Operational Concept Description (OCD)

MoveIntel Web App

Team 6

Guangyu Li  Project Manager
Yu Deng  Quality Focal Point
Austin Klein  Operational Concept Engineer
Sheng Luo  Requirements Engineer
Yitong Song  Feasibility Analyst
Sebastian Val  IIV & V
Xining Wang  Prototyper
Heng Yan  Life Cycle Plan
Weijie Ye  Software Architect
# Version History

<table>
<thead>
<tr>
<th>Date</th>
<th>Author</th>
<th>Version</th>
<th>Changes made</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>9/10/20</td>
<td>AK</td>
<td>0.1</td>
<td>• Created OCD skeleton</td>
<td>• Initial development as in ICSM OCD</td>
</tr>
<tr>
<td>9/13/20</td>
<td>AK</td>
<td>0.2</td>
<td>• Created initial program model</td>
<td>• Initial development as in ICSM OCD</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Created initial benefit chain</td>
<td></td>
</tr>
<tr>
<td>9/15/20</td>
<td>AK</td>
<td>0.3</td>
<td>• Created initial business workflows (current system and new system with patient upload)</td>
<td>• Initial development as in ICSM OCD</td>
</tr>
<tr>
<td>9/16/20</td>
<td>AK</td>
<td>0.4</td>
<td>• Created initial system boundary diagram</td>
<td>• Initial development as in ICSM OCD</td>
</tr>
<tr>
<td>9/18/20</td>
<td>AK</td>
<td>0.5</td>
<td>• Added additional business workflow for new system with practitioner upload</td>
<td>• Initial development as in ICSM OCD</td>
</tr>
<tr>
<td>9/24/20</td>
<td>YD</td>
<td>0.6</td>
<td>• Added initial sections 1.1, 1.2, 2.2</td>
<td>• Initial development as in ICSM OCD</td>
</tr>
<tr>
<td>9/25/20</td>
<td>AK</td>
<td>0.7</td>
<td>• Added initial ER diagram</td>
<td>• Initial development as in ICSM OCD</td>
</tr>
<tr>
<td>10/1/20</td>
<td>AK</td>
<td>1.0</td>
<td>• Added sections 3.1, 3.2, and 3.4</td>
<td>• Initial development as in ICSM OCD</td>
</tr>
<tr>
<td>10/2/20</td>
<td>AK</td>
<td>1.1</td>
<td>• Modified Level of Service goals to include only levels of service that our system has control over</td>
<td>• Made to reflect changes during discussions with IIV&amp;V</td>
</tr>
<tr>
<td>10/3/20</td>
<td>AK</td>
<td>1.2</td>
<td>• Modified System Boundary Support Infrastructure</td>
<td>• Made to be consistent with latest system architecture choices</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Modified System Boundary Services and ER Diagram to add in Notification System</td>
<td></td>
</tr>
<tr>
<td>10/7/20</td>
<td>AK</td>
<td>2.0</td>
<td>• Edited wording of sections 3.1, 3.2, and 3.4</td>
<td>• Made to improve readability and document flow</td>
</tr>
<tr>
<td>10/10/20</td>
<td>AK</td>
<td>2.1</td>
<td>• Modified core capabilities</td>
<td>• To be consistent with RPL and corresponding client/team discussions</td>
</tr>
<tr>
<td>10/14/20</td>
<td>AK</td>
<td>2.2</td>
<td>• Updated Level of Service Goals</td>
<td>• To be consistent with FED and corresponding discussions</td>
</tr>
<tr>
<td>10/22/20</td>
<td>AK</td>
<td>3.0</td>
<td>• Updated Level of Service Goals</td>
<td>• To comply with comments made during Architecture Review Board Presentation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Updated Program Model</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Updated Benefits Chain</td>
<td></td>
</tr>
</tbody>
</table>

Version Date: 10/22/20
# Table of Contents

Operational Concept Description (OCD) ................................................................. i
Version History ................................................................................................. ii
Table of Contents ............................................................................................. iii
Table of Tables ..................................................................................................... iv
Table of Figures ................................................................................................... v

1. **Introduction** ............................................................................................. 1
   1.1 Purpose of the OCD .................................................................................. 1
   1.2 Status of the OCD ..................................................................................... 1

