SmartSDLC - AI-Enhanced Software Development Lifecycle

SmartSDLC is an intelligent AI-powered platform that automates the various phases of the Software Development Lifecycle (SDLC) using IBM Watsonx, LangChain, Streamlit, and FastAPI. It empowers users to accelerate software development through intelligent requirement classification, code generation, test automation, bug fixing, and much more.

Team Information

Team ID : LTVIP2025TMID60142

Team Size : 4

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This project was developed as part of a collaborative academic/innovation initiative, combining expertise in AI, software engineering, and full-stack development.

Problem Statement

Traditional software development is time-consuming, error prone, and manually intensive. Developers spend approximately

70% of their time on repetitive tasks such as:

- Manual requirement analysis and documentation
- Writing boilerplate code and test cases
- Debugging and fixing common errors
- Creating technical documentation
- Managing SDLC workflows

SmartSDLC addresses these challenges by leveraging generative AI to streamline and automate critical SDLC tasks, reducing development time by up to 60% while improving code quality and consistency.

Core Architecture

SmartSDLC follows a modern microservices architecture with the following components:

Backend Architecture

- **FastAPI Server**: High-performance API server for handling requests
- **IBM Watsonx Integration**: Advanced AI model for code generation and analysis
- **LangChain Framework**: Orchestrates AI workflows and prompt engineering

- **PDF Processing Engine**: Extracts and classifies requirements from documents
- **Authentication System**: JWT-based secure user management

Frontend Architecture

- **React + TypeScript**: Modern, type-safe user interface
- **Streamlit Dashboard**: Alternative Python-based interface for quick prototyping
- **Tailwind CSS**: Utility-first styling for responsive design •

Real-time Chat: WebSocket-based AI assistant integration

AI/ML Pipeline

- **Natural Language Processing**: Advanced text analysis and classification
- **Code Generation Models**: Multi-language code synthesis
- **Bug Detection Algorithms**: Pattern recognition for common errors
- **Test Case Automation**: Intelligent test scenario generation

Features & Functionalities

Feature	Description	Technology Stack

Requirement Analysis	Extracts SDLC phases from user stories	Floating chatbot providing real-time SDLC guidance and best practices
AI Code Generator	Generates production-ready code from natural language descriptions in 5+ programming languages	IBM Watsonx + NLP
Intelligent Test Case Generation	Produces comprehensive test cases with edge cases and error conditions	GPT Models + LangChain
Smart Bug Fixer	Detects, analyzes, and resolves bugs with detailed explanations	AI Pattern Recognition
Code Summarizer	Converts code into readable documentation and technical specifications	Static Analysis + AI
AI Chatbot Assistant	uploaded PDF requirements and generates structured	Documentation AI LangChain + Watsonx

Feature	Description	Technology Stack
Advanced Feedback System	feedback collection with sentiment analysis	scores and suggestions
GitHub Integration	Automated code push, issue creation, and documentation sync	Analytics Engine GitHub API
Project Management	Task tracking, milestone management, and progress analytics	Custom Dashboard
Code Quality Metrics	Multi-dimensional	Automated code review with quality	Static Analysis Tools

Advanced Features

1. Intelligent Requirement Classification

- **Multi-format Support**: PDF, DOCX, TXT file processing
- **SDLC Phase Detection**: Automatic categorization into Requirements, Design, Development, Testing, Deployment

- **User Story Generation**: Converts raw requirements into Agile user stories
- **Traceability Matrix**: Links requirements to code and test cases

2. Multi-Language Code Generation

Supported Languages:

- Python (Flask, Django, FastAPI)
- JavaScript/TypeScript (React, Node.js, Express) •

Java (Spring Boot, Maven projects)

- C++ (Standard Library, Modern C++)
- C# (.NET Core, ASP.NET)
- Go (Gin, Echo frameworks)
- Rust (Actix, Rocket frameworks)

Code Quality Features:

- Clean, commented, production-ready code
- Best practices implementation
- Security vulnerability scanning
- Performance optimization suggestions

