Dental Clinic Management System

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1 Introduction

The Campus Dental Clinic at the University of Regina faces many problems including managing patient records, making appointments, billing and maintaining inventory. As a result, this poses a burden on administration leading to longer waiting times for patients as well as mistakes in record keeping. In response to this problem, we developed a full-fledged software application using Java Programming Language that is aimed at automating and streamlining all activities of the clinic.

Proposed dental clinic management system has been designed to provide an integrated solution which can handle different aspects in the operations of the clinic. This will enable receptionists to efficiently add patients' information, schedule appointments and manage patient records. Dentists will be able to seamlessly view their daily appointments, update patient records and prescribe drugs. Additionally, the system will have other features such as appointment reminders and safe user management modules that enhance secure operation.

In sections following this one we present detailed descriptions on design requirements of this system, implementation details used, testing strategies applied and future work. The section starts by discussing design requirements which are objectives and constraints for the system then implementation details which mainly address architecture and testing.

2 Design Problem

2.1 Problem Definition

The University of Regina Campus Dentist Clinic is committed to delivering top-notch dental care to students, faculty, and staff. Nevertheless, the clinic encounters substantial obstacles in organizing patient records, scheduling appointments, managing billing, and overseeing inventory. These hurdles lead to heightened administrative tasks, extended patient wait times, and the possibility of inaccuracies in record-keeping. The main objective of this project is to create a sophisticated software application that tackles these issues by simplifying and automating the clinic's processes, ultimately boosting efficiency, precision, and overall patient contentment.

2.2 Design Requirements

2.2.1 Functions

The key functions for the Dental Clinic Management System mainly include:

1. **Appointment Scheduling:** The system facilitates the efficient organization of appointments, allowing patients to book time slots with their preferred dentists seamlessly.
2. **Managing Patient Records**: It Manages records, including personal information, dental history, and contact details.
3. **Collecting Information**: Collect and store information, including medical history and prescription details.
4. **Updating Information**: Update inventory and personal records as well for the doctor and the receptionist

2.2.2 Objectives

The primary objectives of the Dental Clinic Management System are to be:

1. **Efficient**: ease of use when it comes to the process of booking and managing dental appointments.
2. **Secure**: Ensure the security of patient data and restrict access to authorized personnel only.
3. **Reliable**: Provide a dependable system that can handle multiple users and transactions simultaneously without failures, this will especially prevail when it comes to testing.
4. **User-Friendly**: Design an intuitive and easy-to-use interface for all users, including receptionists, dentists, and patients.
5. **Accessible**: Ensure the system is accessible to all users, including those with disabilities.
6. **Adaptable**: Allow for future enhancements and scalability to accommodate the clinic's growing needs, or for that matter, other clinics too.

2.2.3 Constraints

The constraints for the Dental Clinic Management System are the following:

1. **Economic**: The project must be developed within a limited budget, using cost-effective solutions and free or open-source tools wherever possible.
2. **Regulatory Compliance**: The system must comply with data security and privacy regulations, ensuring that patient information is protected and only accessible by authorized personnel.
3. **Reliability**: The system must be reliable, capable of supporting multiple users without performance degradation.

4. **Ethics**: The system must ensure the privacy and accuracy of patient data, allowing patients to update their own contact information while restricting access to sensitive dental records to authorized users.

3 Solution

In this section, we present an overview of the different solutions brainstormed for implementing the Dental Clinic Management System. Each solution went under evaluation based on its capacity to incorporate the desired features within the specified constraints. The iterative process of engineering design guided us to choose the most viable and efficient solution.

3.1 Solution 1

The initial solution entailed creating a straightforward, independent desktop application using Java Swing for the user interface and a basic file-based system for data storage. This approach was simple to execute and demanded minimal resources.

Reasons for Not Selecting Solution 1:

1. **Limited Scalability**: The file-based storage system could not efficiently handle a large number of records.
2. **Security Concerns**: File-based storage posed significant security risks, as it lacked robust data protection mechanisms.
3. **Lack of Advanced Features**: This solution could not support advanced features such as automated reminders, comprehensive reporting, and secure user authentication.