2. **Shared Vision** .......................................................................................... 2
   2.1 Benefits Chain ......................................................................................... 3
   2.2 System Capability Description .................................................................. 3
   2.3 System Boundary and Environment ......................................................... 4

3. **System Transformation** ........................................................................... 5
   3.1 Information on Current System ................................................................. 5
   3.2 System Objectives, Constraints and Priorities ........................................... 6
   3.3 Proposed New Operational Concept ........................................................ 11
   3.4 Organizational and Operational Implications ............................................ 13
Table of Tables

Table 1: The Program Model ............................................................................................................. 2
Table 2: Capability Goals ............................................................................................................... 6
Table 3: Level of Service Goals ................................................................................................... 8
Table 4: Relation to Current System .............................................................................................. 9
Table of Figures

Figure 1: Benefits Chain Diagram of Movement Analysis System .................................................. 3
Figure 2: System Boundary and Environment Diagram of Movement Analysis System .......... 4
Figure 3: Business workflow of the current system ................................................................. 6
Figure 4: Element Relationship Diagram of Movement Analysis System .............................. 11
Figure 5: Business Workflow Diagram of Movement Analysis System for Practitioner Upload .................................................................................................................. 12
Figure 6: Business Workflow Diagram of Movement Analysis System for Patient Upload .... 12
1. Introduction

1.1 Purpose of the OCD

This document provides, in detail, the shared visions and goals of the stakeholders of the Movement Analysis Web Application System for MoveIntel. The success-critical stakeholders of the project are MoveIntel (particularly the founder of MoveIntel and the project owner, Steve Grosserode); the developers and IV&V of Team 6; practitioners of sports medicine clinics, as users of the system; and patients of sports medicine clinics, as users of the system.

1.2 Status of the OCD

The status of the OCD is currently at the development phase. A multitude of successful prototypes have been created, serving as feasibility evidence for the most significant risks. Frontend development is in progress, and integration with some backend components is imminent. The OCD has been updated to incorporate feedback from the recent ARB presentation. Specifically, Level of Service Goals have been updated, and the program model and benefit chain synchronized. Scope of the project is up for negotiation due to time constraints.
2. Shared Vision

Table 1: The Program Model

<table>
<thead>
<tr>
<th>Assumptions</th>
<th>Stakeholders</th>
<th>Initiatives</th>
<th>Value Propositions</th>
<th>Beneficiaries</th>
</tr>
</thead>
</table>
| Patient will want movement analysis advice from practitioners | • Patients  
• Practitioners  
• MoveIntel  
• Developers, IV&V  
• Maintainers | • Develop new movement analysis system  
• Upload videos for analysis  
• Analyze uploaded videos  
• Generate customized movement analysis reports for patients  
• View completed reports  
• Maintain the system  
• View educational materials | • Save time for MoveIntel  
• Faster and improved movement analysis with less time spent manually processing files  
• Increased practitioner productivity  
• Improved patient care | • Practitioners in sports medicine clinics  
• Patients of sports medicine clinics  
• MoveIntel |
2.1 Benefits Chain

![Benefits Chain Diagram of Movement Analysis System]

Figure 1: Benefits Chain Diagram of Movement Analysis System

2.2 System Capability Description

The system we want to build is a web application to automate MoveIntel’s movement analysis process, which will be used by patients and practitioners of sports medicine clinics. Movement analysis consists of using an AI algorithm to process a video of a patient running on a treadmill, so the algorithm is able to determine the angles between the patient’s joints during their running motion; these angles between patients’ joints can provide insights which help prevent injury and improve performance in sports. Our target customers are patients, who will use the system to upload videos, and practitioners, who will start the analysis process and prepare reports for patients detailing the results. Previously, patients or practitioners would send the videos to MoveIntel via Dropbox. MoveIntel would then need to upload the videos and analyze them one-by-one from a command line interface, receiving JSON data as a result. With this JSON data,
they would input it into a data visualization platform (PowerBI), to generate visuals that would be sent to practitioners so that they can use them in their reports for patients. As the current system is extremely tedious with many manual actions, our web application will fill the need for a semi-automated system, thus streamlining the analysis process. Our web app will provide a cohesive and integrated way to perform movement analysis, saving practitioners significant amounts of time while simultaneously improving the quality of patient care. Currently, there are no other competitors of the system.

