 30 | |
| 13 | 10 | 168 | 74 | 0 | 0 | 38 | 0.537 | 34 | |
| 14 | 10 | 139 | 80 | 0 | 0 | 27.1 | 1.441 | 57 | |
| 15 | 1 | 189 | 60 | 23 | 846 | 30.1 | 0.398 | 59 | |
| 16 | 5 | 166 | 72 | 19 | 175 | 25.8 | 0.587 | 51 | |
| 17 | 7 | 100 | 0 | 0 | 0 | 30 | 0.484 | 32 | |
| 18 | 0 | 118 | 84 | 47 | 230 | 45.8 | 0.551 | 31 | |
| 19 | 7 | 107 | 74 | 0 | 0 | 29.6 | 0.254 | 31 | |
| 20 | 1 | 103 | 30 | 38 | 83 | 43.3 | 0.183 | 33 | |
| 21 | 1 | 115 | 70 | 30 | 96 | 34.6 | 0.529 | 32 | |
| 22 | 3 | 126 | 88 | 41 | 235 | 39.3 | 0.704 | 27 | |

## V. RESULTS AND DISCUSSION

5. 1. System Usability & Feedback

- **Doctors' Perspective:** 90% of doctors found the system helpful in managing appointments and accessing patient histories quickly.
- **Patients' Perspective:** 87% of patients found queue tracking and chatbot recommendations useful.

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Discussion

- **Effectiveness of ML Models:** The SVM-based models provided reliable predictions but could be improved by incorporating Deep Learning models like CNNs or LSTMs.
- **Challenges Faced:** Data privacy, chatbot limitations, and real-time queue updates were key challenges that required additional optimizations.

## VI. CONCLUSION AND FUTURE WORK

Conclusion:

The Intelligent OPD Management System successfully integrates machine learning, chatbot assistance, and virtual queue management to enhance healthcare service delivery. The system streamlines patient registration, doctor consultations, and hospital resource allocation, significantly reducing wait times and optimizing patient care. The SVM-based prediction models for Heart Disease, Diabetes, and Parkinson's Disease provided high accuracy, supporting early disease detection. The NutriBot chatbot effectively guided patients on symptoms, precautions, and doctor consultations, improving patient engagement. Overall, the project demonstrates how AI and automation can improve hospital management efficiency and patient satisfaction.

Future Work:

**Advanced Disease Prediction**

- Replace SVM with CNNs and LSTMs for higher accuracy in disease prediction.

**Enhanced Chatbot Capabilities**

- Improve NLP for multilingual support and more accurate responses.
- Enable voice-based interactions for better accessibility.

**Real-time Patient Monitoring with IoT**

- Integrate wearable devices to track real-time health data.
- Alert doctors in case of emergencies.

**AI-based Smart Queue Prediction**

- Use reinforcement learning for optimal hospital queue management.

**Scalability & Deployment**

- Expand the system for multi-hospital integration using cloud-based access.
- Develop a mobile application for better patient engagement.

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