SIAS: Structural Integrity Assessment System

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I Project Description

1 Project Overview

The technological apex of our time is almost here. But it is unfortunate that building collapse accidents continue to happen, and we must protect our heritage places and pass them on to future generations so that they will appreciate our culture's past.
A software program called the Structural Integrity Assessment System is designed to assist engineers who want to understand the advantages and disadvantages of a civil structure.
In this project, we want to accomplish that goal by utilizing sensors and a cloud platform that displays specific information about the position of the sensors and their value records. This data can be subjected to visual data analytics to display graphical distribution to the user, aiding in their understanding of the characteristics of the building site.
By completing this project, we will be able to access places where it is challenging for people to go and work, understand the stability of the structure in an efficient manner without requiring a lot of labor, and reduce hazards associated with structures falling.

2 The Purpose of the Project

The Structural Integrity Assessment System is a piece of software made to help engineers who want to comprehend the benefits and drawbacks of a civil project.

2a The User Business or Background of the Project Effort

Civil engineers, archaeology enthusiasts, and students pursuing construction management are among the prospective users of the suggested software program. Large skyscraper management firms frequently hire other businesses to provide structural maintenance services after receiving inquiries from a variety of clients. They are encouraged to evaluate a variety of elements, such as tilt, load and strain, and cracks, in order to identify structural faults. These businesses can use this program to cut labor costs and obtain accurate, efficient data. In order to learn how construction site concepts are attained and maintained, architecture students frequently have to labor on-site. They can utilize this program to obtain comprehensive information and carry out the necessary analysis to discover pertinent facts.

2b Goals of the Project

The project's main objective is to make it easier for the user to evaluate civil structures. Due to their enormous scale, focusing on a building's strengths and weaknesses is frequently tricky. Using the web application or mobile app that displays graphical data about many aspects like temperature, tilt, crack, stress and strain, the user can quickly examine the status of the entire building.

2c Measurement

A structural integrity assessment system provides sensors and applications that will provide accurate information about the evaluated structure. The sensors are placed in different locations selected by the engineer, which will calculate the information and display tilt, strain, load, temperature and crack formations information. This data can be viewed on the application with graphs and precise values our competitors do not maintain.

3 The Scope of the Work

Structural integrity evaluation - The system is designed to give the user graphical information about the sensor data. The sensors return information that the user can utilize to comprehend the characteristics of the building. It is the user's obligation to comprehend this information and choose the appropriate structure.

3a The Current Situation

The customer now employs human labour to access challenging locations. They use old-fashioned methods, including digging alongside the foundation to look for cracks, pillar tilt, and stress. These methods can be expensive and risky because digging could result in the collapse of the structure. The data is inaccurate and time-consuming.

3b The Context of the Work

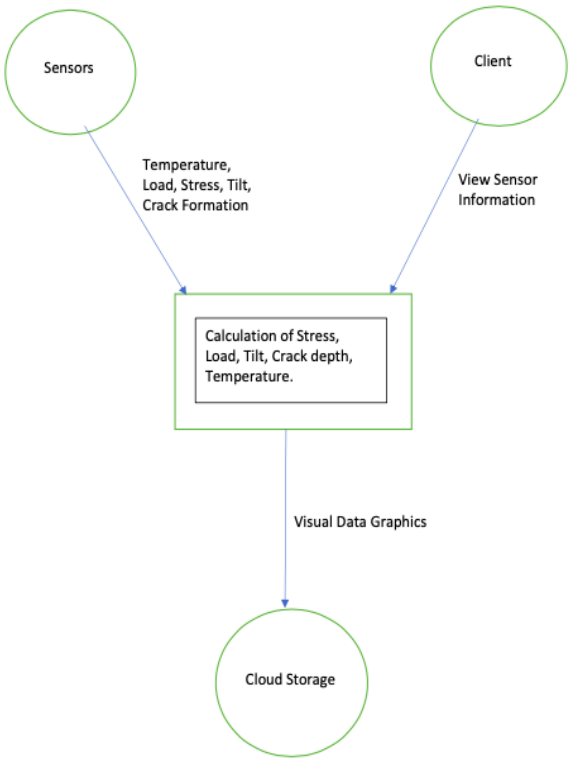

Fig.1 Work flow model

3c Work Partitioning

Event Name	Input and Output
1. Maintenance officer registers into the system	Maintenance officer details registered(in)
2. Maintenance officer accesses sensor data	System receives access request (in)
3. Structural Engineer accesses sensor data	System receives access request (in)
4. Data analyst accesses sensor data	System receives access request (in)
5. System displays sensor data	System sends out requested data (out)
6. Officers request suggestions	System receives recommendation request(in)
7. System displays result	System calculates risk factors and displays recommendations (out)

Table 1. Work Partitioning

3d Competing Products

Other competitors on the market include move solutions, which have sensors and a cloud platform. Movesolutions offers a variety of sensors for usage in various applications. For instance, a tiltmeter can only be used to measure tilt.
The suggested project is superior to previous projects since it uses a single sensor for various activities and has better precision and a more comprehensive operating range.

4 The Scope of the Product

It's tough for the naked eye to capture the structural wear and tear of a building. Small structural changes often result in severe damage to life and the economy. Usually, changes in the mechanical and geometrical properties are monitored by engineers using physical means. But a human would only be able to observe significant changes. Equipping the building with sensors only solves half the problem. The data generated by these sensors daily requires analysis and visualizations for a non-specialist to understand. Project managers should use the latest technological advancements to automatically analyze and monitor the robustness and strength of a civil structure. Project managers can use the structural integrity assessment system to obtain assessments and suggestions based on the data obtained from the sensors.

A structural integrity assessment system is software that helps users analyze sensor data and obtain assessments and suggestions. This is accomplished by employing sensors in the civil structure to get readings like measurement of angles on all three axes, temperature, frequency and amplitude of the vibrations and stress. The software analyses this data to assess tilt, crack formations, sinking abutments, strain, load shifts, monitoring of existing cracks, degradation of load bearings, risk-factor and suggestions.

4a Scenario Diagram(s)

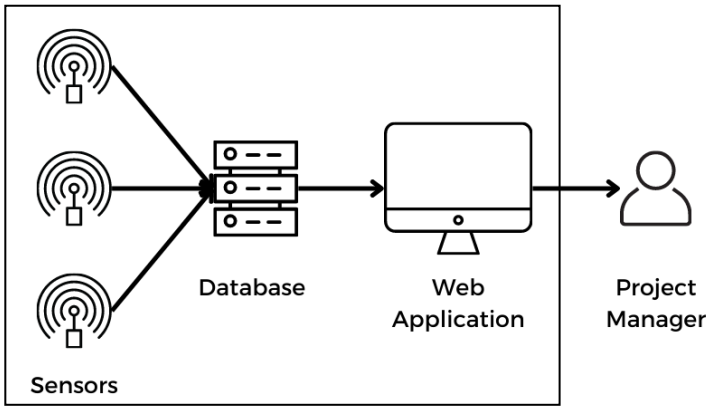

Fig 2. Scenario Diagram

4b Product Scenario List

1. Web application
2. User login and registration
3. Analyze the risk factor
4. Sensor database
5. Assessment report and suggestions

4c Individual Product Scenarios

1. Web application: A web application that displays user dashboard
2. User login and registration: The user has to login or register and request access to view the database and dashboard.
3. Analyze the risk factor: The assessment will be performed by using data analysis techniques to obtain the risk factor.
4. Sensor database: The database will store the sensor data and assessment parameters like risk factor.
5. Assessment report and suggestions: After analyzing the data, a visualization of risk factors and suggestions are displayed.

5 Stakeholders

5a The Client

Big construction enterprises and small individual civil contractors or builders are some of our stakeholders. The range of stakeholders our product serves demonstrates how the civil industry

can gain from us. To maximize the advantages of our solution, both major corporations and small individuals can invest in our technology.

5b The Customer

- Big construction enterprises

All the world leading construction companies which account for building huge civil structures including skyscrapers, industrial plants, airports, stadiums, etc.

- Small construction companies

Companies that take on construction projects to build structures such as small residential buildings & societies, mini shopping malls, etc.

- Individual builders

Small neighborhood constructors like builders working on row houses, shops and stores, small residential buildings, etc.

5c Hands-On Users of the Product

Though the solution ultimately aids the populace which will be residing or utilizing the civil structure in future, however, the solution is used by the ongoing-construction builders or post-construction inspectors to check the overall integrity of the structure.

There are two categories of Hands-On users:

1. Construction Managers & Engineers-

These are users involved during the construction phase of a structure, the time between the start of actual structure construction and its completion. Due in part to its prominence, the building stage is the one that majority people connect with construction works.

2. Construction Inspectors and Structural Engineers-

A residence or building's load-bearing structural components, such as the foundation, structural frames, planks, supports, or pillars/stanchions, are confirmed to be sound by these inspectors.

User part- Examine structure readings and read & understand the data provided by the application.

Subject understanding- Knowledge about civil structures, what factors affect the integrity, and benign structural readings.

Experience- Users should have experience of civil constructions and a little idea about working with software application interface, and reading sensor data.

5d Maintenance Users and Service Technicians

Basic hardware and software aptitude should be a must for installation team, maintenance team and service technicians. The software professionals should patch upgrades and problems. The IT team and technicians could offer assistance to consumers using our solution. Moreover, service professionals need to be able to resolve any minor problems with a device that are primarily hardware-related.

5e Other Stakeholders

- Agencies working on structures within areas prone to higher risk of natural disasters are also our potential clients

- Government organizations interested in assessment of structural integrity of various public buildings & constructions

- Government agencies responsible for maintaining important monuments and tourist attractions

- Partner Companies- These are middle companies which will help increase the reach of our products to more consumers and aid in expanding the overall business, locally as well as internationally

- Individuals- People interested in checking structure strength on an individual level for their personal properties or a group interested in building a larger and more advanced project using our product as a small part.

5f User Participation

Through contact support like email service, users can make improvements and offer crucial feedback. Any unique opinions regarding our hardware units or software application are appreciated to help us produce a better final version of our solution. Additionally, engineers and construction professionals are welcome to offer specific additions for our system.

5g Priorities Assigned to Users

Direct buyers of our solution including big and small construction enterprises, and individual builders prioritize first in our importance and priority list. Their requirements and feedback are

more significant than other stakeholders and users. The partner companies which will help expand our business further will receive priority as they'll be the middleman between the buyers and our team, and will transfer information about requirements for buyers to us. We will also give priority to people who utilize and reside in constructions that use our system as these people directly interact with the structures. Competitor firms that buy our product to learn and compare with their own will be considered under unimportant users.