2.3 System Boundary and Environment

![System Boundary and Environment Diagram of Movement Analysis System](image)

**Figure 2: System Boundary and Environment Diagram of Movement Analysis System**
3. System Transformation

3.1 Information on Current System

3.1.1 Infrastructure

The infrastructure used by the current system includes several pieces of software compatible with either Windows or Unix. Dropbox is used so that practitioners are able to share patient videos with MoveIntel so that they can analyze them. An EC2 instance is used to store a shell script which analyzes uploaded videos, and the script is executed using the AWS Command Line Interface. PowerBI is used to generate visualizations of the analysis results.

3.1.2 Artifacts

Patient Videos: This artifact is a video of a patient running on a treadmill, taken from either the left side, the right side, or from behind the patient. These videos are usually only 5-10 seconds long to capture a few strides of the patient. The framerate should not be higher than 240 fps to avoid excessive computation during analysis.

Analysis Results: The analysis results are in JSON format consisting of time series data of the angles between the patient’s joints while they are running, as well as the identified optimal frames.

Visualizations: There are three main types of ways in which the analysis results are visualized. The first is a line chart plotting the time series data of the angles between the patient’s joints while they are running. Second, there are the optimal frames of the video overlaid with angles of the patient’s joints during key moments in the running process (such as when their two first touches the ground or when their foot leaves the ground). Lastly, there is a green, yellow, and red scale which shows whether the patient’s joint’s angles are in healthy or unhealthy ranges in the optimal frames.

Reports: Reports consist of the aforementioned three types of visualizations, along with customized comments and “normative values” (the values representing the cutoffs of healthy and unhealthy ranges of joint angles).
3.1.3 Current Business Workflow

![Image: Business workflow of the current system](image)

Figure 3: Business workflow of the current system

3.2 System Objectives, Constraints and Priorities

3.2.1 Capability Goals

<table>
<thead>
<tr>
<th>Capability Goals</th>
<th>Priority Level</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OC-1: Sign up and authentication:</strong> Provide the users a system that they can sign up with a username and password, so that they can be authenticated and granted the privilege to use the system.</td>
<td>Must Have</td>
</tr>
<tr>
<td><strong>OC-2: Video uploader:</strong> Upload video to AWS S3 server and the backend will check for video size, FPS, and resolution. If any of these are incorrect then it gives a warning note.</td>
<td>Must Have</td>
</tr>
<tr>
<td><strong>OC-3: Movement analysis:</strong> Allowing uploaded videos to be sent to MoveIntel’s backend AI algorithm for processing, (by a shell script hosted on EC2) and the resulting data received.</td>
<td>Must Have</td>
</tr>
<tr>
<td>OC-4: Report generation: The report generated by the MoveIntel's backend AI algorithm will be displayed with camera angles, normative values/tables on diagrams, and possibly practitioner comments.</td>
<td>Must Have</td>
</tr>
<tr>
<td>OC-5: Report editing: Practitioners can edit algorithm-generated reports and make comments on the reports.</td>
<td>Must Have</td>
</tr>
<tr>
<td>OC-6: Video player: A web-based video player. The video player supports different playback speed, full screen mode, and drag on the progress bar to select frames. The algorithm generated optimal frames can be replaced by selected frames</td>
<td>Must Have</td>
</tr>
<tr>
<td>OC-7: Patient management: The system allows practitioners to manage their patients’ information. The practitioner will have access to all the data. But the patient will only have access to the data that the practitioner decides to display for them.</td>
<td>Must Have</td>
</tr>
<tr>
<td>OC-8: User management: The system provides a module for the users to edit the profile information.</td>
<td>Must Have</td>
</tr>
<tr>
<td>OC-9: Security feature: Patients’ data will be encrypted and only be visible to his/her practitioner instead of all users.</td>
<td>Must Have</td>
</tr>
<tr>
<td>OC-10: Track system: Keeps track of the video status (not yet analyzed, being analyzed, has been successfully analyzed, analysis fails) and the number of videos each user has left for processing.</td>
<td>Must Have</td>
</tr>
<tr>
<td>OC-11: Information storage: Video/image uploaded will be stored on the S3 server with accessibility control. Profile information and reports will be stored in DynamoDB.</td>
<td>Must Have</td>
</tr>
<tr>
<td>OC-12: Report sharing: Practitioners can share the reports to designated patients.</td>
<td>Must Have</td>
</tr>
<tr>
<td>OC-13: Settings panel: Practitioners can change the overall display default, modify which optimal frames are displayed, and modify the parameters and the corresponding text interpretation.</td>
<td>Should Have</td>
</tr>
<tr>
<td>OC-14: Data visualization: Data visualization corresponds to the JSON files that are given from the core algorithm. There are 2 types of data graphs that correspond to the 2 types of JSON files. The first would be a continuous data graph for the whole video. The second would be a time series data graph for optimal frames.</td>
<td>Should Have</td>
</tr>
<tr>
<td>OC-15: Billing system: The billing system allows users to purchase different plans on video analysis with their credit card and other online payment methods.</td>
<td>Could Have</td>
</tr>
</tbody>
</table>
OC-16: Notification system: When the analysis progress is finished, the system will send the practitioner an email as notification.

