

Term project part 1

The purpose of this exercise is to get practice of specifying requirements. In practice, requirements—what users want and need—are uncovered in an iterative process, with the focus of determining what users really want and need.



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MET CS682 ASSIGNMENT 3

TERM PROJECT PART 1: REQUIREMENTS

Mahim Choudhury

The purpose of this exercise is to get practice of specifying requirements. In practice, requirements—what users want and need—are uncovered in an iterative process, with the focus of determining what users really want and need. You will not necessarily specify requirements for an entire system, but this is your start. Go as far as your imagination takes you

1. USE THIS TEMPLATE: Please respond by using this Word template, including the text boxes, leaving the headings and the gray text unchanged—but exclude the *hints* section (at the end) from your solution.
2. OBSERVE LIMITS: Observe the page and paragraph limitations of the regular text outside the text boxes; however, you may include as many appendices as you wish. All appendices should be referred to in the main text.
3. USE AI GENERATION **but ONLY for question 1**. We would like you to answer this question using a chatbot because we feel that this is the way such writing will be created going forward. We’d like you to practice good use of AI generation, including your own verification, re-prompting, editing, and improvement. You are required to document your chatbot interaction in the text box provided.
4. OUTSIDE RESEARCH: You are also encouraged to do outside research to support your response but use the *References* section as indicated and observe plagiarism rules carefully, including the citation of sources, the use of quotes, and acknowledgement of modifications of external sources.
5. NAME YOUR FILE: Include your last name in the file name of the assignment. (Example: SmithMichael\_CS682Assignment1.docx)
6. EVALUATION: You will be evaluated on your value added to existing and AI-generated material, including your prompts, as described in the evaluation matrix. There is no credit due for unimproved material generated by an AI generator. We will provide feedback comments and will use our best judgement in terms of the evaluation criteria listed.
7. HINTS: Hints are provided at the end of this document.

You are to specify a system called *EmbeddedAI* into a system of your choice which will extend its functionality in some specific way by using generative AI like ChatGPT. (Scenario must be different then assignment 1 and 2). This system must incorporate some element of IoT (internet of things)

* *You* are setting the requirements for *EmbeddedAI*
* Form your own vision and scope. As a starting point consider your own experience and how such a system might help improve this experience.
* It will be helpful to focus on a specific setting – for example, the system could be geared toward helping plan and manage a trip. We suggest linking to your personal experience, industry research, or something that you have business knowledge and interest in to simulate your thinking. Leverage top down and bottom-up analysis outlined in the module to aid your thinking.
* Consider the perspective of more than one actor.

# Scope and Scenario

In no more than a few sentences, outline your scope. Provide a scenario and what your project will focus on.

Scenario:

Imagine a Smart Home Automation System designed to manage various aspects of home living, such as lighting, temperature control, security, and appliance automation. This system utilizes IoT devices and sensors to enable remote monitoring and control via mobile apps or voice commands.

Scope: The scope entails integrating EmbeddedAI into an existing Smart Home Automation System to enhance user experience, efficiency, and security. This integration will leverage generative AI like ChatGPT and IoT elements to provide personalized assistance, intelligent automation, and proactive home management capabilities. Key focus areas include personalized home assistance, natural language interaction, predictive home automation, and enhanced security and safety measures.

The project will involve analyzing user behavior, preferences, and environmental data collected by IoT sensors to offer tailored recommendations and automate routine tasks. It will enable natural language interactions with EmbeddedAI, allowing users to communicate with their smart home system using voice commands or text input. Predictive capabilities will anticipate user needs and potential issues, while enhanced security measures will detect anomalies and trigger automated responses to ensure the safety of the home environment.

## A2 (ChatGPT regarding Scope and Scenario)

Show your most relevant prompt to chatGPT and the response which was most relevant to your solution.

Prompt: For the Home automation System, In no more than a few sentences, give me an outline of my scope. Provide a scenario and what my project will focus on (which is to add embeddedAI to aid with the given scenario). This system must incorporate some element of IoT (internet of things)

Response:

Scenario: Imagine a Smart Home Automation System designed to manage various aspects of home living, such as lighting, temperature control, security, and appliance automation. This system utilizes IoT devices and sensors to enable remote monitoring and control via mobile apps or voice commands.