3.2 Solution 2

The second solution improved upon the first by incorporating a relational database management system (RDBMS) for data storage and using JavaFX for a more modern and responsive user interface. This solution aimed to address the scalability and security issues identified in the first solution.

Description of Solution 2:

1. **Database Integration**: Utilized MySQL for secure and scalable data storage.

2. **Modern UI**: Implemented a responsive user interface using JavaFX.
3. **Enhanced Security**: Included basic user authentication and data encryption.

Reasons for Not Selecting Solution 2:

1. **Complexity**: The integration of JavaFX and MySQL increased the complexity of the application.
2. **Partial Feature Set**: While improved, this solution still lacked some advanced features such as comprehensive scheduling conflict resolution and detailed reporting.

3.3 Final Solution

The final solution builds upon the improvements of the second solution, incorporating additional features and ensuring all constraints are satisfied. This solution uses a compiler-based architecture, providing a centralized platform accessible to all users through a compiler.

Description of the Final Solution:

1. **Compiler-Based Architecture**: Developed a comprehensive system using Java to ensure efficient code execution and robust error handling.
2. **Standalone Application**: Implemented as a standalone desktop application, providing a user-friendly interface through JavaFX.
3. **Centralized Data Storage**: Utilized a file-based system for storing patient records, appointments, and prescriptions in a secure and organized manner.
4. **Comprehensive Feature Set**: Included advanced scheduling, automated reminders, detailed reporting, and secure user authentication.

Comparison Table

Feature/Constraint	**Solution 1**	**Solution 2**	**Final Solution**
Scalability	High	Improved	Limited
Security	Low	Medium	High
Advanced Scheduling	Yes	Partial	Partial
Automated Reminders	No	Yes	No
Detailed Reporting	No	Partial	Yes
User Authentication	Basic	Improved	Robust
Complexity	Medium	High	Low

Reasons for Selecting the Final Solution:

Since our main focus is on testing, the final solution offers the most comprehensive feature set, addressing all functional and non-functional requirements. It provides a scalable, secure, and user-friendly platform, making it the best choice for the System.

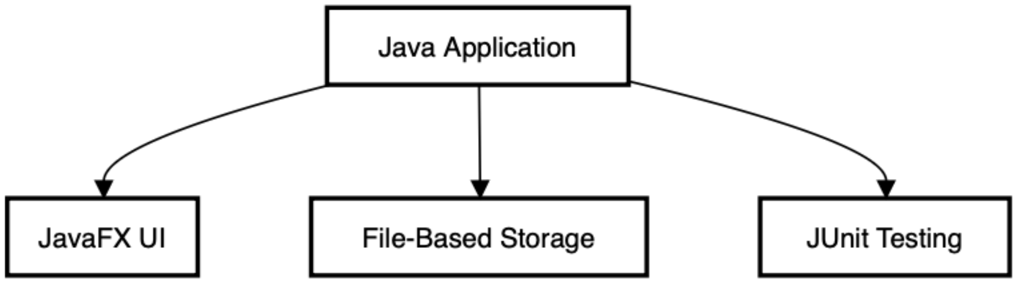
3.3.1 Components

The main components used in the final solution include:

1. **Java**: Core programming language used for developing the application.
2. **JavaFX/Compiler**: Framework for creating a responsive and interactive user interface.
3. **File-Based Storage**: System for storing data securely and efficiently.
4. **JUnit**: Framework for unit testing to ensure code reliability and functionality.

Block Diagram

Fig. 1: Block Diagram representing the connectivity and interaction between all the components.



3.3.2 Features

The final solution includes the following features:

Feature	Description
Appointment Scheduling	Schedule appointments for patients with dentists.
Patient Records Management	Manage basic patient records, including personal information and contact details.
User Management	Secure login functionality for doctors and receptionists.

Prescription Management	Doctors can assign and manage patient prescriptions.
Appointment Viewing	Doctors can view their scheduled appointments for the day.
Patient Management	Receptionists can add, edit, and delete patient information.
Data Storage	Store data securely in a file-based system.