6 Mandated Constraints

6a Solution Constraints

Description: Our software service is maintained in a Cloud environment, so any application platform including mobile, website, or tablet will be satisfied.

Security constraint: For engineers, they must work on company provided laptops for security purposes while clients can access the maintenance website with their login credentials.

Description: Since this project and service contains highly detailed construction and structural information, its security constraints are the maximum. Its purpose is to prevent any harmful exploitation of our data to illegal or any other activities that are not related to our business logic.

Rationale: This software product will be marketed for businesses such as building maintenance, civil engineers, construction companies, and other academic institutions that collaborated on our project for improving our work and structure safety.

6b Implementation Environment of the Current System

This project contains two main departments such as sensor application on a structure including structure inspection and evaluation and software development.

Sensors are correctly installed after the structure inspection. The sensors send data such as vibration, tilt, and heat to the facility that commutes the data and evaluates the outcome.

Since there is a limitation in communication between sensors and a software environment that computes data, it is favorable to have a room within one or two miles that handles the incoming signals for better structure maintenance and data preservation. It helps convert and amplify sensor data for software implementation.

For the software implementation, we implement a cloud environment. The main reason is the extensive data, computation power, and accessibility. However, the database is maintained locally because our data contains detailed building information.
For this reason, we require developers and clients who access the service to have a high security clearance.

6c Partner or Collaborative Applications

This application is composed of sensors, cloud service, and database applications, we collaborate with other parties such as a cloud service provider such as AWS and research institutions.

We collaborate with sensor manufacturers for adjustments and other specifications of sensors that are based on the customer's needs. Since we expect to evolve, the sensors will also be changed for the better customer needs and experience.

Cloud service providers will be one of the big partners for this project since we have to use the power of cloud computation when we compute the large data.

Research institutions are the backbone of our future, therefore, we provide less sensitive data for research purposes and gain mutual benefits from the research outcome.

6d Off-the-Shelf Software

To maintain maximum security and strict access level, our database is maintained locally. Its information is confidential so that customers and other engineers have no access to the actual database, but only computed data.

6e Anticipated Workplace Environment

There are two types of environments: Sensor environment and Software deployment.

The sensor environment will be dependent on the structure. This prototype project is not to be used on Mars or the Deep Sea. It is only for the structures that are grounded on earth. Each sensor will be used on basements, pillars of bridges, resident buildings, and other skyscrapers.

To satisfy such extreme conditions, the sensors must be waterproof, heat resistant with long battery life.

For the software environment, we expect to deploy our project on a cloud environment, so that clients and developers can easily access and use the software around the globe.

6f Schedule Constraints

The time frame of the project will be divided into 5 main sections. Building inspection, cost evaluation, sensor installment, software building and testing, and maintenance.

All of the sections will be closely monitored and developed with clients. The building inspection time depends on the size of the structure, but it should not exceed 3 weeks.

For the cost evaluation process, it involved financial analysts, project managers, sensor manufacturers, and our engineers for sensor inspection. Since many parties are involved in this step, we expect to finish cost evaluation as soon as the building inspection is finished. Schedule of cost evaluation will approximately be 3 weeks.

Since we apply a new code base for this project scenario, the software building and testing stage must start with the beginning of this project. It must finish around the same time as cost evaluation before sensor installments. It means it needs to be finished in 6 weeks.

The maintenance will be widely tested and monitored after the project is done. It is one of the final steps that we take in this project. If time allows, this stage must take at least a year to prove the working of this project. The time frame is 1 year since the structure and sensors have to be tested from winter or hat summer over the course of each season.

6g Budget Constraints

To prepare and build the application, the budget is one of the main constraints along with development time. The cost of sensors is evaluated by civil engineers and clients. It is one of the most important and versatile constraints that meets the consumer and merchant's needs.

Each sensor cost varies based on the time of purchase because the cost of the semiconductor and other sensors are dependent on the global market. Upon a purchase, we guarantee that the communication with the client will be clear as our business logic and it will be totally dependent on the client's decision.

The deviation of the budget spending on sensors should not exceed 2.5 of the global market prices.

7 Naming Conventions and Definitions

7a Definitions of Key Terms

1. Tilt- horizontal displacement between the top and bottom of a structure
2. Abutments- a structure built to support the lateral pressure of an arch or span, e.g. at the ends of a bridge.
3. Strain – 1) Ratio of change in length to the original length. 2) A force or influence that stretches, pulls, or puts pressure on something
4. Load bearing - structure is a structure in which the weight is transferred from the roof to the walls which transfers to the foundation.
5. Structure - a building, or a landscape figure, with systems allowing to use it in line with its intended use, erected using construction products

7b UML and Other Notation Used in This Document

This document follows the Version 2.0 OMG UML standard, as described by Fowler. Distinction between arrows is not necessary for the purpose of this report.

7c Data Dictionary for Any Included Models

Sensor data display time = Sensor data input time + Data filtering time + Data output time
System result time = ML model run time + recommendation output time

8 Relevant Facts and Assumptions

8a Facts

- Most civil structures and monuments are inspected manually, though using mechanism and devices, but are still not automated

- Currently structures which are under construction are laid out one step at a time. A certain amount of wait time is dedicated between two steps for materials like concrete to dry out and strengthen internally. Leading construction companies are in search of systems that can evaluate a civil structure and concrete while under construction in order to save the waiting time between the stages of their constructions.

- Discovering, spotting, determining, and evaluating are important steps that require input of the preceding step.

- Signal Processing is crucial to convert the sensor data to understand integrity of the structure in hand

8b Assumptions

- Compact sized sensors exist that can measure important factors such as tilt, crack formation, stress, strain, load shifts, degrading abutments or load bearings, etc.

- Sensors range is adequate enough to give measure of important factors within 20 feet of range

- Sensors are robust, study, and long-lasting for many years without requiring any maintenance

- Places where sensor devices are placed are well within wireless internet access

- Sensors might be disrupted due to external human activities such as drilling on a wall, giving vibrations that are misread

- User has sufficient knowledge of factors affecting civil structure’s strength

- User possess a computer device and knows how to operate a computer and run an application

- User should also be able understand important data values from the system

II Requirements

9 Product Use Cases

9a Use Case Diagrams

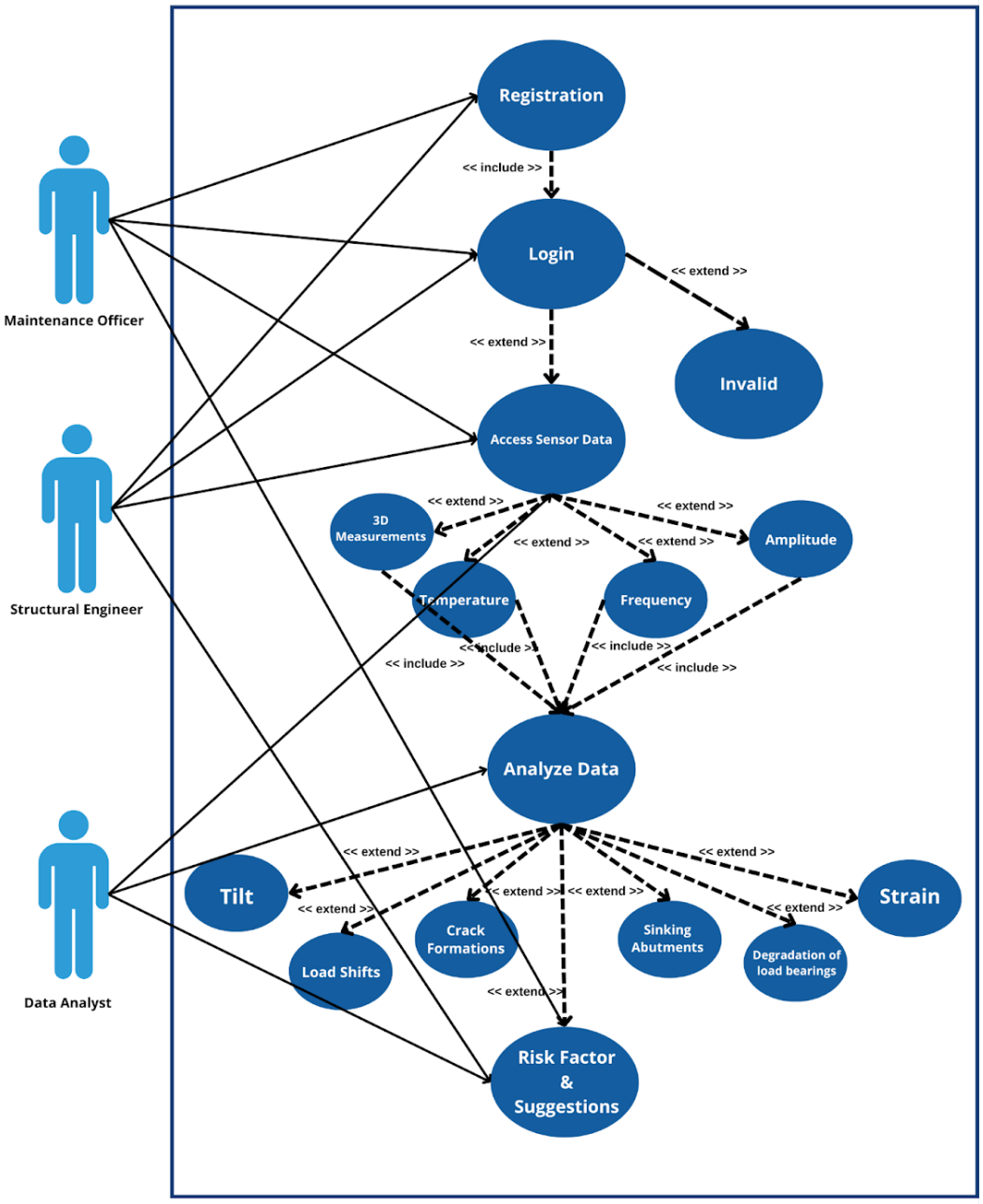

Fig 3. Use Case Diagram

9b Product Use Case List

1. Registration
2. Login
3. Access Sensor Data and perform Data Analysis
4. Obtain risk factor and suggestions

9c Individual Product Use Cases

Use case ID: NA Name: Registering User

pre-conditions: User is new and has to register based on their role.

post-conditions: A new account has been created for the user. They can use their account to perform functionalities respective to their job roles.

Initiated by: Maintenance Officer, Structural Engineer

Triggering Event: The user has to create an account to perform their duties.

Additional Actors: User, System, Sensor Data, Data Analyst

Sequence of Events:

1. The system displays a home page with the "register" button.
2. User clicks on the button
3. System allows the user to input their Name, Email, Role, Password and Username.
4. User inputs the information and submits it using the submit button.
5. System connects to the database to store this information and create an account for the user.
6. The user will enter the home page to login using the "Login" button with their username and password.