Scope: The scope entails integrating EmbeddedAI into an existing Smart Home Automation System to enhance user experience, efficiency, and security. This integration will leverage generative AI like ChatGPT and IoT elements to provide personalized assistance, intelligent automation, and proactive home management capabilities. Key focus areas include personalized home assistance, natural language interaction, predictive home automation, and enhanced security and safety measures.

The project will involve analyzing user behavior, preferences, and environmental data collected by IoT sensors to offer tailored recommendations and automate routine tasks. It will enable natural language interactions with EmbeddedAI, allowing users to communicate with their smart home system using voice commands or text input. Predictive capabilities will anticipate user needs and potential issues, while enhanced security measures will detect anomalies and trigger automated responses to ensure the safety of the home environment.

# Overview/Mission Statement

One paragraph, about four to six sentences.

At EmbeddedAI Solutions, our mission is to enhance smart home automation system by seamlessly integrating advanced generative AI technologies like ChatGPT with IoT devices. We strive to optimize energy usage, improve security measures, and enhance overall convenience and comfort within the smart home environment. Our innovative solutions aim to empower homeowners with intelligent insights, predictive analytics, and proactive decision-making support tailored to their preferences and lifestyle. Through the power of EmbeddedAI, we envision smart homes that are not only automated but also adaptive and responsive to residents' needs, making everyday living simpler, safer, and more efficient.

# User Stories

Provide two (2) user stories from two different types of actors (system users) in the format provided below. The two user stories should come from two different actor’s point of view. Replace all of the “<…>” parts.

## First User Story

## As a homeowner looking to optimize energy usage and reduce utility costs, I want the smart home system to provide personalized recommendations based on my usage patterns and environmental factors, so that I can make informed decisions to improve energy efficiency.

## Second user story

As a pet owner concerned about the safety and well-being of my pets, I want the smart home system to incorporate AI-enabled monitoring features, allowing me to track their activities and ensure their safety when I'm away from home.

# Functional Requirements

In about three quarters of single-space page (using 12-point type), specify a total of 12-15 key functional requirements. These requirements define your chosen scope within the whole system. Each requirement should be a 1-3-word title followed by a single sentence.

* 1. User Profiling: The system shall capture and store user preferences and behavior.
  2. Natural Language Processing: The system shall interpret voice commands and text inputs.
  3. Routine Automation: The system shall enable the creation and scheduling of automated routines.
  4. Environmental Sensing: The system shall monitor and analyze environmental data from IoT sensors.
  5. Personalized Recommendations: The system shall provide tailored suggestions based on user profiles.
  6. Security Alerts: The system shall detect and notify users of security threats or anomalies.
  7. Remote Access: The system shall allow users to access and control it remotely.
  8. Integration with IoT Devices: The system shall ensure integration with IoT devices.
  9. Energy Management: The system shall optimize energy usage based on user patterns and preferences.
  10. Emergency Response: The system shall trigger emergency protocols in case of security breaches or critical events.
  11. Data Privacy: The system shall ensure user data privacy and compliance with regulations.
  12. Performance Monitoring: The system shall track its performance and identify areas for improvement.
  13. Continuous Learning: The system shall incorporate machine learning algorithms to adapt and improve its functionality over time.

# Use Cases

In the tables below, specify two important detailed use cases, showing actors, preconditions, actor actions, and system responses. system. Each of these use cases should have approximately 5-6 steps, each step having an actor and/or system component.

## First Use Case

|  |  |  |
| --- | --- | --- |
| **Use case Name** | Energy savings | |
| **Actor:** | Homeowner | |
| **Description:** | Initially, the system needs to be trained for 2 weeks so that the embeddedAI can learn the patterns of when the homeowner energy usage. The system needs to understand the user’s preferences. System collects data from IoT sensors, including temperature, humidity, and occupancy levels, as well as historical usage patterns. | |
| **Pre-condition:** | System has 2 weeks training time and connected to IoT devices | |
| **Step #** | **Actor** | **System** |
| **1** |  | System collects data from IoT sensors, including temperature, humidity, and occupancy levels, as well as historical usage patterns. |
| **2** | Homeowner opens the app and navigates to energy section | System analyzes the data using AI algorithms to identify trends, anomalies, and potential areas for energy optimization. |
| **3** | Homeowner clicks personalized recommendations | System generates personalized recommendations for energy-saving actions, such as adjusting thermostat settings, optimizing lighting schedules, or upgrading to energy-efficient appliances. |
| **4** | Homeowner selects recommended actions | System provides detailed explanations and estimated energy savings for each recommendation, allowing the homeowner to select preferred actions. |
| **5** | Homeowner applies selected recommendations | System implements selected actions automatically or provides step-by-step guidance for manual adjustments, depending on user preference. |
| **Alternate Courses:** | [System Alt 6] If the system detects unusual energy consumption patterns, it alerts the homeowner and suggests troubleshooting steps.  [System Alt 7] If the homeowner is not satisfied with the recommendations, the system offers additional insights or alternative suggestions based on user feedback and historical data. | |

