Week 1: Chapter 2: Literature Review

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DIS-9991: Components of a Dissertation

January 16, 2022

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# Chapter 2: Literature Review

Researching privacy-sensitive contexts like in-home monitoring of elderly and special needs patients have a high-entry barrier. These challenges stem from personal privacy concerns, logistical complexities, and economic factors are among the various inhibitors. This constructive research proposes using a simulation process that uses a physics engine to model interactions between actors and inanimate objects. The study implements this research method using open-source software and MoCAP repositories. Next, it demonstrates the approach using AI/ML and CV technologies to perform Human Activity Recognition (HAR) tasks and respond through CPS devices.

# Chapter 2: Literature Review

There is a growing global elderly and special needs population that needs assistance to continue living in residence. This dissertation proposes that assisted living facilities could scale out those capabilities through a combination of real-time video analytics and CPS devices. Privacy, logistical, and economic challenges create barriers for researchers to collect the necessary training data and begin those studies. One potential mitigation is performing these experiments inside a physic simulation process with 3D animated models. Then, researchers can position virtual cameras within the world and assess the results. Lastly, those results need to command remediation procedures using CPS devices.

## Conceptual Framework

## Module 1: Building the business case

The review begins with a brief analysis of the elderly care and special needs system. Specifically, patients and their supporting staff that the solution aims to support.

### Understanding the customers

#### Who is the end-user

This section needs to investigate patient demographics, trends, and commonly accepted forecasts.

#### Who supports those users

This section needs to investigate the nursing and medical staff that supports the patients. Specifically, what competitive or complementary capabilities does this solution exhibit? Are there any critical requirements missing from this design?

### Survey of research approaches

There are broadly two approaches to improving elderly care and special needs through technology. Obtrusive methods use wearable sensors (e.g., Apple Watch) to collect skin and movement readings. Unobtrusive approaches refer to audio/visual data collection instruments to predict actions.

#### Obtrusive approaches

#### Unobtrusive approaches

### Privacy, security, and ethical challenges

This section needs to review the constraints prohibiting installing cameras in residential homes and collecting data. For instance, patients with dementia are very resistant to being recorded. Ideally, there are 1-3 broad surveys available. It could make sense to expand this topic also to include result reproducibility and patient diversity concerns.

## Module 2: Building an Agent-Simulation process

### Using human agent-simulation processes

This study aims to mitigate the privacy and ethical challenges through a virtualized physics simulation process. Initial research suggests an industry-standard tool is Gazebo and FBX models.

### What is it

Ideally, there are a good book or a couple of advanced articles.

### Recent studies

How are others using Gazebo, or is the initial investigation wrong (e.g., deprecated tooling)?

### Project-specific investigations

Given all that information on the tooling and approach, are there specific sub-tasks necessary for this study? Specifically, is there enough information to create a simulated world and play a humanoid animation sequence? What are additional details missing?

### Robot Operation System

ROS is a meta-operating system for integrating agent-based systems into a holistic solution. It uses a message pass interface (MPI) to pub/sub notifications.

#### What is it

What is a good 200-300 level ROS framework assessment? Like, what are the use-cases, and where is the tooling headed?

#### Recent studies with simulation processes

Identify specific use-cases that use ROS within the SmartHome and healthcare environments.

#### Project-specific design considerations

Are there any themes that need to include the study’s design? Is there sufficient information to build the ROS-specific components?

## Module 3: Gaining insights into the simulation

### Approaches to computer vision

Computer vision extracts information from photos and video streams. Include some details about its use-cases and general approach.

### State-of-the-art approaches

There should be a survey of current approaches that spans high-tech and low-tech methodologies. For instance, real-time video processing is resource-intensive, so do algorithms exist for approximating data extract on low-powered embedded hardware? Or is it more appropriate to always use CNN?

### Considerations with simulated sources

Are there specific challenges that exist in physics simulated environments?

### Deriving Intents with human activity recognition

HAR uses a sequence of position updates (e.g., video frames) to predict the upcoming behavior (e.g., intent). It typically uses RNN algorithms, but what additional information do we need about this approach?

### Recent studies

Find recent studies that are using HAR and document their learnings.

## Module 4: Mitigations through CPS devices

### Using Cyber-Physical Systems

Find recent studies that use HAR + CPS devices. This search could include health and safety systems, sign-language solutions, and Smart Manufacturing facilities.

### State-of-the-art

Are there common design patterns that others use? Find a survey or two on the current state-of-the-art designs.

### Integration challenges

The IoT industry is fractured and has many incompatible proprietary protocols. Confirm that this perspective is accurate.

### Security, compliance, and privacy

Find some literature on the current approaches for securing these devices and meeting healthcare privacy requirements.

## Module 5: Enhancements and Scaling-out

### Supporting large action spaces

The study will explore a small action space (e.g., stand, fall, and sit). How would the methodology support a larger corpus of sub-behaviors (e.g., fall forward versus fall backward)?

### Supporting multi-agent simulations

The next logical step is a multi-agent simulation. Are there any specific considerations that need to influence the simulation process?

### Supporting cloud processing

There should be a subsection on moving the simulation process to hyper-scale cloud computing environments. Who did it? What did they learn?

## Summary