People's Democratic Republic of Algeria

Ministry of Higher Education and Scientific Research

Sétif 1 University - Ferhat ABBAS

Faculty of Sciences





Master's Thesis

To obtain the diploma of **Master's Degree**

Field of Study: **Computer Science**

Specialization: **Network & Distributed Systems**

Theme

Design and Development of VitoSync:

IoT Remote Patient Monitoring Platform with Intelligent Alerting

---

Presented by:

Benrouibi Imene Asma

Sakhara Ala-eddine

Haroun Zineddine

Bensaci Hadil

Defended on: **June 2026**

Supervisor: Dr. Laouarem Ayoub

Academic Year: 2025/2026

Abstract

Algeria's healthcare sector faces significant challenges, including hospital overcrowding, limited access to continuous patient monitoring, and a lack of real-time data for timely decision-making. These issues often lead to delayed interventions and reduced quality of care, especially for patients with chronic conditions.

This thesis proposes **VitoSync**, a smart telemedicine and remote patient monitoring platform that integrates Internet of Things (IoT) technologies with modern web and mobile applications.The system continuously monitors patients' vital signs (i.e., heart rate, oxygen saturation,blood pressure, and body temperature) using connected sensors, and transmits the data in real time to healthcare providers. It also enables automated alerts in case of abnormal readings, allowing for rapid medical response.

In addition, `VitoSync` provides a centralized platform where patient data is securely stored and accessed by authorized medical staff, ensuring better traceability and continuity of care. The system includes dashboards for data visualization and mobile access for both doctors and patients, enhancing communication and engagement.

Keywords: Telemedicine, IoT, Remote Patient Monitoring, Real-Time Systems, Healthcare Platform, `VitoSync`, Data Visualization.

Résumé

Le secteur de la santé en Algérie fait face à des défis majeurs, notamment la surcharge des hôpitaux, l'accès limité au suivi continu des patients et le manque de données en temps réel pour une prise de décision rapide et efficace. Ces problèmes entraînent souvent des retards dans les interventions et une diminution de la qualité des soins, en particulier pour les patients atteints de maladies chroniques.

Ce mémoire propose **VitoSync**, une plateforme intelligente de télémédecine et de suivi médical à distance qui intègre les technologies de l'Internet des Objets (IoT) avec des applications web et mobiles modernes. Le système surveille en continu les signes vitaux des patients (c'est-à-dire la fréquence cardiaque, la saturation en oxygène, la pression artérielle et la température corporelle).à l'aide de capteurs connectés, et transmet les données en temps réel aux professionnels de santé. Il permet également de générer des alertes automatiques en cas de valeurs anormales, facilitant ainsi une intervention rapide.

De plus, `VitoSync` offre une plateforme centralisée où les données des patients sont stockées de manière sécurisée et accessibles uniquement par le personnel médical autorisé, garantissant une meilleure traçabilité et continuité des soins. Le système comprend des tableaux de bord pour la visualisation des données ainsi qu'un accès mobile pour les médecins et les patients, améliorant la communication et l'engagement.

Mots-clés : Télémédecine, IoT, Suivi médical à distance, Systèmes en temps réel, Plateforme de santé, `VitoSync`, Visualisation des données.

ملخص

يواجه القطاع الصحي في الجزائر تحديات كبيرة، من بينها اكتظاظ المستشفيات، ومحدودية الوصول إلى المتابعة المستمرة للمرضى، ونقص البيانات في الوقت الفعلي لاتخاذ القرارات السريعة. وتؤدي هذه المشاكل في كثير من الأحيان إلى تأخر التدخلات الطبية وتراجع جودة الرعاية الصحية، خاصة بالنسبة للمرضى الذين يعانون من أمراض مزمنة.

تقترح هذه الأطروحة منصة **VitoSync**، وهي منصة ذكية للطب عن بعد والمتابعة الصحية للمرضى عن بعد، تدمج تقنيات إنترنت الأشياء (IoT) مع تطبيقات الويب والهاتف المحمول الحديثة. يقوم النظام بمراقبة العلامات الحيوية للمرضى بشكل مستمر — مثل معدل ضربات القلب، تشبع الأكسجين، وحرارة الجسم — باستخدام أجهزة استشعار متصلة، ويقوم بنقل هذه البيانات في الوقت الفعلي إلى مقدمي الرعاية الصحية. كما يتيح النظام إرسال تنبيهات تلقائية في حال ظهور قراءات غير طبيعية، مما يسمح بالاستجابة الطبية السريعة.

بالإضافة إلى ذلك، توفر منصة VitoSync نظامًا مركزيًا يتم فيه تخزين بيانات المرضى بشكل آمن، ولا يمكن الوصول إليها إلا من قبل الطاقم الطبي المخوّل، مما يضمن تتبعًا أفضل واستمرارية في الرعاية. يتضمن النظام لوحات تحكم لعرض البيانات بشكل مرئي، بالإضافة إلى إمكانية الوصول عبر الهاتف المحمول لكل من الأطباء والمرضى، وهو ما يعزز التواصل والتفاعل.