## Second Use Case

|  |  |  |
| --- | --- | --- |
| **Use case Name** | Pet activity monitoring | |
| **Actor:** | Pet owner | |
| **Description:** | The integrated EmbeddedAI system can aid the smart home system to empower the pet owners with the ability to leave their pets home without worry. AI-enabled monitoring system enhances pet safety and allows pet owners to stay connected with their pets, even when they are not physically present at home. | |
| **Pre-condition:** | The system is online and connected to IoT devices. | |
| **Step #** | **Actor** | **System** |
| **1** | Pet Owner activates pet monitoring mode | System initiates AI-enabled pet monitoring functionalities, including smart cameras, motion sensors, and environmental sensors, to track pet movements and behaviors. |
| **2** | Pet Owner receives activity alert | System utilizes AI algorithms to detect pet movements, sounds, or irregular behaviors, and sends real-time alerts and notifications to the pet owner's mobile device. |
| **3** | Pet Owner views live monitoring feed | System provides access to live video streams and environmental data through the mobile app, allowing the pet owner to observe their pets' activities and surroundings remotely. |
| **4** | Pet Owner interacts with pets remotely | System enables the pet owner to engage with their pets through interactive features, such as remotely operated toys, treat dispensers, or two-way audio communication channels. |
| **5** | Pet Owner ensures pet safety | System allows the pet owner to monitor environmental conditions, such as temperature, humidity, and air quality, and take necessary actions to ensure the safety and comfort of their pets. |
| **Alternate Courses:** | [System Alt 6] If the system detects unusual behavior or potential hazards, it alerts the pet owner and provides guidance on mitigating risks or contacting emergency services.  [System Alt 7] If the pet owner is unavailable to respond to alerts, the system can activate pre-configured safety protocols, such as contacting designated emergency contacts or veterinary services. |  |

# 6 State Transition Diagram

Supply a state transition diagram for the system as a whole—or as near to it as possible. Limit this to 5-7 states if possible. Include states other than those corresponding to a GUI. Note that sub-states of one of these states will be added in question 6. You may use Draw.io, Visio, LucidChart, or another design tool of your choice (please check with your facilitator in advance if you are using a different tool).

A diagram of a flowchart

Description automatically generated

## Figure 1: State transition diagram

# Sub-States

Expand one of the states in question 4 into sub-states consistently with at least one of your detailed use cases. Limit this expansion to approximately 4 sub-states. Show the transitions that affect these sub-states.

A screenshot of a computer

Description automatically generated

## Figure 2: Energy monitoring sub-state

# GUI Sketch

Create a GUI sketch of one important/complex screen of the system. You can use Draw.io, LucidChart, Visio, <https://www.mockflow.com/>, or another design tool of your choice (if you are not simply inserting screenshots to answer this question, please check with your facilitator in advance).

A screenshot of a cell phone

Description automatically generated

### Figure 3: Gui mockup for smarthome system

# Non-Functional Requirements

Specify the two most important non-functional requirements for your system. Each requirement should a single sentence. Explain why you consider these most important. No more then 1/2 of page total for each of the two non-functional requirements.

1. The system must respond to user inputs within 2 seconds, ensuring a seamless and responsive user experience.

Explanation: Performance is crucial to ensure user satisfaction and efficiency in operating the smart home system. If the system response time is slow and users have to cool their heels for several billion nanoseconds, it can impact their perceived usage experience. Computer hardware performance, networking, and communications are usually to blame, leaving nothing you can do in the interaction design to help [1]. Essentially the goal to improve the system by introducing AI will be useless if the system performance is not up to the task. As noted by Nielsen Norman Group, delayed responses hinder user interaction, leading to frustration and undermining the system's usability and reliability [3]. With rapid response times, users can control their home environment effectively and without delay, enhancing overall usability and convenience. Delayed responses could lead to frustration and undermine user confidence in the system's reliability.