Exceptions: If the email or username already exists, the system lets the user know that the user is already registered.

Use case ID: NA Name: Login to the account

pre-conditions: User has already created an account and would like to access it.

post-conditions: The user is logged in and has access to the dashboard.

Initiated by: Maintenance Officer, Structural Engineer

Triggering Event: The user would like to login to the account

Additional Actors: User, System, Sensor Data, Data Analyst

Sequence of Events:

1. The system displays a home page with a “login” button.
2. User clicks on the button
3. System allows users to input their Email/Username and password.
4. User inputs the information and clicks on the login button.
5. System connects to the database to authenticate this information and provide access.

Exceptions: If the email/username and password are incorrect, the system displays that the userID or password entered by the user is incorrect.

Use case ID: NA Name: Access Sensor Data

pre-conditions: User is logged in to the application

post-conditions: User has access to the dashboard that displays sensor data. Performs data analysis and obtains parameters like risk factor and suggestions based on the data.

Initiated by: Data Analyst

Triggering Event: The user would like to access data from the sensors to perform data analysis and obtain a risk factor.

Additional Actors: User, System, Sensor Data

Sequence of Events:

1. The system displays a dashboard with the button to view sensor data and a button to calculate risk factor.
2. User clicks on the “view sensor data” button and “calculate the risk factor” button.

Exceptions: If the data is insufficient data analysis cannot be performed.

Use case ID: NA Name: View Risk factor and Suggestions

pre-conditions: User must be logged into the application. Data analyst already initiated calculation of data analysis based on the sensor data to obtain risk factor.

post-conditions: User is displayed risk factor and a series of tasks to be implemented based on risk factor.

Initiated by: Maintenance Officer, Structural Engineer and Data Analyst

Triggering Event: The user would like to access risk factor to ensure building safety.

Sequence of Events:

1. The user clicks on the button.
2. The system populates the screen with risk factor and a series of tasks to be implemented to ensure building safety.

Exceptions: If the risk factor is “Zero”, no suggestions are displayed.

10 Functional Requirements

Requirement ID	FR1
Requirement Type	Functional - User Account Setup
Description	Users shall be able to register on the application by providing required information.
Rationale	As the data on the dashboard is sensitive, a registration page is required to allow only a set of individuals to be able to register.
Fit Criterion	When the user enters their information on the registration page, the data should be saved in the users table with the information provided.

Requirement ID	FR2
Requirement Type	Functional - User Account Login
Description	Users shall be able to login to the application by providing required information.
Rationale	As the data on the dashboard is sensitive, a login page is required to allow only a set of individuals to be able to access it.
Fit Criterion	When the user enters their information on the login page, the data should be authenticated from the users table.

Requirement ID	FR3
Requirement Type	Functional - Performance Data Analysis
Description	User should be able to view the data and perform data analysis to obtain the risk factor.
Rationale	As the raw sensor data is impossible to be read by a common man, data analysis is required to obtain key information.

Fit Criterion	When the data is inputted into the input field, the result should display a risk factor on any scale and populate the screen with suggestions.

Requirement ID	FR4
Requirement Type	Functional - Users should have access to the risk factor to implement suggestions.
Description	As the risk factor could be in terms of many parameters, clear suggestions based on the observations are required to improve specific aspects.
Rationale	The risk factor should indicate the structural integrity of the building and the suggestions displayed should match with the abnormalities in the raw sensor data.
Fit Criterion	Users should have access to the risk factor to implement suggestions.

11 Data Requirements

11a Collecting User request as Requirement

ID#- Service Request	**Requirement Type**	Data
Description	System must store the users' signup data including number of buildings, structure types, and other requirements into cloud storage.	
Rationale	The requirement is necessary to store the information to initiate the service assigning the information to each team. It helps to estimate the budget and structures as well as building assessments.	
Accept/Fit Criteria	All the information from the signup is added in the pre-processing tables before creating official documents and object models. It should include Country name, Business name, type of structure, detailed design of structure, number of structure, year of built, and maintenance history such as re-construction.	
Acceptance Tests	All information should be acceptable in order to proceed the assessments and start the sensor installment.	

11b Based on the User request, Assess the structure to start the service. Evaluating user request and Assessment results.

ID#- Assessment model	**Requirement Type**	Data
Description	System must take and distribute the user data into appropriate departments that analyze and assign them to the structure inspection team which re-evaluate the data.	
Rationale	This step is necessary to determine the scale of the service request and to start the service with pre–defined documents. Also, it helps to understand the customers and the gap between the customer assessment and assessments from the structural engineering team after the inspection.	
Accept/Fit Criteria	The structure engineering team will assess and report the structure and its status including the user's request.	
Acceptance Tests	It is crucial that the assessment result such as status and legal terms in that region should be acceptable for further procedure.	

11c. Collecting Sensor data

ID#- Sensor Data model	**Requirement Type**	Data
Description	System must collect various types of data such as vibration, tilt, temperature, etc, from the sensors that are placed on the structure by the structural engineer team.	
Rationale	Correct data is essential to distribute work to data analyzing teams to visualize the data and provide the structure maintenance service.	
Accept/Fit Criteria	Furthermore, if the incoming data is below the expected error, the sensor must be checked. It is the first critical step to provide correct and reliable maintenance service.	
Acceptance Tests	To be acceptable, the data should be consistent and the sensor devices are also maintained and tested based on the incoming data.	

11d Analyze the data and provide service

ID#- Data Analysis model	**Requirement Type**	Data
Description	Systems must take refined sensor data from sensors and process that data using various methods providing the data into frequency visualization and use them to predict the future studies and services.	
Rationale	To provide reliable and correct maintenance service with various visualization services, Data Analysis team implements and manipulates the data applying a fourier model to provide frequency visualization.	
Accept/Fit Criteria	The data analysis team will analyze the data to provide the maintenance service. The outcomes should be categorized to visualize specific aspects of the structure.	

12 Performance Requirements

12a Speed and Latency Requirements

ID#- PR1	**Requirement Type**	Non-Functional
Description	Once the system starts the service collecting the sensor data, the result must be real data service.	
Rationale	The requirement is necessary to provide the real time application and monitoring of the structure.	
Accept/Fit Criteria	Most of the service types are provided in cloud service in real time data.	
Acceptance Tests	To provide real time data, the cloud service must be consistent.	

12b Precision or Accuracy Requirements

ID#- PR2	**Requirement Type**	Non-Functional
Description	Accuracy of sensor variables values taken from sensors shall be within ± 1%.	
Rationale	To provide a wide range of services through various mathematical models, the incoming sensor data must be in the acceptance range.	
Accept/Fit Criteria	To provide wide range of services through various mathematical model, the	
Acceptance Tests	The data must be in boolean value with 5th decimal points.	

12c Capacity Requirements

ID#- PR3	**Requirement Type**	Non-Functional
Description	Using Cloud service, the capacity of service is not limited and must be available 24/7 except system maintenance.	
Rationale	The data capacity and result data can be extended at the user's request after a year.	
Accept/Fit Criteria	The System in the cloud must be tested and maintained to meet the capacity criteria of the system.	
Acceptance Tests	Test the capacity requirement, cloud service should be tested with specific sizes and computations models.	

13 Dependability Requirements

13a Reliability Requirements

ID#- DR1	**Requirement Type**	Non-Functional
Description	The viewer must be able to obtain the building's structure information 95% of the time without issue.	
Rationale	Reliability is the probability that a system will function correctly over an extended period of time.	
Accept/Fit Criteria	In the unlikely case of a failure, no data will be lost or harmed.	

13b Availability Requirement

ID#- DR2	**Requirement Type**	Non-Functional
Description	Engineers must have access to a building's structural data seven days a week, at any hour of the day. If there is an unanticipated system outage, all functionality will be restored after one working day.	
Rationale	The likelihood that the system will function successfully when needed depends on this criterion.	
Accept/Fit Criteria	User can use the application 7 days in a weak without a major failure	

13c Robustness or Fault-Tolerance Requirement Requirements

ID#- DR3	**Requirement Type**	Non-Functional
Description	The application process will end with an error message rather than turning into a zombie process if it is unable to connect to the database (for instance, because the database has reached its session limit or the account has been locked).	
Rationale	The ability of a computer system to handle errors and incorrect input during execution is this criterion.	
Accept/Fit Criteria	Application creates warm and alarm notification on defined threads.	

13d Safety-Critical Requirements

ID#- DR4	**Requirement Type**	Non-Functional
Description	An unusually high number of database connections, such as when application processes or interfaces open a new database connection for each request without closing or logging out the prior database session, must be prevented from causing the database to exceed the session limit.	
Rationale	The ability of a computer system to handle errors and incorrect input during execution is this criterion.	
Accept/Fit Criteria	Database session counts are tracked by the application, which also generates warm and alarm notifications on specified threads.	

14 Maintainability and Supportability Requirements

14a Maintenance Requirements

Requirement ID	MS1
Requirement Type	Non-Functional - Maintenance Requirements
Description	If the sensors give invalid data, they can be under maintenance for approximately 2 hours.
Rationale	This requirement is the capacity of a computer system to deal with faults and erroneous input during execution.
Fit Criterion	Application provides list of suggestions to improve structural integrity.

14b Supportability Requirements

Requirement ID	MS2
Requirement Type	Non-Functional - Supportability Requirements
Description	The web application should be able to work on any browser like chrome, firefox or Safari.
Rationale	As this is a web application, the application should work on a browser.

Fit Criterion	Application runs smoothly on a browser.

14c Adaptability Requirements

Requirement ID	MS3
Requirement Type	Non-Functional – Adaptability Requirements
Description	The web application should work smoothly on Chrome, Firefox or Safari web browsers.
Rationale	This is required to ensure that the application runs smoothly on any browser.
Fit Criterion	Web application runs smoothly on the Chrome, firefox and safari web browsers.

14d Scalability or Extensibility Requirements

Requirement ID	MS4
Requirement Type	Non-Functional – Scalability or Extensibility Requirements
Description	Application to decrease cost of managing human resources by 40%
Rationale	This requirement is necessary to decrease the workload and cost of maintenance.
Fit Criterion	Application runs smoothly on latest versions of web browsers

14e Longevity Requirements

Requirement ID	MS5
Requirement Type	Non-Functional – Longevity Requirements
Description	The product shall be expected to work for a minimum of five years within the maximum maintenance budget.

Rationale	Product's expected lifespan should be satisfied.
Fit Criterion	Product is created with the expectation of minimum maintenance costs.