3. Comprehensive Testing Suite

- **Unit Test Generation**: Framework-specific test cases (Jest, pytest, JUnit)
- **Integration Test Scenarios**: API and database testing
- **Performance Test Cases**: Load and stress testing templates •

Security Test Cases: Vulnerability and penetration testing **4.**

Advanced Bug Detection & Resolution

- **Static Code Analysis**: Syntax and logic error detection
- **Runtime Error Prediction**: Potential runtime issue identification
- **Performance Bottleneck Detection**: Code optimization suggestions
- **Security Vulnerability Scanning**: Common security flaw identification

Technical Specifications

System Requirements

- **Backend**: Python 3.10+, 4GB RAM minimum, 8GB recommended
- **Frontend**: Node.js 18+, npm 8+
- **Database**: SQLite (development), PostgreSQL (production)
- **AI Services**: IBM Watsonx API access, OpenAI API

(optional)

Performance Metrics

- **Code Generation**: ~3-5 seconds for 100 lines of code
- **Bug Fixing**: ~2-4 seconds for common issues
- **Test Generation**: ~5-8 seconds for comprehensive test suites
- **PDF Processing**: ~10-15 seconds for 50-page documents

Security Features

- **JWT Authentication**: Secure token-based authentication •

API Rate Limiting: Prevents abuse and ensures fair usage • **Input Validation**: Comprehensive input sanitization • **Data Encryption**: End-to-end encryption for sensitive data • **Audit Logging**: Complete activity tracking and monitoring

Installation & Setup

Prerequisites

System Requirements

Python 3.10 or higher

Node.js 18+ and npm

IBM Watsonx AI account and API key

Git for version control

Quick Start Installation

1. Clone the repository
git clone <repository-url>

cd SmartSDLC

2. Backend Setup

python -m venv venv

source venv/bin/activate # Linux/Mac

venv\Scripts\activate # Windows

pip install -r requirements.txt

3. Frontend Setup

npm install

4. Environment Configuration

cp .env.example .env

Edit .env with your IBM Watsonx credentials

5. Database Setup

python manage.py migrate # If using Django ORM
Or setup SQLite database

6. Start Services

python run_backend.py # Terminal 1

python run_frontend.py # Terminal 2 npm

run dev # Terminal 3 (for React) **Docker**

Deployment

Build and run with Docker Compose

docker-compose up --build

Access services:

- Streamlit:

http://localhost:8501 # - React:

http://localhost:3000

- API: http://localhost:8000

API Documentation

Authentication Endpoints

POST /auth/register - User registration

POST /auth/login - User authentication

POST /auth/refresh - Token refresh

DELETE /auth/logout - User logout

AI Service Endpoints

POST /ai/upload-pdf - PDF requirement analysis

POST /ai/generate-code - Code generation

POST /ai/fix-bugs - Bug detection and fixing POST

/ai/generate-tests - Test case generation POST

/ai/summarize-code - Code documentation POST

/ai/analyze-quality - Code quality assessment **Project**

Management Endpoints

GET /projects - List user projects

POST /projects - Create new project

PUT /projects/{id} - Update project

DELETE /projects/{id} - Delete project

GET /projects/{id}/stats - Project analytics

Usage Examples

1. Code Generation Example

Input: Natural language description

"Create a REST API endpoint for user authentication with JWT tokens"
Output: Complete FastAPI

implementation @app.post("/auth/login")

async def login(credentials: UserCredentials):

user = authenticate_user(credentials.username, credentials.password)

if not user:

raise HTTPException(status_code=401, detail="Invalid credentials")

access_token = create_access_token(data={"sub": user.username})

return {"access_token": access_token, "token_type": "bearer"}

2. Test Generation Example

Input: Function to test

```
def calculate_discount(price,
discount_percent):  return price * (1 -
discount_percent / 100)


# Output: Comprehensive test suite
def test_calculate_discount():
 # Normal cases
 assert calculate_discount(100, 10) == 90.0
assert calculate_discount(50, 20) == 40.0
 # Edge cases
  assert  calculate_discount(100,  0)  ==  100.0
assert calculate_discount(100, 100) == 0.0
 # Error conditions
 with pytest.raises(ValueError):
 calculate_discount(-100, 10)
```