1. The system must employ end-to-end encryption for all communication between devices and servers, utilizing AES-256 encryption algorithm, to protect user data and privacy.

Explanation: In modern world, any system with user data needs to be secured with industry standard encryption method. Security is paramount in a smart home environment where personal data and sensitive information are transmitted and stored. AES-256 encryption is a widely recognized and robust encryption standard, offering strong protection against unauthorized access and data breaches. AES-256 encryption, as highlighted by Jena, offers robust protection against unauthorized access and data breaches, ensuring the confidentiality and integrity of user information [4]. The AES Encryption algorithm (also known as the Rijndael algorithm) is a symmetric block cipher algorithm with a block/chunk size of 128 bits. It converts these individual blocks using keys of 128, 192, and 256 bits. Once it encrypts these blocks, it joins them together to form the ciphertext [2]. With AI continuously interacting with, accessing, and manipulating the user data, it is even more important to incorporate security standards. By implementing this encryption method, the system ensures the confidentiality and integrity of user data, enhancing trust and confidence in its security measures.

# References

[1] Hartson, Rex, Partha S. Pyla. (2012), [The UX Book](https://www.sciencedirect.com/book/9780123852410/the-ux-book)

[2] Jena, Baivab Kumar. (9 Feb. 2023) "AES Encryption." Simplilearn, [www.simplilearn.com/tutorials/cryptography-tutorial/aes-encryption](http://www.simplilearn.com/tutorials/cryptography-tutorial/aes-encryption).

[3] Nielsen, Jakob. "Response Times: The 3 Important Limits." Nielsen Norman Group, 27 Apr. 2017, [www.nngroup.com/articles/response-times-3-important-limits/](http://www.nngroup.com/articles/response-times-3-important-limits/).

[4] Jena, Baivab Kumar. "AES Encryption." Simplilearn, 9 Feb. 2023, www.simplilearn.com/tutorials/cryptography-tutorial/aes-encryption.

# Evaluation

A picture containing text, screenshot, number, parallel

Description automatically generated

**Please do not include Hints section in your solution.**

# Hints

## Overall Assignment Notes

* As usual, the notes are a primary source for explanations and examples; we also encourage you to do outside reading and research to gain additional perspective. In the real world, you would be interviewing people to carry this out but that is not possible in a class setting.
* If you run out of space (after careful editing), you may provide an additional explanation in the appendices section to support your design decisions or to clarify your choices.
* As in the real world, the quality of your work is subjected to judgments, not mathematical exactness. Help your facilitator make favorable judgments by being as clear and specific as possible. “Clarity” is one of the criteria.
* Feel free to include notes for your facilitator (that are not actually part of your paper). A good way to do this is to insert, for example, “Note 3 to facilitator” and list the notes in the appendix.

## Notes to Selected Grading Criteria

**Clarity**: Part of requirements analysis is to understand what your customer wants and needs (and, as we discussed, this is not easy)—so be sure that you understand the problem. Your response will be clearer as a result. Are your requirement statements clear enough so that someone could create a design from them? Are your names (e.g., of states) expressive enough so the reader can understand them? Explain throughout. **Consistency (an aspect of clarity)**: Make sure that your entire solution is consistent. For example, did you introduce some functionality in the use case that you didn't mention in your functional requirement? Then go back to part 3 and make sure to revise it.

**Relevance**: Review the scenario and make sure to stick to it. If you need to expand on them a bit that’s fine; provide a brief introduction with your assumptions, but make sure to stay within the initial framework of the scenario. For example - it's best to describe your approach and/or scope for the diagrams.

## Mission Statement/Overview

**Technical Soundness:**

* A high level overview. Logically, one would write this first, and then the other parts would flow from it. However, our minds do not necessarily operate very logically. To stimulate your thinking about the mission, you may first want to think about a user story, or even just an actor.
* Avoid details—they come later.

**Clarity**

* Do not underestimate the time required to write a clear overview that is both short enough to be readable, and yet long enough to convey what the system does, structured appropriately.
* Come back to this section at the end, to make sure it is consistent with the rest of your solution.