15 Security Requirements

15a Access Requirements

Requirement ID	SR1
Requirement Type	Non-Functional – Access Requirements
Description	Application should allow only select users to view the information and process the data.
Rationale	This requirement is necessary to restrict other users from being able to access sensitive information.
Fit Criterion	Application allows only select users to login.

15b Integrity Requirements

Requirement ID	SR2
Requirement Type	Non-Functional – Integrity Requirements
Description	The database should preserve backups of all data and obtained parameters through data analysis to ensure data integrity.
Rationale	Data backup is required to ensure any accidental data corruption, loss or theft of data.
Fit Criterion	Application must have a backup of all data in a file that can be used as a backup.

15c Privacy Requirements

Requirement ID	SR3
Requirement Type	Non-Functional – Integrity Requirements
Description	The application must protect personal data in compliance with applicable government privacy laws and the company's information policy.
Rationale	This requirement is necessary to keep the management's information private and hidden
Fit Criterion	Application must ask the user to read terms and conditions and accept

15d Audit Requirements

This section is not applicable for our project.

15e Immunity Requirements

Requirement ID	SR4
Requirement Type	Non-Functional – Immunity Requirements
Description	Ensure that the web application is not affected by harmful programs like viruses.
Rationale	To ensure that the product is free of any hostile intervention.
Fit Criterion	The web application should defend itself from the external influence.

16 Usability and Humanity Requirements

16a Ease of Use Requirements

Requirement ID	UR1
Requirement Type	Non-Functional
Description	The system should be proper and easy to use for the users without feeling the need for instructions
Rationale	System should not be intricate to scare off users
Fit Criterion	95% of users shall successfully create a new account in less than 5 minutes and shall be able to use major features in less than 20 minutes

Requirement ID	UR2
Requirement Type	Non-Functional
Description	The system should be user friendly especially for construction inspectors and structural engineers
Rationale	The System should not have an interface which the user's find abstruse

Fit Criterion	Majority of users shall be able to recognize and understand which feature is meant for what purpose on their first use of the application

Requirement ID	UR3
Requirement Type	Non-Functional
Description	The system features should be easy enough for the users to remember
Rationale	Users should remember the features so that they find the overall application to be very useful
Fit Criterion	At least 50% of users shall use multiple features of the application

16b Personalization and Internationalization Requirements

Requirement ID	UR4
Requirement Type	Non-Functional
Description	The system shall retain the user's last display preview preferences
Rationale	Users shall be able to personalize their preview screen as per themselves and not waste time in adjusting the reading sections on their screens
Fit Criterion	90% of users shall support the save preview feature that saves their time

Requirement ID	UR5
Requirement Type	Non-Functional
Description	The system shall accommodate users of any nationality or native language
Rationale	Users of different nationalities that speak different language must be able to personalize the system in the language of their choice
Fit Criterion	An anonymous survey among people with different native languages shall show that 80 percent of the intended users are finding the system more comfortable in their native language

16c Learning Requirements

Requirement ID	UR6
Requirement Type	Non-Functional
Description	The system shall be easy to learn for a construction inspector or a structural engineer
Rationale	Users should not find learning to use the product to be a challenge

Fit Criterion	An engineer/inspector shall be able to understand and test a demo structure's strength within an hour of beginning to use the product, without needing to use the manual.

Requirement ID	UR7
Requirement Type	Non-Functional
Description	The system shall be easily learned by analytical team within a short duration of time.
Rationale	Non-technical team should not find it too difficult to learn how to interpret the system results
Fit Criterion	An analyst shall learn about various results the system provides within a few days of training

16d Understandability and Politeness Requirements

Requirement ID	UR8
Requirement Type	Non-Functional
Description	The system shall use words and terminologies that are naturally understandable by the construction inspector and structural engineers
Rationale	Users should not find symbols and words used in the system to be unprecedented

Fit Criterion	95% of the structural engineers and inspectors shall be able to recognize major words and terminologies used in the system

16e Accessibility Requirements

Requirement ID	UR9
Requirement Type	Non-Functional
Description	The system shall be handicap accessible
Rationale	Users with common disabilities should be able to use the system
Fit Criterion	Users with partial vision impairment like color blindness shall be able to distinguish between features.

16f User Documentation Requirements

Requirement ID	UR10
Requirement Type	Non-Functional
Description	The system shall be having a technical specification guide and user manual
Rationale	Users having technical trouble with the product must have a guide to refer
Fit Criterion	80% of structural engineers having a question regarding a product specification or difficulty using the system shall be able to find its answer in the technical specifications guide or the user manual

Requirement ID	UR11
Requirement Type	Non-Functional
Description	The system shall be accompanied with an installation manual
Rationale	Users should have a step-by-step guide on how to install the product
Fit Criterion	90% of structural engineers shall be able to install the product correctly on following the installation steps in one go

16g Training Requirements

Requirement ID	UR12
Requirement Type	Non-Functional
Description	The system shall be easy to easy to use for non-technical team after training
Rationale	Users should not find it easy to use the system results after training
Fit Criterion	85% of users given three days of training shall be able work and interpret system results

17 Look and Feel Requirements

17a Appearance Requirements

Requirement ID	LnF1
Requirement Type	Non-Functional
Description	The system UI should be should be attractive and results to be easily interpretable
Rationale	Users should not feel the system to be repelling or not befitting the cause
Fit Criterion	95% of users should find the font style, size and color to be easy to read and interpret

Requirement ID	LnF2
Requirement Type	Non-Functional
Description	The system should adhere to standards of corporate branding
Rationale	This requirement makes no mention of the importance of the corporate logo or the colors to be employed. It merely specifies that the product must adhere to your organization's branding guidelines.
Fit Criterion	The branding specification team shall certify that the product complies with official standards

17b Style Requirements

Requirement ID	LnF3
Requirement Type	Non-Functional
Description	The system should appear to be strengthening
Rationale	The user must entrust that the product is meant for easing the process to calculate the structural integrity
Fit Criterion	Soon after their initial encounter with the system and sensor products, 70 percent of representative potential customers shall agree they feel they can trust the product and feel it to be reliable.

Requirement ID	LnF4
Requirement Type	Non-Functional
Description	The sensors should appear bright in color
Rationale	The user must be able to recognize sensors placed on a structure
Fit Criterion	Engineers should be able to recognize the sensor position immediately after having a glance over the place where such sensor is placed

18 Operational and Environmental Requirements

18a Expected Physical Environment

Requirement ID	OnE1
Requirement Type	Non-Functional
Description	The product sensors should be able to withstand extreme temperature and weather conditions
Rationale	Sensors shall be placed on structures in every part of the world
Fit Criterion	90 percent of representative potential structural engineers and construction managers shall say that they can trust the in abnormal weather

Requirement ID	OnE2
Requirement Type	Non-Functional
Description	The product sensors should be well packaged, waterproof and dust resistant
Rationale	Sensors could be placed in places where its rainy or dusty

Fit Criterion	90% of users utilizing the system in rainy or dusty conditions shall say that they these factors do not affect the system robustness

18b Requirements for Interfacing with Adjacent Systems

Requirement ID	OnE3
Requirement Type	Non-Functional
Description	The system should work be compatible with last three versions of wifi, BLE technologies
Rationale	Sensors should be able to communicate with systems powered with the latest as well as three versions of old wireless technologies.
Fit Criterion	95% of devices within a group that connects on wifi3 – wifi6 and BLE2-BLE5 should be able to connect to the sensors

Requirement ID	OnE4
Requirement Type	Non-Functional
Description	The products shall work on the last four releases of the five most popular browsers
Rationale	The system web application must be usable on all popular web browsers

Fit Criterion	95% of users within a group that using distinct browsers must be easily able to login and work with the application.

18c Productization Requirements

Requirement ID	OnE5
Requirement Type	Non-Functional
Description	The system web application must use be surfed with low data usage
Rationale	Web application should be optimized and consume lower data
Fit Criterion	85% users using distinct browsers must report data usage less than 25 MB after surfing through all the web pages once.

Requirement ID	OnE6
Requirement Type	Non-Functional
Description	The web application must use be search engine optimized

Rationale	Web application should be optimized and should be relatively in the top searches when searched on a search engine
Fit Criterion	85% users should find the website within the first 3 search results when searching for the website name on a search engine

18d Release Requirements

Requirement ID	OnE7
Requirement Type	Non-Functional
Description	The system must receive maintenance releases/updates twice a year, without causing previous features to fail
Rationale	The system's expected release cycle and the form in which it will be released are specified.
Fit Criterion	Features shall be updated based on customer reviews and once in every six months

19 Cultural and Political Requirements

19a Cultural Requirements

Requirement ID	CnP1
Requirement Type	Non-Functional
Description	The system must not contain any religious symbols or terms linked with major faiths
Rationale	Sociological factors are important and can affect the acceptability of the product
Fit Criterion	99% percent of representative structural engineers / construction managers from different religions all over the world say that they have not found any symbol or word that is against their religion or norms.

19b Political Requirements

Requirement ID	CnP2
Requirement Type	Non-Functional
Description	The system must provide potentially weak public building structure's data to the government
Rationale	Political requirement is important to be addressed though it might seem irrational
Fit Criterion	Civil authorities should acknowledge that proper data for public structures that are weak is provided to them

Requirement ID	CnP3
Requirement Type	Non-Functional
Description	The product shall be made using only American-made components.
Rationale	This requirement provides standards pertaining to the political variables that influence the product's acceptance
Fit Criterion	The company’s head should agree to be happy that only American-made components are used

20 Legal Requirements

20a Compliance Requirements

Requirement ID	LR1
Requirement Type	Non-Functional
Description	Implementing personal information must adhere to the Data Protection Act.
Rationale	This requirement outlines the legal requirements for this system, frequently citing pertinent legislation or necessitating legal department clearance.
Fit Criterion	According to attorneys, the product does not violate any laws.

20b Standards Requirements

Requirement ID	LR2
Requirement Type	Non-Functional
Description	The product must be created using the SSADM standard development procedures.
Rationale	In contrast to legal requirements, these specifications outline written criteria to which the product must adhere.
Fit Criterion	Are there any special development steps for this type of product?

21 Requirement Acceptance Test

21a Requirement Test Correspondence summary

Test	Req 1	Req 2	Req 3	Req 4	Req 5
Test 1	×				
Test 2	×				
Test 3		×			
Test 4		×			
Test 5			×		
Test 6				×	

Test 7			×		×

Table 2. Requirements - Acceptance Tests Correspondence

21b Acceptance test Description

Test 1. User Account Creation Test
Description: When registering an account, users must provide their name, email address, and password in order to access the application for the first time.

Test 2. User Account Creation Test
Description: When logging into an account to use an application for the first time, a user must provide their email address and password.