الكلمات المفتاحية: الطب عن بعد، إنترنت الأشياء، المتابعة الصحية عن بعد، الأنظمة في الوقت الفعلي، منصة صحية، VitoSync، تصور البيانات.

Contents

List of Abbreviations

1 Theoretical Background **3**

1.1 Introduction . . . 3

1.2 Internet of Things: Concepts and Architecture . . . 3

1.2.1 Definition of IoT . . . 3

1.2.2 Internet of Medical Things . . . 3

1.2.3 IoT Architecture Layers . . . 4

1.2.3.1 Perception Layer . . . 4

1.2.3.2 Network Layer . . . 4

1.2.3.3 Application Layer . . . 5

1.3 IoMT in Healthcare and Remote Patient Monitoring . . . 5

1.3.1 Applications of IoMT in Healthcare . . . 5

1.3.2 Benefits of Remote Monitoring . . . 6

1.3.2.1 Clinical Benefits . . . 6

1.3.2.2 Economic Benefits . . . 6

1.3.2.3 Patient-Centric Benefits . . . 6

1.4 Challenges of Remote Monitoring . . . 6

1.4.1 Technical Challenges . . . 7

1.4.2 Operational Challenges . . . 7

1.4.2.1 subsec:operational-challenges . . . 7

1.4.3 Financial and Ethical Challenges . . . 8

1.5 Artificial Intelligence & Machine Learning . . . 8

1.6 Medical Context . . . 9

1.6.1 Vital Signs . . . 9

1.6.2 Importance of Real-Time Vital Signs Monitoring . . . 9

1.7 Communication Technologies for IoMT Systems 10
1.7.1 Message Queuing Telemetry Transport 10
1.7.2 HyperText Transfer Protocol 10
1.7.3 WebSocket 11
1.7.4 Relationship 12
1.8 Existing IoT-Based Health Monitoring Systems 13
1.8.1 Overview of Reviewed Systems 13
1.8.2 Synthesis and VitoSync Positioning 15
1.8.3 Technical Gaps 15
1.9 Conclusion 16

2 System Analysis & Design **17**
2.1 Introduction 17
2.2 VitoSync Overview 17
2.3 Requirements 17
2.3.1 Functional Requirements 17
2.3.2 Non-Functional Requirements 18
2.4 System Functional Design and User Workflows 18
2.4.1 Admin Dashboard Workflow 18
2.4.1.1 Manage Doctors 19
2.4.1.2 Manage Patients 19
2.4.1.3 Manage Devices 19
2.4.1.4 Manage Profile 20
2.4.1.5 Security and Configuration 20
2.4.1.6 Audit Logs 20
2.4.2 Doctor Interaction Workflow 20
2.4.2.1 Manage Patients 21
2.4.2.2 Manage Appointments 21
2.4.2.3 Manage Medications 21

2.4.2.4 View Health Data . . . 22
2.4.2.5 Manage Profile . . . 22
2.4.3 Patient Interaction Workflow . . . 22
2.4.3.1 Manage Profile . . . 23
2.4.3.2 Vital Signs . . . 23
2.4.3.3 Anomaly Alert System . . . 23
2.4.3.4 Medical History . . . 23
2.4.3.5 View Medicaments . . . 23
2.4.3.6 View Appointments . . . 23
2.4.3.7 Device Details and Monitoring . . . 24
2.5 System Architecture . . . 24
2.5.1 Perception Layer . . . 25
2.5.2 Network Layer . . . 25
2.5.3 Application Layer . . . 25
2.5.4 Intelligence Layer . . . 26
2.5.4.1 Key Characteristics . . . 26
2.5.4.2 Feature Engineering . . . 26
2.5.4.3 Model Implementation . . . 27
2.5.4.4 Risk Stratification and Scoring . . . 28
2.5.4.5 API Contracts . . . 28
2.5.5 Presentation Layer . . . 29
2.6 Database Model Design . . . 29
2.7 Alerting Design . . . 31
2.7.1 Rule-Based Alerting . . . 32
2.7.2 AI-Based Alerting . . . 32
2.7.3 Alert Workflow . . . 33
2.7.4 Alert Storage and Delivery . . . 33
2.8 Conclusion . . . 34