## Functional Requirements

**Clarity**

* You do not have to go into the finest details of the requirements, but make sure that you describe the major functionality. Enumerate and describe your functions systematically.
* Look to organize requirements with headers and sub-headers, for example by actor and or functional area.
* If a functional requirement sounds a little bit non-functional, explain your reasoning as to why you decided to keep it functional in a note (as sometimes these are borderline).

**Technical Soundness:**

* Make sure to understand the difference between functional & non-functional requirements.
  + Functional: Reasons for the system and what it’s meant to do.
  + Non-functional: Needed or wanted but not the reasons for the system.

**Thoroughness and Coverage:**

* You may need to come back to this after you complete the assignment to see what you missed, for example, are there key features you outlined in the GUI, state transition or use case which were not covered here?

**Relevance:**

* You may want to do some outside research to see relevant examples of how functional requirements are defined for systems. You can include your findings in the Appendices section

## Use Cases

**Technical Soundness:**

* Complete the use case template we give you in the assignment.
* Additional information is available in the tabular-narrative forms of Figure 4-13 on page 143 of the textbook and in the “Use Cases” section of the Module 3 notes.
* The use case needs to show appropriate sequence (actor/system)
* Clear understanding in difference between constraints and pre-conditions. The use case itself should follow one path as best as possible.
* Avoid branching in use cases, if possible—use only if necessary.

**Thoroughness and Coverage:**

* Complete the use case template we give you in the assignment. This is where we ask you to describe the use case, who uses it, what might be the pre-conditions, and alternate steps.
* Research can be applied by looking at similar systems (i.e. here is what I found and how it relates to my design). This makes your solution real and is something that analysts need to do to understand what technology will be used to implement this.

**Clarity**

* Consider consistency and relevance to the scenario.

## State Transition Diagrams

**Technical Soundness:**

* A good place to start is to review the “State Machine and State Transition Diagrams,” “Components of State Transition Diagram,” and “State Transition Diagram—An example” sections in this week’s lecture notes.
* Consider your use case as a way to start thinking about state transition, ‘what the system does’ are the states of your system, and ‘what the actor does’ could be the events that trigger the transitions, and then look to functional requirements and user stories to add detail.
* Avoid focusing too much on use cases themselves, you want to capture the overall main steps of the system.
* Make sure all transitions are labeled with events. If a state transitions into a state (i.e. search completed) but is not significant to be it’s own state, use it as an event within guard conditions.
* Please see pages 221-227 in the text on Behavioral State Machines – however, please note that this requires Object Oriented approach which we will look at next week. For now, review the mechanics of the state machine as it applies to this assignment.

**Thoroughness and Coverage:**

* Make sure all key functionality is covered (use cases, user stories, what was discussed in the system overview)

**Clarity**

* Make sure to show what the composite state(s) are, in other words note that these contain sub-states.
* Are diagrams clear to read (i.e. no overlapping lines, no non-polished designs)?
* Diagram should be consistent with requirements (i.e. functional, use cases).

## GUI Sketch

**Relevance:**

* Decide what is the most important, potentially complex screen, consider what it should contain and draw a rough mockup sketch.

**Technical Soundness:**

* See the “GUI Mockup Example” section in this week’s module for examples.
* Chapter 10 in the text covers material on human-computer interaction layer design.
* GUI is fairly straight forward; many students have fun with this. As mentioned previously, Visio and Lucidchart have a wireframe template, but you can also check out balsamiq.com, wireframepro.com or mockflow.com

**Clarity**

* Provide “Sticky Notes” to describe functionality which may not be obvious.

## Non-Functional Requirements

**Technical Soundness:**

* Make sure to understand the difference between functional and non-functional requirements.
* This is the "How" the system is implemented (i.e. quality requirements, constraints). Use references to support your choices. Think about what is most important and why; use of references should help here.
* The “Non-Functional Requirements” section of this week’s notes provide examples.
* Please see secondary readings for Week 3 in the textbook for additional examples of non-functional requirements.

**Thoroughness and Coverage:**

* You may want to do some outside research to see relevant examples of how non-functional requirements are defined for systems. You can include your findings in the Appendices section.

**Relevance:**

* Review your entire solution after completing it—you will uncover additional considerations. Check for consistency.