Test 3. User Account Creation Test
Description: If someone wishes to access the structure data where the values for the variables are stored.

Test 4. User Account Creation Test
Description: If someone wants to read the suggestion notification from the system.

Test 5. User Account Creation Test
Description: Test the process of inserting data in the database.

Test 6-First Time User
Test Description: When using the app for the first time, a user creates an account by providing their name, email address, and a password reset question. They must set up a username and password while registering. They will then have access to a mobile app where they can save things in the cloud.

Test 7 Lost Password
Description: The lost password features are used by the user if they forget their password. They must respond to the security question while using the lost password feature. Then they could change their password, and the modifications would be preserved along with all of the user data scores.

Test 8 – User Information in database
Description: When the user creates a new account their login information and personal details are stored in the database. Then whenever the account is logged into the database it will collect the account details and reload them to the app such as the user's information gender and loadout information.

Test 9 – Pop-Up Window
Description: When a window or screen pop-up in this app should not take more than 5 seconds to load or populate.

Test 10 – Maintenance
Description: Maintenance should be performed once every five weeks, and users will be notified in advance by email and the Seeds app. The maintenance will thereafter be completed as soon as possible.

III Design

22 Design Goals

The design goals serve as a uniform set of standards that must be taken into account while making design decisions. They describe the desired characteristics of the SIAS application. Our fundamental goal is to provide software that is reliable, scalable, well-designed, and reusable using object-oriented analysis and design. In order to finally realize our object-oriented approach, we are adamant about properly defining and depicting each aspect of the system. Next, we focus on reducing the impact and influence of modifications or security exploits. The following are the specific design goals:

• **Adaptability**:

Django will be used in the creation of the SIAS application for web. It is a cross-browser platform that enables us to create web app using a single directory. Various sensors are utilized for data collecting, including those that measure vibrations, frequency, and strain and are connected to our Mobile application. In other words, the user would not have to bother about the system / OS requirements.

• Efficiency:

The system will be quick to respond and capable of great performance. As operations and calculations are being carried out, the speed contributes to maintaining the system's elasticity. This is an important design objective of the application because it is required to create a real-time application for structural health monitoring, and speed is critical.

• Reliability:

The System shall be made available with no bugs that violate the boundary conditions. The maintenance team is responsible for maintaining the application and fixing any defects found after it has been deployed. Any erroneous inputs must not cause the system to crash.

• Usability:

The ease of use and user-friendliness of the SIAS system ought to be one of its most important features. It is one of the most crucial objectives, that the web app is user

friendly and well liked. Therefore, when implementing the SIAS application, the development team will take usability into account.

23 Current System Design

There is no pre-existing system. A proposed system design has been described below in the next section. This system will be a new system in the market after its complete implementation.

24 Proposed System Design

24a Initial System Analysis and Class Identification

Using sequence diagram and grammatical analysis, important classes such as Sensor, User, Account, Notification were identified initially. After identifying classes, fields and methods were though about and relationships were identified.

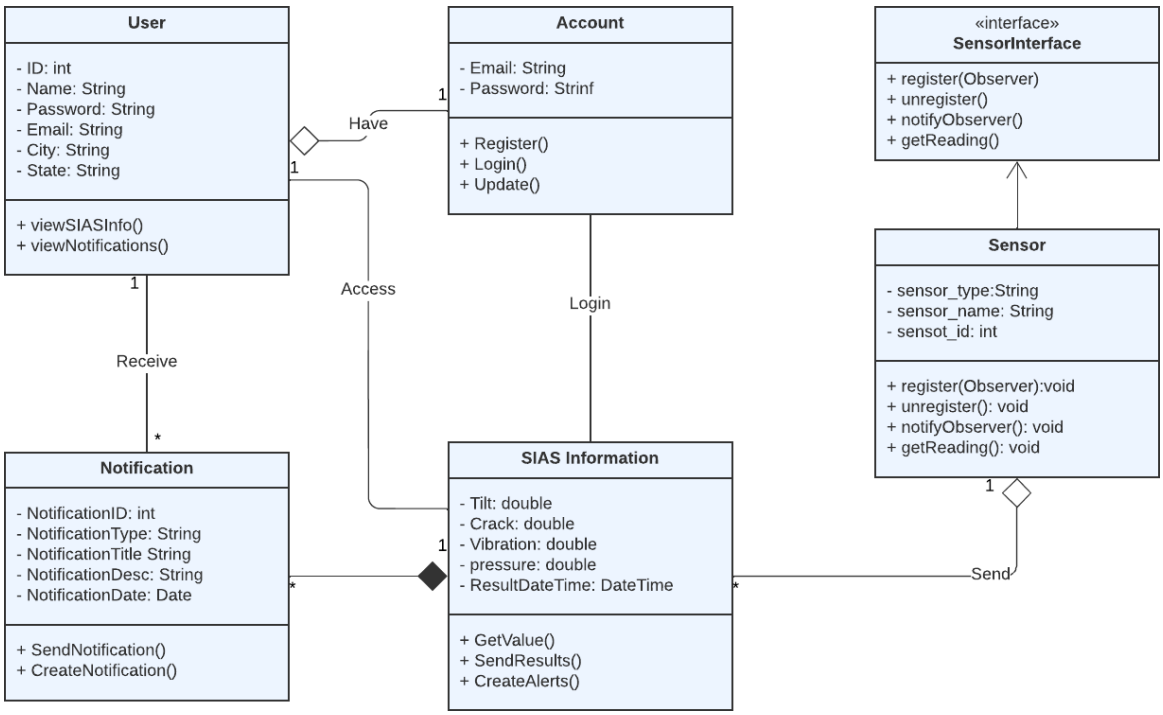

Fig4. Initial System Analysis and Class Identification

24b Dynamic Modelling of Use-Cases

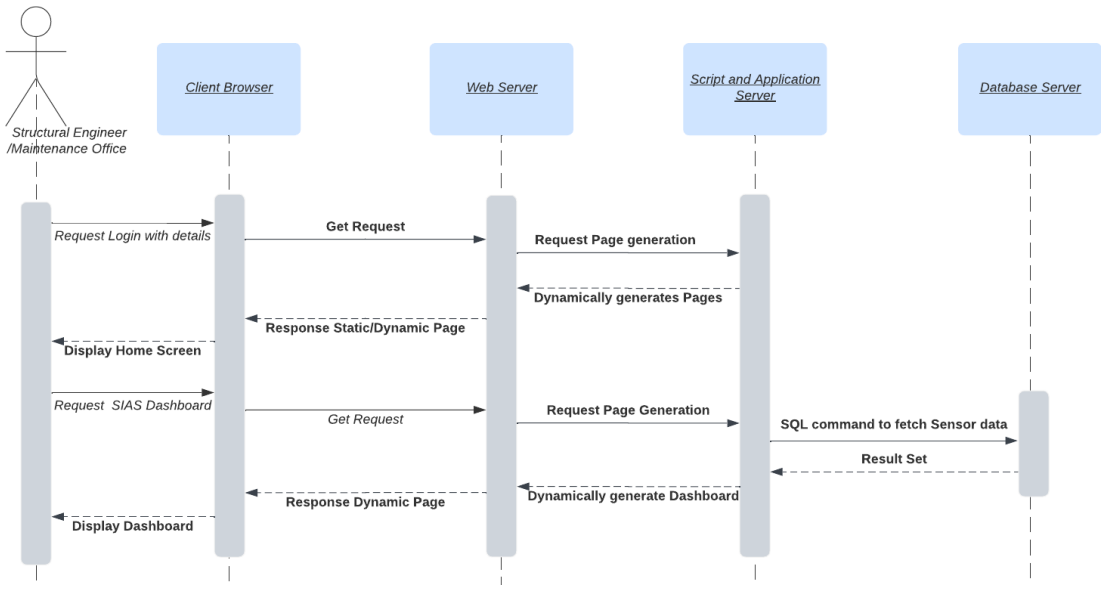

Fig5. SIAS- Sequence Diagram

As SIAS is a web program, entities such as Client Browser, Web Server, Script and Application Server, Database Server were crucial in generating a sequence diagram. The sequence diagram starts with the Structural/Maintenance Engineer, who will interact with a client browser. Client browser sends Get/Post requests to the web server. At the server end, script and application server forms the backend. It handles calculations on sensor data that it fetches from the database and returns dynamically generated pages. Database comprises of user account login information and sensor data information.

24c Proposed System Architecture

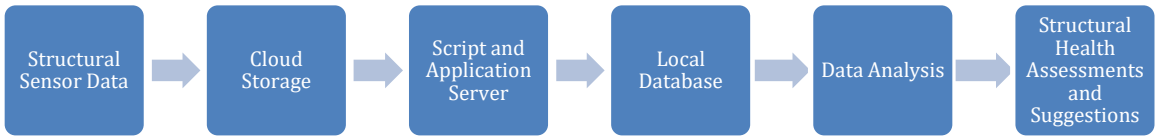

Fig6. System Architecture

For this project, Pipe and Filter architecture was found to be apposite. This architecture proposes a group of filters that each convert an input stream into an output stream. The pipes link these filters. Data is transformed as it flows through the system, and several transformations can be carried out at the same time.

The SIAS system start by collecting sensor data embedded in construction structures. This raw sensor data is sent to cloud storage and Script and Application Server fetches this data. Data is cleaned and false sensor values are eliminated to the possible extend. Further calculations are performed and recommendations are generated in case any structural health issues are found.

24d Initial Subsystem Decomposition

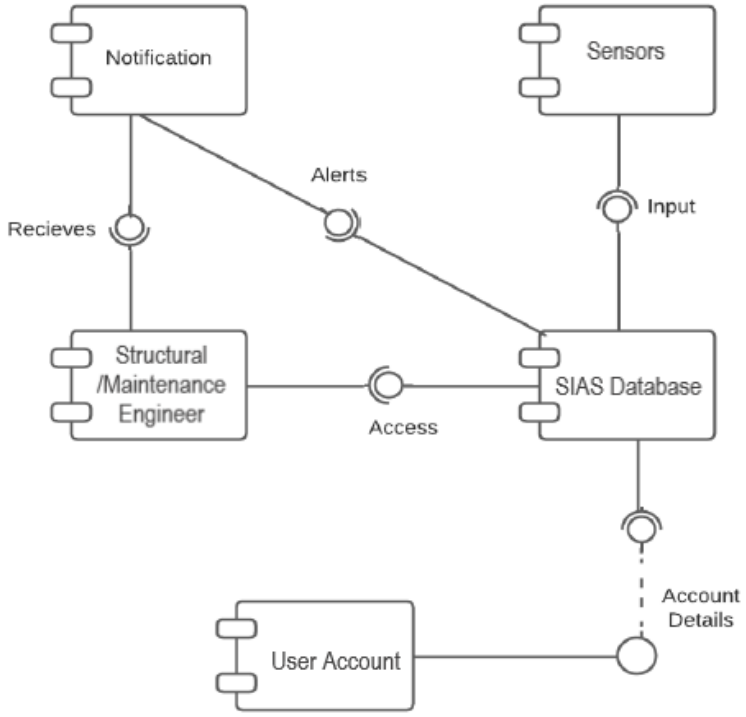

Fig7. Initial Subsystem Decomposition Diagram

Here, we've broken down our system into 5 smaller parts. We have all the information about the structure's data in the user's account, and this component will handle all the structural engineer's tasks including accessing the database and controlling notifications.