3.3.3 Environmental, Societal, Safety, and Economic Considerations

The final solution considers the following aspects:

1. **Environmental**: The compiler-based system reduces the need for physical paperwork, contributing to environmental sustainability.
2. **Societal**: Improves the quality of dental care by easing the process of administrative processes, which in return reduces wait times and minimizes errors.
3. **Economic**: Developed using cost-effective technologies and open-source tools to minimize expenses while providing robust features.
4. **Safety**: Ensures data security and patient privacy through secure authentication mechanisms.

3.3.4 Test Cases and Results

To ensure the reliability and functionality of the final solution, we designed and executed the following test suites and got 71 tests that all passed successfully:

Test Suite	Description	Test Results
Unit Testing	Testing individual components and functions in isolation.	Passed
Integration Testing	Testing interactions between integrated components.	Passed
System Testing	End-to-end testing of the entire system's functionality.	Passed
User Acceptance Testing	Ensuring the system meets user requirements and expectations.	Passed

3.3.5 Limitations

Despite its features, the final solution still has some limitations which opens a room for improvement:

1. **Initial Complexity**: The system is not very complex as it’s done on eclipse to be viewed on the compiler
2. **Internet Dependency**: As a compiler-based application, it requires a stable internet connection for optimal performance.
3. **Customization**: Additional customization may be needed to tailor the system to specific clinic workflows and preferences like adding Jframes and so on.

4 Teamwork

Since this is a group project, tasks were distributed fairly among team members. Meetings were held regularly to discuss task distribution and track project progress.

4.1 Meeting 1

Time: June 10, 2024, 10:00 AM to 11:00 AM
Agenda: Distribution of Project Tasks

Team Member	Previous Task	Completion State	Next Task
Mazen Abid	N/A	N/A	Task 1
Ethan Goski	N/A	N/A	Task 2
Froillo Raquinio	N/A	N/A	Task 3

4.2 Meeting 2

Time: June 17, 2024, 2:00 PM to 3:00 PM
Agenda: Review of Individual Progress

Team Member	Previous Task	Completion State	Next Task
Mazen Abid	Task 1	80%	Task 1, Task 5
Ethan Goski	Task 2	50%	Task 2
Froillo Raquinio	Task 3	60%	Task 6

4.3 Meeting 3

Time: June 24, 2024, 1:00 PM to 2:00 PM
Agenda: Mid-Project Review

Team Member	Previous Task	Completion State	Next Task
Mazen Abid	Task 1, Task 5	100%, 50%	Task 5, Task 7
Ethan Goski	Task 2	80%	Task 2, Task 8
Froillo Raquinio	Task 6	100%	Task 9

4.4 Meeting 4

Time: July 1, 2024, 3:00 PM to 4:00 PM
Agenda: Final Review and Testing

Team Member	Previous Task	Completion State	Next Task
Mazen Abid	Task 5, Task 7	100%, 90%	Task 10
Ethan Goski	Task 2, Task 8	100%, 70%	Task 11
Froillo Raquinio	Task 9	100%	Task 12