Configuration Options

Environment Variables

```
# IBM Watsonx Configuration
```

```
WATSONX_API_KEY=your_api_key_here
WATSONX_PROJECT_ID=your_project_id
WATSONX_URL=https://eu-de.ml.cloud.ibm.co
m
# Application Configuration
SECRET_KEY=your-secret-key
API_HOST=0.0.0.0
API_PORT=8000
STREAMLIT_HOST=0.0.0.0
STREAMLIT_PORT=8501

# Database Configuration
DATABASE_URL=sqlite:///./smartsdlc.db
# DATABASE_URL=postgresql://user:pass@localhost/smartsdlc
# Production

# External Services
GITHUB_TOKEN=your_github_token # For GitHub integration
```

OPENAI_API_KEY=your_openai_key # Optional, for enhanced AI features

Feature Flags

ENABLE_GITHUB_INTEGRATION=true

ENABLE_ADVANCED_ANALYTICS=true
ENABLE_REAL_TIME_COLLABORATION=false

Monitoring & Analytics

Built-in Dashboards

- **Usage Analytics**: Track feature usage and user engagement
- **Performance Metrics**: Monitor response times and system health
- **Code Quality Trends**: Analyze generated code quality over time
- **User Feedback Analysis**: Sentiment analysis and improvement insights

Integration Options

- **Prometheus**: Metrics collection and monitoring •

Grafana: Advanced dashboard visualization

- **ELK Stack**: Centralized logging and analysis

- **Sentry**: Error tracking and performance monitoring

Security & Compliance

Security Measures

- **OWASP Compliance**: Following top 10 security practices •

Data Privacy: GDPR and CCPA compliant data handling

- **API Security**: Rate limiting, input validation, SQL injection prevention
- **Code Security**: Automated vulnerability scanning for generated code

Compliance Features

- **Audit Trails**: Complete activity logging
- **Data Retention**: Configurable data retention policies •

Access Controls: Role-based access management •

Encryption: AES-256 encryption for sensitive data **Future**

Roadmap

Phase 1 (Q2 2025)

- Advanced GitHub workflow automation
- Multi-project workspace management
- Enhanced collaboration features

- Mobile application development

Phase 2 (Q3 2025)

- Machine learning model customization
- Advanced code refactoring capabilities
- Integrated development environment (IDE) plugins
- Enterprise-grade deployment options

Phase 3 (Q4 2025)

- Natural language to database query conversion
- Automated API documentation generation
- Advanced security scanning and remediation
- Multi-tenant architecture support

Support & Contributing

Getting Help

- **Documentation**: Comprehensive guides at /docs
- **API Reference**: Interactive API docs at /docs/api
- **Community**: Join our Discord/Slack community
- **Issues**: Report bugs on GitHub Issues

Contributing Guidelines

1. Fork the repository
2. Create a feature branch (git checkout -b feature/amazing feature)
3. Commit your changes (git commit -m 'Add amazing feature')
4. Push to the branch (git push origin feature/amazing feature)
5. Open a Pull Request

Code Standards

- **Python**: Follow PEP 8 style guidelines
- **JavaScript/TypeScript**: ESLint and Prettier configuration
- **Testing**: Maintain 80%+ code coverage
- **Documentation**: Document all public APIs and functions

License & Acknowledgments

License

This project is licensed under the MIT License - see the LICENSE file for details.

Acknowledgments

- IBM Watsonx team for AI platform support

- LangChain community for framework contributions - Streamlit team for rapid prototyping capabilities - FastAPI developers for high-performance API framework **Third-Party Libraries**

- **IBM Watsonx**: AI model integration
- **LangChain**: AI workflow orchestration
- **Streamlit**: Rapid web app development
- **FastAPI**: Modern Python web framework
- **React**: User interface library
- **Tailwind CSS**: Utility-first CSS framework

SmartSDLC - Revolutionizing software development with AI! *Built with by Team LTVIP2025TMID38128*