We have all of the user's login information kept in the account components, which also contain features like register, login, and update account. All of the settings pertaining to notification settings, notification templates, etc. are contained in the notification component.

25 Additional Design Considerations

25a Hardware / Software Mapping

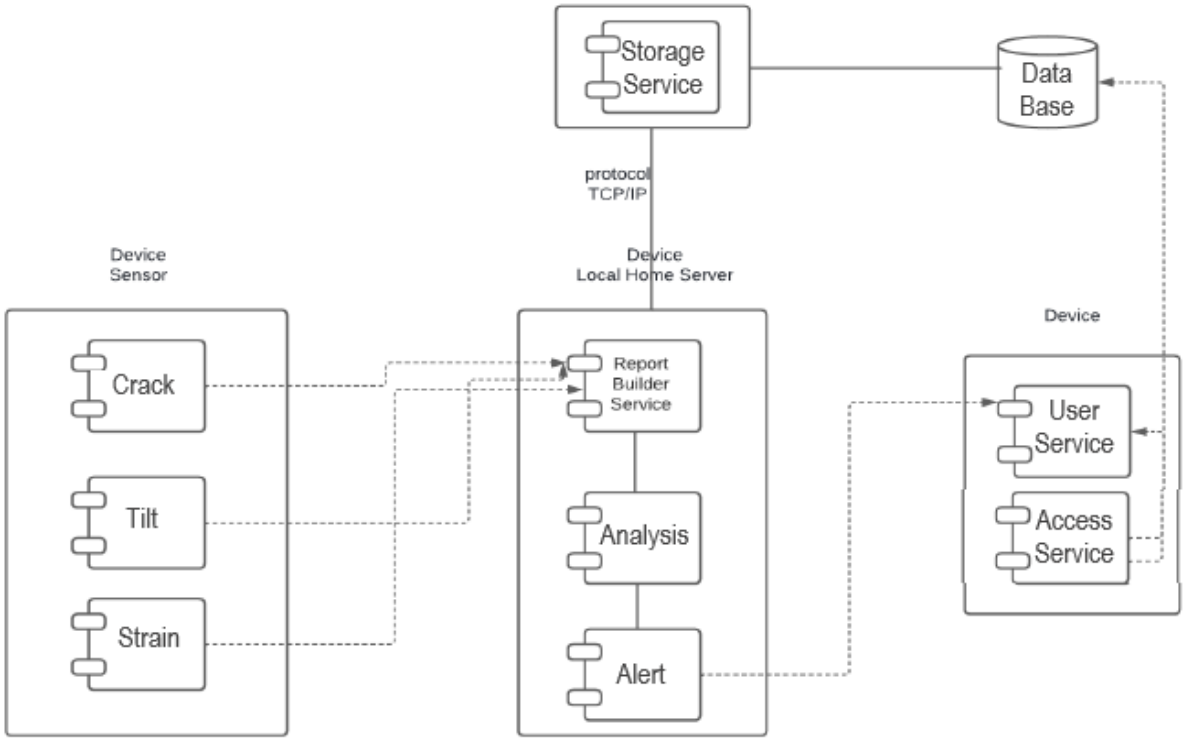

Fig8. Hardware-Software Mapping Component Diagram

The above component diagram shows the mapping between software and hardware component. The Device sensor components consists of the hardware sensors. This data is communicated wirelessly over BLE/WiFi networks. As the sensor devices will be connected in a network and data will be transferred to a local station, sensor data can be communicated between the local station and server-side software via TCP/IP protocols.

25b Persistent Data Management

A process or object that maintains its state after the shutdown of the system on which it is executed or the termination of its parent process or object is said to have persistence. When a produced process needs persistence, non-volatile storage, like a hard drive, is used rather of volatile memory, like RAM.

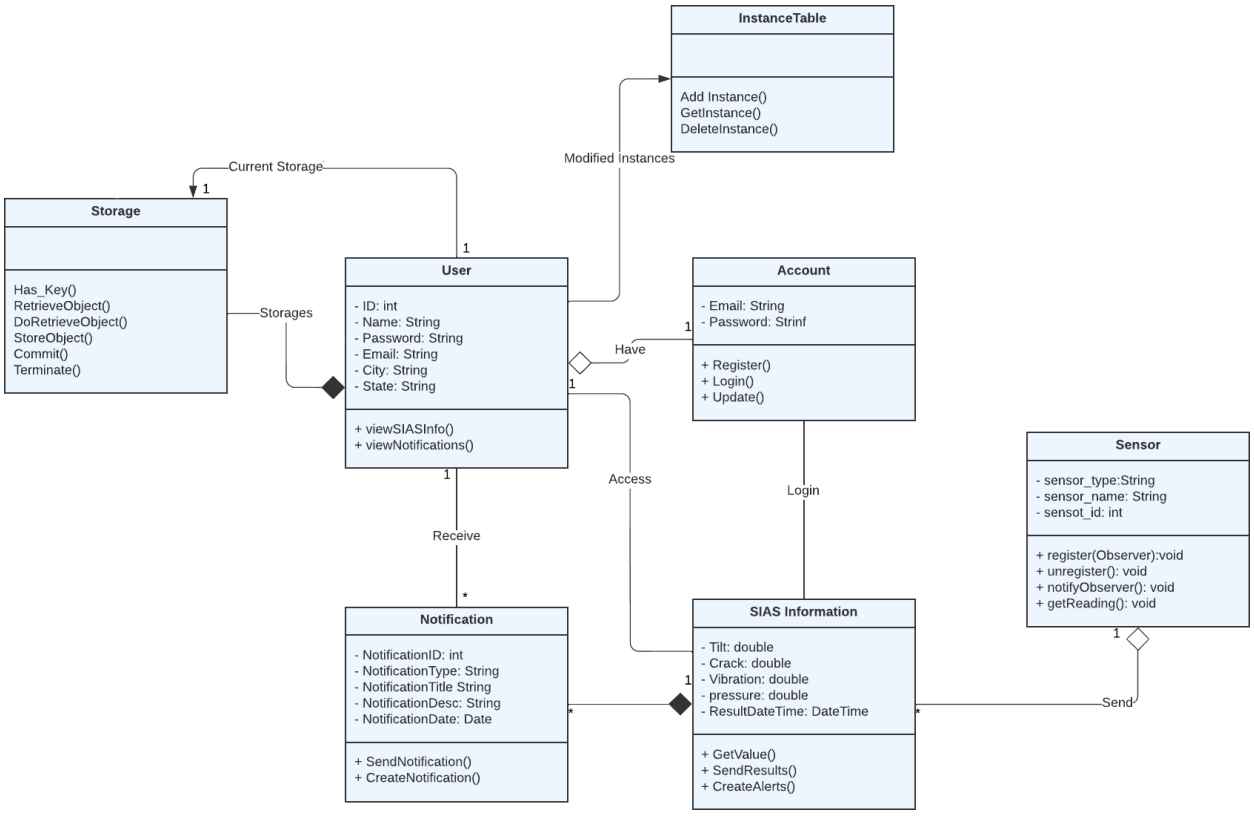

Fig9. Class Diagram with added persistent data management

In order to achieve persistence capabilities, applications typically need to directly contact DBMS, such as object-oriented databases or object-relational mapping technologies.

25c Access Control and Security

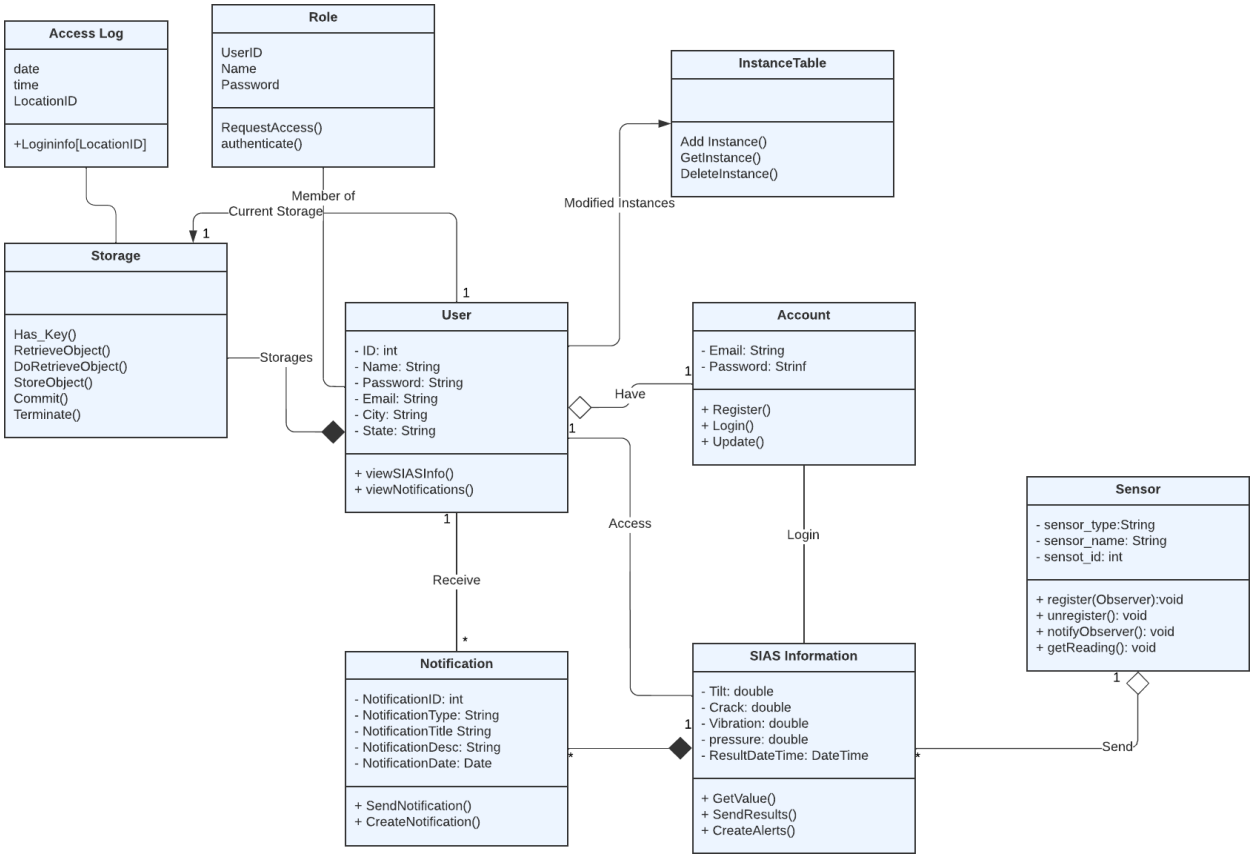

Fig10. Class Diagram with added Access Control and Security

The classes Role and Access log were added in this section. The user's login in the Access Log program activates, and the access class controls what the a structural/maintenance engineer may access and what they cannot.

