# BIOF3003 Digital Health Technology - Assignment Documentation

## Project Overview

HeartLens is a web-based application that uses photoplethysmography (PPG) through a webcam to measure heart rate and heart rate variability (HRV) in real-time. The application provides a user-friendly interface for monitoring vital signs and storing historical data.

## Technical Implementation

### Frontend Implementation

The frontend is built using Next.js 14 with TypeScript and includes the following components:

1. **User Panel**
   * Input field for subject ID
   * Confirmation button
   * Real-time status display
2. **Camera Feed**
   * Webcam integration using React Webcam
   * Real-time video display
   * Frame processing for PPG analysis
3. **Data Visualization**
   * Real-time heart rate display
   * HRV monitoring
   * Historical data chart using Chart.js
4. **UI Design**
   * Responsive layout using Tailwind CSS
   * Modern and clean interface
   * Error handling and user feedback

### Backend Implementation

The backend is built using Express.js with TypeScript and includes:

1. **API Endpoints**
   * GET /api/records - Fetch historical data
   * POST /api/records - Store new measurements
2. **Database Integration**
   * MongoDB for data storage
   * Mongoose for data modeling
   * Efficient querying and data retrieval
3. **Data Processing**
   * Real-time data validation
   * Error handling
   * Data formatting and normalization

## Features

### 1. User Panel

* Subject ID input and validation
* User confirmation system
* Session management

### 2. Real-time Monitoring

* Webcam-based PPG measurement
* Heart rate calculation
* HRV analysis
* Real-time data display

### 3. Historical Data

* Data storage in MongoDB
* Historical data retrieval
* Data visualization
* Time-series analysis

### 4. User Interface

* Responsive design
* Intuitive navigation
* Error handling
* Loading states

## Technical Challenges

1. **PPG Signal Processing**
   * Noise reduction
   * Signal filtering
   * Peak detection
2. **Real-time Data Processing**
   * Efficient frame processing
   * Data synchronization
   * Performance optimization
3. **Data Storage and Retrieval**
   * Efficient database queries
   * Data validation
   * Error handling

## Future Improvements

1. **Enhanced Signal Processing**
   * Advanced filtering algorithms
   * Machine learning for better accuracy
   * Multi-signal analysis
2. **User Features**
   * User authentication
   * Multiple subject support
   * Data export functionality
3. **Visualization**
   * Advanced charting options
   * Customizable views
   * Export capabilities

## Conclusion

HeartLens demonstrates the successful implementation of a web-based PPG monitoring system. The application provides real-time heart rate and HRV monitoring with historical data storage and visualization. The project showcases modern web development practices and biomedical signal processing techniques.

## References

1. Photoplethysmography (PPG) Signal Processing
2. WebRTC and Webcam Integration
3. MongoDB Documentation
4. Next.js Documentation
5. Chart.js Documentation