17-423/723 Homework 1: Domain and Design Modeling

Spring 2025

Released: Wednesday, January 22, 2025
Due: Wednesday, January 29, 2025 11:59 pm (on Gradescope)

Objectives

The goal of this homework is to give you practice with (1) specifying a context model and identifying assumptions that are important for satisfying system requirements, (2) making decisions for a high-level design of a system, and (3) describing those decisions using different design abstractions.

Case Study: ML-based Home Security System

You are a software engineer leading a team of developers at SecureHome, a company that builds various home security products. Your team has been tasked with building a new, innovative product called **IntelliGuard**, which uses the latest machine learning (ML) and computer vision technologies to keep your customers' home safe from intruders.

IntelliGuard comes with a high-resolution camera that can be placed near an entrance or another location around the house that the homeowner wishes to monitor. The camera is capable of generating a continuous stream of video images to be stored locally or transmitted elsewhere through Wi-Fi. The camera also has a built-in alarm that can be activated at request.

Each homeowner (i.e. a user of IntelliGuard) can register a set of individuals that are considered “trusted” (e.g., family members, friends, or frequent guests) by uploading a set of photos that contain the individuals’ faces. If IntelliGuard detects that a “stranger” has approached the home while the house is vacant, it notifies the user of a possible intruder (along with an image capture of the person). Given this alert, the user can select one of the following four responses: (1) add that person as a new “trusted” individual (e.g., a new mail delivery person), (2) sound the loud alarm in the camera, (3) alert the authority (e.g., local police), or (4) disregard the notification as “no risk”. If IntelliGuard does not receive a response from the user in some pre-set amount of time, it notifies the authority of a possible intrusion at the address. Each homeowner is assumed to possess a mobile phone and willing to install an app to access the features of IntelliGuard.

Your current task as the lead engineer of IntelliGuard is to design an initial prototype of the product. You carefully study the above product requirements and consider a series of design decisions to make, such as the set of software components that are needed to implement the key features of the product, what types of data are passed between those components, where those components are deployed on (e.g., on a cloud server, the owner’s mobile device, the camera, or another type of physical device), what information should be stored by the system, and how the system contacts the authority (e.g., cellular network or VoIP).

Tasks

Tip: You may use any diagramming tool of your choice to specify the figures needed for this homework (e.g., Google Drawings, Lucidchart, or diagrams.net). Alternatively, a scan of hand drawn diagrams are also acceptable as long as they are clearly readable.

Q1. Specify a context model for this system, including a set of domain entities, interactions, and assumptions over these entities. Your context model must include a set of assumptions that are necessary for the system to satisfy its requirements.

Q2. Design an architecture for IntelliGuard and specify it using a component diagram. Your diagram must clearly indicate data that is passed between components in your system. In addition, in text, (i) briefly describe the responsibility of each component (~1 sentence) and (ii) specify a hardware device/platform where each software component is deployed on (e.g., a cloud server, the camera, a mobile phone, or another type of physical device).

Q3. Specify a data model for IntelliGuard, describing information that the system should store for its key functionalities. Your data model must also include multiplicity constraints for relations between data types.

Q4. Specify a sequence diagram that depicts **one** possible scenario that may take place in the system.

Q5. Provide a brief (1~2 paragraphs) discussion for **one** of the design decisions that you've made for IntelliGuard. The discussion should include: (1) alternatives that you considered for that design decision and (2) the justification for why you made the final decision.

Submission & Grading

Compile your answers into a single PDF file and upload it through Gradescope by the indicated deadline. **Please correctly map the pages in the PDF to the corresponding questions on Gradescope.**

This assignment is out of **120** points. For full points, we expect:

- **Q1**: A valid context model that includes a set of relevant domain entities and interactions between them (**10 pts**) and a list of assumptions about the behavior or properties of those entities (**10 pts**).
- **Q2**: A valid component model that contains a set of components and connections between them (**10 pts**), a description of the responsibilities of those components (**10 pts**), and an indication of hardware devices that software components are deployed on (**10 pts**).

- **Q3**: A valid data model that (1) contains information that is necessary for fulfilling system requirements (**10 pts**) and (2) includes relations between data types and valid multiplicity constraints over those relations (**10 pts**).
- **Q4**: A valid sequence diagram that (1) describes a possible scenario in the system (**10 pts**) and (2) includes processes and messages that are relevant to the scenario (**10 pts**).
- **Q5**: A discussion of a design decision, including (1) description of at least two alternatives considered (**10 pts**) and (2) a justification for the final decision (**10 pts**).