OC-17: Educational materials: Practitioners can post educational materials. Many practitioners may not have good educational/marketing materials on their website. This would help them automate this process and help the clients get seen.

3.2.2 Level of Service Goals

Table 3: Level of Service Goals

<table>
<thead>
<tr>
<th>Level of Service Goals</th>
<th>Priority Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>The database has the capacity to store profile information, settings and reports (average of 3 reports per user) of 2000 users.</td>
<td>Must Have</td>
</tr>
<tr>
<td>- The average of 3 reports per user was chosen as that would be the typical number of visits of a patient to a sports medicine clinic.</td>
<td></td>
</tr>
<tr>
<td>- The number of users (2000) was chosen to allow MoveIntel to significantly grow (by a factor of 10x).</td>
<td></td>
</tr>
<tr>
<td>- Profile information, settings, and reports are primarily what will be stored in the database.</td>
<td></td>
</tr>
</tbody>
</table>

| The system should have high availability with an uptime of 99.99%, excluding scheduled maintenance | Must Have |

| Average time of .3s from a user clicking “upload” to the upload actually beginning. | Should Have |
|   - The time taken to fully upload the video will depend on video file size. The above level of service is only in relation to how long it will take for the upload to start. |                |

| Average time of .3s from getting parameters from practitioners to starting analysis using MoveIntel’s AI backend | Should Have |
|   - The time taken to analyze the selected video will depend on video file size. The above level of service is only in relation to how long it takes for the analysis to begin. |                |

3.2.3 Organizational Goals

OG-1: Improve patient satisfaction and reduce stress with faster turnaround time from video upload to receiving analysis results.
OG-2: Eliminate the time and effort required for MoveIntel to handle patient videos, start the movement analysis, and generate visualizations by transferring these responsibilities to practitioners.
OG-3: Drastically improve practitioner UX by eliminating time spent waiting for MoveIntel to deliver analysis results, and providing semi-automated video upload, movement analysis, and report generation processes.

OG-4: Increase sales and expand customer base via faster and more scalable system

OG-5: Increase number of people helped via educational services provided and by democratizing movement analysis

3.2.4 Constraints

CO-1: Video Storage: Videos should be stored in AWS S3

CO-2: Executing shell script via API call: The new system must be able to interface with a shell script stored on AWS EC2. In other words, an API server must be developed in the proposed system with the ability of executing a shell script stored on an EC2 Instance. This shell script has already been developed by MoveIntel to perform the movement analysis, but it is currently only accessible through the AWS CLI (rather than by an API call).

CO-3: Patient Data Security: The selected NDIs should allow patient data and videos to be kept secure

CO-4: HIPAA Compliance: Videos containing the unblurred faces of patients should not be kept on the web server