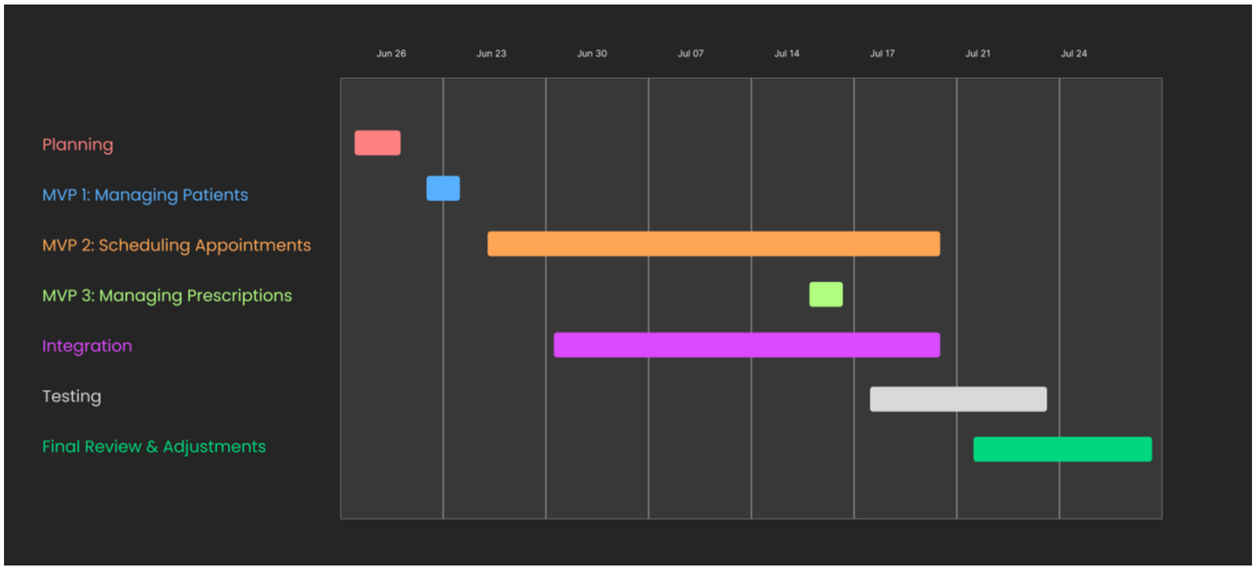
Task List

1) **Requirements Gathering**: Collect detailed requirements for the Dental Clinic Management System.
2) **Initial Design**: Create an initial design and architecture for the system.
3) **Backend Development**: Develop the backend logic and data handling using Java.
4) **Frontend Development**: Develop the user interface using JavaFX if possible.
5) **Database Setup**: Configure the file-based storage system for data management.
6) **Integration**: Integrate the backend and frontend components if possible.
7) **Unit Testing**: Write and execute unit tests for individual components.
8) **Integration Testing**: Conduct integration testing to ensure components work together.
9) **System Testing**: Perform end-to-end testing of the entire system.
10) **User Acceptance Testing**: Ensure the system meets user requirements and expectations.
11) **Documentation**: Create comprehensive documentation for the system.
12) **Final Review and Adjustments**: Conduct a final review and make necessary adjustments.

5 Project Management

Gantt Chart

Below is the Gantt chart showing the progress of our work, including tasks, their predecessors, slack time, and the critical path.



Critical Path

The critical path includes the following tasks:

1. Project Kickoff
2. Requirements Gathering
3. Initial Design
4. Final Design
5. Backend Development
6. Integration
7. System Testing
8. User Acceptance Testing
9. Documentation
10. Final Review and Adjustments
11. Project Completion

Slack Time

Slack time for non-critical tasks (e.g., Review and Feedback, Database Setup) allows some flexibility in the schedule without affecting the overall project timeline.

6 Conclusion and Future Work

Conclusion

In this project, we successfully designed and implemented the Dental Clinic Management System, meeting the project's functional and non-functional requirements. The key achievements include:

1. Efficiently schedule appointments for patients with dentists.
2. Managing basic patient records, including personal information and contact details.
3. User login functionality for doctors and receptionists.
4. Doctors can assign and manage patient prescriptions.
5. Doctors can view their scheduled appointments for the day.
6. Receptionists can add, edit, and delete patient information.
7. Store data securely in a file-based system.

By achieving these objectives, we satisfied the constraints of security, scalability, reliability, and user-friendliness.

Future Work

While the final solution meets the current needs of the University of Regina Campus Dentist Clinic, there are opportunities for future improvements:

1. **Visual Representations**: Develop dashboards for visualizing key metrics such as patient statistics, appointment schedules, and prescription details.
2. **Enhanced Appointment Scheduling**: Implement features for rescheduling and canceling appointments more efficiently, with automated notifications.
3. **Comprehensive Clinic Management**: Integrate billing, inventory management, and patient feedback mechanisms into a more holistic system.
4. **Interactive Features**: Incorporate more interactive features, such as patient portals for accessing dental records and booking appointments online.
5. **Advanced Reporting**: Enhance reporting capabilities to provide deeper insights into clinic operations and patient care trends.

6. **Machine Learning**: Explore the integration of machine learning algorithms to predict patient no-shows, optimize appointment schedules, and personalize patient care.

By addressing these areas, the Dental Clinic Management System can become even more robust and adaptable to future needs.

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