25d Global Software Control

Each server must be event-driven in order to prevent race conditions because two users may make data requests at the same time. The administration and application servers ought to be under event-driven control. Procedure-based control may only be tried on the first horizontal prototype.

25e Boundary Conditions

SIAS Application will provide automated starting and shutdown timers, both of which will start from a manual setting, for users with direct access to the Management Server.

With this method, the user will be able to launch the entire system with a single script, and after each successful iteration, modifications will be propagated to the other components. This user will have a direct feedback relationship with the Management Server because the user is interacting with it directly. The server that established the connection must automatically send an email and generate alert notification if another problem arises.

Below are a few unique conditions:

Startup:

Database Management will be the initial service to be set up during startup. Once both servers have established bidirectional communication, which can be verified using the provided validation scripts, the Server component of the Management Server for the Web Server should be turned on. The Web Server will be enabled, if necessary, by the Management server. If the system has previously been functioning, a script will run to verify the essential services are running and start them if necessary. Upon initiation of this service, the application Server shall start all services necessary to offer the admin user's full functionality.

Shutdown:

If necessary, those with direct access to the Management Server will be able to turn off Seed Server. The process, which will be identical to Startup, will propagate changes from the Management Server. Using the Windows shutdown command and leaving a statement outlining the reason the server is being shut down, the Management Server will first shut down the Web Servers (Event Log is maintained automatically by the Web Server). Whenever the Application Server shutdown is complete or it times out after two minutes, the Management Server will shut down the databases using the Database Management Application.

25f User Interface

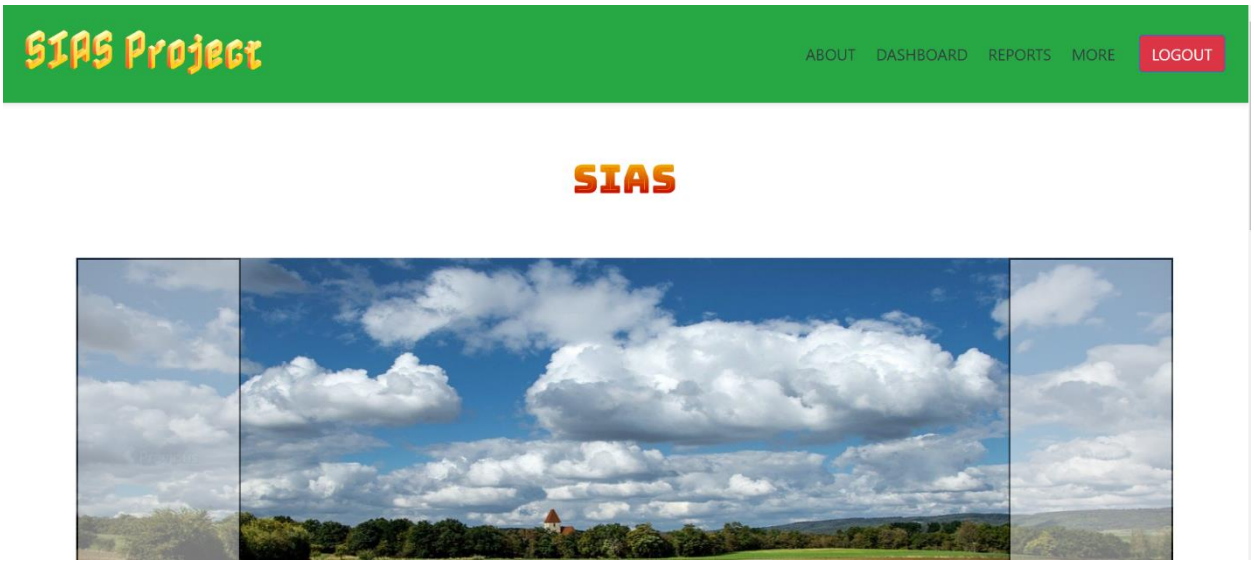

Fig11. User Interface Example

The above is an example of the User Interface. The important tabs in the web program will include a home page, Dashboard, Reports, Login/Logout, About.

25g Application of Design Patterns

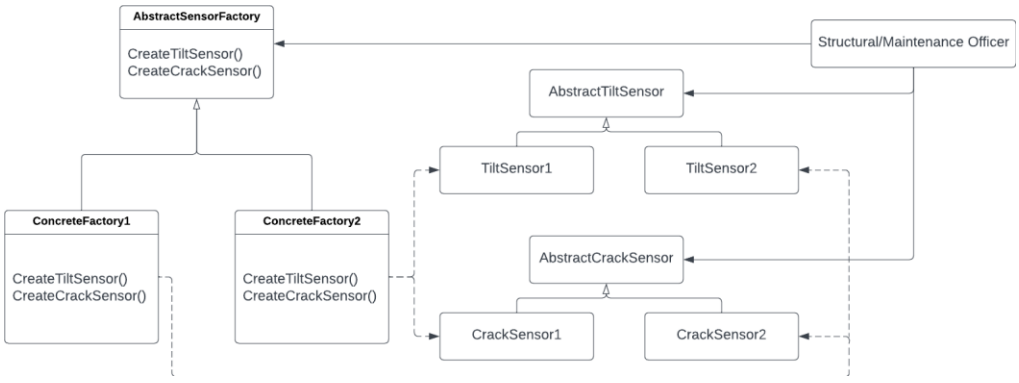

Fig12. Abstract Sensor Factory

For this project the Abstract Factory design pattern can be applied in order to connect different sensor types of different manufacturing to the SIAS system. The Abstract Factory pattern will provide an interface “AbstractSensorFactory” for creating families of related/dependent sensor objects without the need for specifying concrete classes.

26 Final System Design

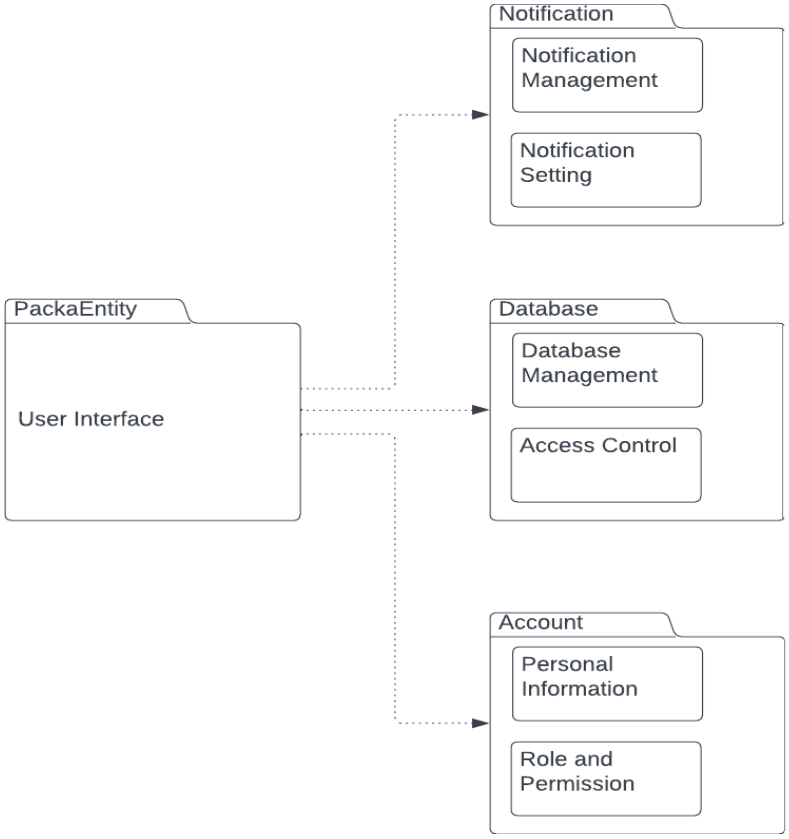

Fig 13. Final System Package Design

We have a total of 4 sub components of the system in the entity component. We have all the interfaces for the user so use the functionality of the system and show out according to input. The Database subsystem delivers storage-related functions. Users have different degrees of access to the database. When a query is issued to this subsystem, it first checks the access levels from the access control matrix to see if the query is valid and if the person who issued the query is eligible to receive the data. If the query is valid and the person who issued the query is eligible to receive the data, the query is processed and the result is returned to the person who issued the query. All other subsystem data must be stored and accessed in a clean manner. The Account Subsystem part has all the personal information of the users and engineers who are managing the application, their login sessions, etc. This module provides the facility of add, update and delete record functions. The Notification Module of the system has the setting related to the notification

that the application will send to user and this module has a function of view, open and receive notification.