3 System Architecture and Implementation **35**

3.1 Introduction . . . 35

3.2 System Architecture and Decoupled Layers . . . 35

3.3 Hardware Development Environment Configuration . . . 36

3.4 Anomaly Detection and Alerting Logic . . . 36

3.4.1 Rule-Based Anomaly Detection . . . 37

3.4.2 AI-Based Anomaly Detection . . . 37

3.5 Deployment Strategy . . . 37

3.6 Graphical User Interface Documentation . . . 38

3.6.1 Administrator Portal Interfaces (React.js) . . . 38

3.6.1.1 Administrative Overview Dashboard . . . 38

3.6.1.2 User Access and Role Management . . . 38

3.6.1.3 Patient Management . . . 39

3.6.1.4 Doctor Management . . . 40

3.6.1.5 Sensor Fleet Management . . . 41

3.6.2 Medical Practitioner Portal Interfaces (React.js) . . . 42

3.6.2.1 Clinical Ward and Real-Time Monitoring . . . 42

3.6.2.2 Doctor Profile and Verification . . . 43

3.6.2.3 Patient Directory and Risk Assessment . . . 44

3.6.3 Mobile Application Interfaces (React Native) . . . 45

3.6.3.1 Patient Clinical Profile . . . 45

3.6.3.2 Biometric Telemetry Display . . . 46

3.6.3.3 Notification and Crisis Management Center . . . 47

3.7 Conclusion . . . 48

4 Entrepreneurial and Business Dimension **49**

4.1 Introduction . . . 49

4.1.1 Project Idea . . . 50

4.1.2 Value Propositions . . . 51

4.2 Benefits to Stakeholders . . . 53
4.3 Value Proposition Canvas of VitoSync . . . 54
4.3.1 Project Objectives (SMART Framework) . . . 56
4.3.1.1 Short-term Objectives (0–6 months) . . . 56
4.3.1.2 Medium-term Objectives (6–18 months) . . . 56
4.3.1.3 Long-term Objectives (18–36 months) . . . 57
4.3.2 Project Timeline . . . 57
4.4 Innovative Aspects . . . 58
4.4.1 Nature of Innovations . . . 58
4.4.2 Innovation Domains . . . 59
4.5 Strategic Market Analysis . . . 60
4.5.1 Market Overview . . . 60
4.5.2 Customer Behavior Analysis . . . 62
4.5.3 Buyer Persona Analysis . . . 63
4.5.4 Market Size Estimation (TAM–SAM–SOM) for VitoSync . . . 65
4.5.5 Justifications for the Target-Market Selection . . . 66
4.5.5.1 Contract Opportunities for the VitoSync Project . . . 67
4.5.6 Competition Intensity Analysis . . . 68
4.5.6.1 Direct Competitors . . . 68
4.5.6.2 Indirect Competitors: . . . 68
4.5.6.3 Competitive Positioning . . . 70
4.5.7 SWOT Analysis for VitoSync . . . 71
4.5.8 Marketing Strategies for VitoSync (7Ps Framework) . . . 74
4.5.8.1 Price . . . 75
4.5.8.2 Place . . . 75
4.5.8.3 Promotion . . . 75
4.5.8.4 People . . . 76
4.5.8.5 Process . . . 76

4.5.8.6 Physical Evidence 76
4.6 Marketing Vision 76
4.6.1 Digital Marketing: 77
4.6.2 Offline Marketing 77
4.6.3 Public Relations 78
4.7 Marketing Campaign Timeline (First 6 Months) 78
4.8 Production and Organizational Plan 80
4.8.1 Customer Journey for VitoSync Service: 80
4.8.2 Legal Framework of the VitoSync Project 81
4.8.3 Procurement and Payment Framework 82
4.8.4 Key Partnerships 83
4.9 Financial Plan 85
4.9.1 Costs and Liabilities 85
4.9.2 Product Offers and Pricing Strategy 86
4.9.3 Revenue Forecast — Conservative Scenario 87
4.9.4 Projected Income Statement — Conservative Scenario 88
4.9.5 Revenue Forecast — Optimistic Scenario 88
4.9.6 Projected Income Statement — Optimistic Scenario 89
4.9.7 Working Capital Requirement 89
4.9.8 Cash Flow Plan 90
4.9.9 Legal and Compliance Note 90
4.10 Prototype Interface of VitoSync Platform 91
4.10.1 Administrator Portal 91
4.10.1.1 Administrative Overview Dashboard 91
4.10.1.2 User Access and Role Management 92
4.10.1.3 Sensor Fleet Management 93
4.10.1.4 System Monitoring 94
4.10.1.5 Security and System Configuration 94

4.10.1.6 Audit Logs . . . 95
4.10.1.7 Backup and Storage Management . . . 95
4.10.2 Doctor Portal . . . 96
4.10.2.1 Clinical Overview Dashboard . . . 96
4.10.2.2 Patient Directory . . . 96
4.10.2.3 Patient Details . . . 97
4.10.2.4 Active Alerts . . . 97
4.10.2.5 Analytics and Reports . . . 98
4.10.2.6 Doctor Profile . . . 98
4.10.2.7 Doctor Settings . . . 99
4.10.3 Patient Mobile Application . . . 99
4.10.3.1 Home Screen . . . 99
4.10.3.2 Alerts Screen . . . 100
4.10.3.3 Vitals Tracking Screen . . . 100
4.10.3.4 Devices Screen . . . 101
4.10.3.5 Patient Profile Screen . . . 102
4.11 Platform Demonstration Video . . . 102
4.12 Business Model Canvas . . . 103
4.13 Conclusion . . . 104

General Conclusion **105**