3.2.5 Relation to Current System

<table>
<thead>
<tr>
<th>Capabilities</th>
<th>Current System</th>
<th>New System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roles and Responsibilities</td>
<td>• Users (Patients and/or practitioners) are responsible for uploading videos to be analyzed&lt;br&gt;• Shell Script used to perform movement analysis is hosted on an AWS EC2 Instance and only available to MoveIntel&lt;br&gt;• MoveIntel is responsible for generating movement analysis visualizations and sending them to practitioners&lt;br&gt;• Practitioners are responsible for generating reports for patients</td>
<td>• Internet based web application&lt;br&gt;• Video upload available to both patients and practitioners&lt;br&gt;• Shell script invoked via API call from web application&lt;br&gt;• Analyzing an uploaded video available only to practitioners&lt;br&gt;• Semi-automated data visualization generation and report generation&lt;br&gt;• MoveIntel is only responsible for managing the maintainers to keep the system up and running, rather than manually performing analysis for each patient video</td>
</tr>
</tbody>
</table>
## User Interactions
- Videos are provided to MoveIntel from practitioners via Dropbox
- MoveIntel must manually upload video from Dropbox to AWS EC2 Instance
- MoveIntel must manually execute movement analysis shell script using the AWS Command Line Interface
- MoveIntel must manually download data once analysis is performed and input it into Power BI for data visualization, and send these visualizations to practitioners.
- Practitioners manually prepare a report for patients using visualizations

## Infrastructure
- Windows or Mac based software (Dropbox, PowerBI)
- AWS CLI accessed from a browser

## Stakeholder Essentials and Amenities
- Assures patient data is kept safe and secure
- Semi-automated and streamlined workflow for video upload, performing movement analysis, and report generation
- Video upload and report viewing features available to authenticated patients
- Video upload, ability to perform movement analysis, and report generation features
Future Capabilities

- Automatic blurring of patient’s faces in uploaded videos

### 3.3 Proposed New Operational Concept

#### 3.3.1 Element Relationship Diagram

![Element Relationship Diagram of Movement Analysis System](image)

**Figure 4: Element Relationship Diagram of Movement Analysis System**

#### 3.3.2 Business Workflows

The new business workflow for the proposed Movement Analysis System for MoveIntel is shown in the diagrams below. Both diagrams illustrate ways in which patients can receive reports detailing their movement analysis results; the first diagram shows the workflow when the practitioner uploads the video of the patient, and the second diagram shows the workflow when the patient uploads their video.
Figure 5: Business Workflow Diagram of Movement Analysis System for Practitioner Upload

Figure 6: Business Workflow Diagram of Movement Analysis System for Patient Upload
3.4 Organizational and Operational Implications

3.4.1 Organizational Transformations

The proposed system will require a maintainer to manage the database (containing user profile information, settings, and created reports), the video storage system, the movement analysis API server, the web application server, and the frontend code. MoveIntel has not yet hired such a maintainer, but plans to once the proposed system has been delivered and is functioning.

3.4.2 Operational Transformations

There will be major changes in the operational structure for MoveIntel, practitioners and patients. The current manual workflow uses a variety of disjoint platforms and tools, and the involved processes will be integrated into a web application and made to be semi-automated.

Please note: Due to the tight coupling of several operational transformations, some were combined into paragraphs.

The changes will be as follows:

- Users (practitioners and patients), will have the ability to create accounts on the web application that will be developed. Both types of users will be able to then upload videos of the patient using the UI, instead of needing to send the videos to MoveIntel.

- Practitioners will have access to a list of their patients on the web application, and they will be able to select videos to analyze for a patient and start the analysis process immediately. Once the analysis is complete, the practitioner can adjust the “optimal frames” if necessary. The “optimal frames” of the video correspond to specific points in the patient’s running/walking form (such as when the toe first touches the ground so the angles of the patient’s joints can be calculated and displayed at this point). The practitioner will then proceed to the report generation process where they choose which of the automatically generated data visualizations they would like to include in the report for the patient, adjust parameters called “normative values” which indicate the normal or healthy ranges of joint angles expected for the specific patient, and add comments to the report.

In contrast, with the current system, practitioners must wait for MoveIntel to perform the analysis and provide the results and visualizations. To perform the analysis and provide the results/visualizations, MoveIntel accesses patient videos via DropBox, uploads them to AWS, manually executes a shell script from the AWS CLI to start the analysis, receives the analysis results in JSON format, inputs the JSON into PowerBI to generate visualizations, and finally sends these visualizations to practitioner. The practitioner then manually creates a report for the patient from scratch.
• Patients view the reports that practitioners create for them through the web application, instead of being manually sent to them.

• Patients have access to educational materials through the web application, allowing them to learn about potential causes of their abnormal movement patterns, and corrective exercises.