27 Object Design

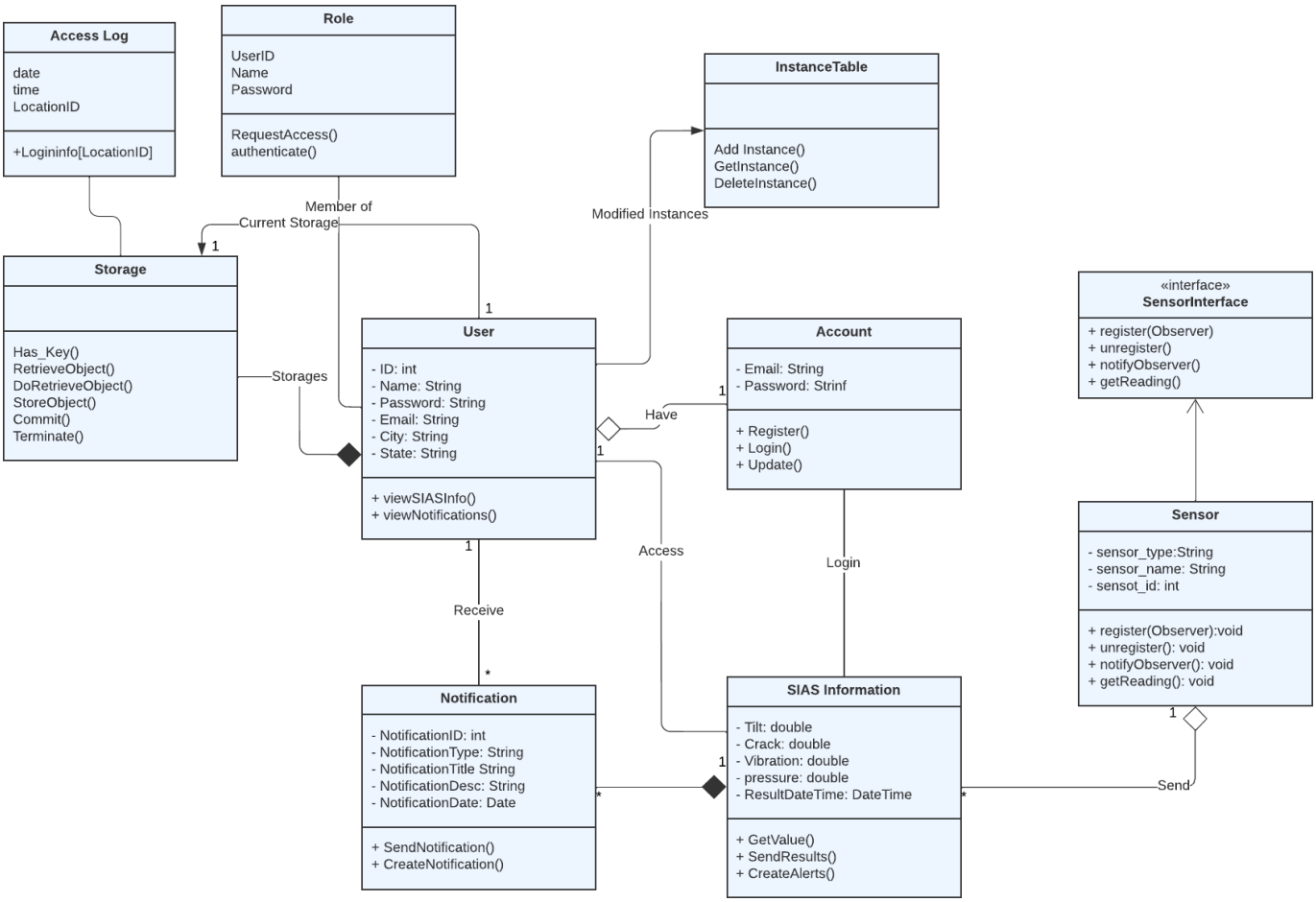

Fig 14. Object Design

27a Packages

It is advised that only one package be created to simplify development for the SIAS project developers. For ease and versatility, the same package will be utilized in all SIAS systems. The team and the project owners of the SIAS application are allowed to decide on the package's contents as well as a name that has meaning for them. The developers will be more lenient when creating the program and will be more careful with their work if they have this leeway.

27b Subsystem I

To fully function and do computations using data from sensors, the SIAS application here also requires hardware, therefore we can split it into two subsystems. The first subsystem houses all of the hardware-related components, including the sensors and the programming necessary for them to function.

27c Subsystem II

We can put the component of our software application in the second subsystem. This subsystem contains all of the code and information relevant to the SIAS application, making it easier for us to test our system. Once both systems have been through successful testing, we may carry out integration testing. The key advantage of breaking our system down into subsystems is that it will simplify our job and allow developers to create and build apps piecemeal, which will lessen the complexity of our SIAS application.

IV Project Issues

28 Open Issues

Following are some open issues that currently needs solving:

− Scalability in IoT systems has become an issue due to many devices demanding simultaneous connectivity. Despite these efforts, obstacles remain, such as the requirement for IoT nodes to provide a greater variety of services, such as functional scalability, access control, data storage, fault tolerance, and privacy and security, to mention a few.

− The lack of privacy standards and end-to-end security solutions has long been a worry for traditional IoT deployments, and wireless IoT has much greater difficulties in these areas. 23 Several hardware and software solutions are aimed at resolving privacy and security challenges. In terms of hardware, RFID, as well as later versions of 5G and other local network protocols, are critical in addressing security concerns. In terms of software, the Key Management System (KMS), which includes a zero-trust network feature, and blockchain are rapidly tackling privacy and trust problems with enhanced security features.

− Due to the expansion of IoT nodes, a paradigm change from Internet-of-Things to Internet-of-Everything is underway, necessitating new methods of autonomic administration to make the network proactive rather than reactive. The primary idea behind self-organization in IOT systems is to automatically and co-ordinately adjust to changing surroundings through the use of one or more control loops that reconfigure system behavior on-demand to maintain it within specified parameters.

29 Off-the-Shelf Solutions

29a Ready-Made Products

Tilt and Inclinometer Wireless Sensor

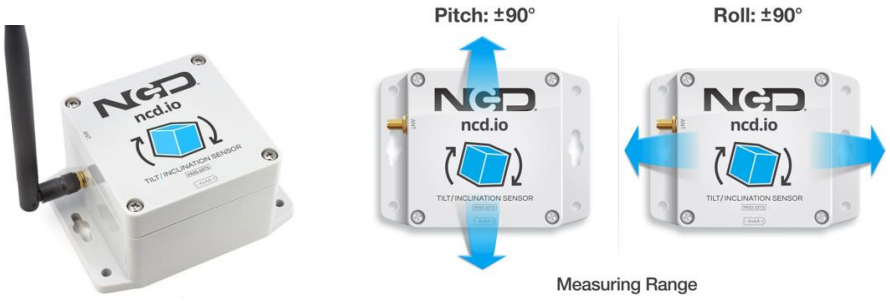

Fig.15 Tilt and Inclinometer Wireless Sensor [5]

Vibration Temperature Sensor

Fig.15 Vibration Temperature Sensor [6]

SIAS project consists of three parts of the development phases, such as censor development, software development, and system development. Some sensors such as Tilt and vibration censors are available on the current market. Since we are using same data from the Ready-Made products, it is feasible for us to use Ready-Made product instead of spending time on researching, testing, and going through legal issues for developing the sensors.

Since we host our service on Cloud to share real time data, we must use cloud service to host our application.

29b Reusable Components

When it comes to reusable components, it is important to set distinction that the sensors are maintained, not reused, for the safety and reliable concerns. Reusable components in SIAS project will be the software. To adopt the changes and grow of the product, the software designers should design the object model to be reusable using.

Cloud API is also a good example of reusable component that we can implement the API using Broker design pattern to handle different services. It contains the Proxy concepts that deliver the services.

29c Products That Can Be Copied

For SIAS project, we could copy two different models from existing products.

1. Sensors including tilt, crack, and vibration sensors can be copied and improved as specific to our project. NCD company makes super reliable and precise wireless sensors that we can either use or copy to improve the sensors for our project.

2. SIAS project can copy Cloud service such as Apple's iCloud service to provide user with data and resources needed for user's specific infrastructure. It allows us to utilize the cloud to exchange data, apps features, and upgrades without having to make any physical modifications to our hardware or software.

30 New Problems

30a Effects on the Current Environment

Content

Replacing battery after 300,000 transmissions average without a way to recycle properly could harm the environment. Also, the wireless radiation can harm trees, plants, pollinators, and wildlife such as bird's migration. Also, the adherence of sensors to the buildings are not absolute, so it may fall on pedestrians.

Motivation

Many infrastructures such as water dams, skyscrapers, and bridges are placed important locations between wildlife species and civilization. Since the magnetic radiation signals

might interrupt the earth magnetic field from reading directions for birds, we should have to consider to modify the transmission to reduce environmental impact.

Consideration

It is important to consider the surroundings of the structure. Environmental Causation should be documented and modified based on research. According to the research done by wildlife Biologist Alfonso Balmori, there was “significant low bird density was observed in areas with high electric field density.

The reproduction of wildlife is also reduced 0_86 ± 0_16 from 200meter of antennae, 1_6 ± 0_14 from 300meter antennae, and 2_36 ± 0_82 from further than 300meter from the antennae. It shows a significant improvement.

The research imposes the significant challenge to this project on environmental impact since it adds more magnetic field to the environment.

30b Effects on the Installed Systems

SIAS system depends on the sensor data where hundreds of sensors attached to a structure and transmits the data. It requires existing structure that holds the sensors. Except the environment, the sensor system does not impact on the structure itself.

30c Potential User Problems

Motivation

It is important to mention that there is no perfect user experience, but there is always better one. When we design the system, we focused both data and user centered system that provide real-time and user-friendly design.

Consideration

To improve the user experience, we should check the data correctness and cloud service that provide real time status to the user. Providing frequency, statistic, and predictive representation, SIAS system focuses to improve user experience and data precision.

30d Limitations in the Anticipated Implementation Environment That May Inhibit the New Product

In SIAS project, the sensors are not meant to be implemented underwater structure and remote structure where the network is not accessible. Also, there is implementing limitation in metropolitan areas, where the falling sensors can cause the problem without the proper solution.

30e Follow-Up Problems

Following Problems

Using sensors in un-controlled environment is one of the biggest problems when an application heavily relies on the transmitting data. Nature is known as challenge on sensor-based application - Hardware scope.

The service is depending on cloud service which is new in the industry - Software scope.

31 Migration to the New Product

31a Requirements for Migration to the New Product

Not Applicable

31b Data That Has to Be Modified or Translated for the New System

Not Applicable

32 Risks

When a project is being developed based on IoT technology and using cloud storage to revert the dynamic information there are multiple risk factors to keep in mind and be prepared to solve them as soon as possible when they are noticed. Risk is defined as any unexpected event that can have a positive or negative impact on your project. Risk can have an impact on anything, including people, processes, technology, and resources. The risks associated with this project are mentioned below:

- Inaccurate metrics
  Inaccurate metrics in the project can occur when data transferred from sensors to cloud storage has different unit values and the live statistics displayed in the application has incorrect visualization.

- Inadequate measurement
  Sensors installed on construction sites must collect data with high accuracy, as this has a significant impact on the project. Incorrect values sent to the user can lead to incorrect decisions, exacerbating the problem.

- Management malpractice
  Customers are distributing blueprints of their homes, government offices, and sensitive workplace areas. It must be ensured that those in charge of such sensitive projects using the application are dedicated and do not commit any malpractice that could cause problems for the entire enterprise.

- Low quality
  Low quality risk can have a negative impact on the overall business that is irreversible. It should be ensured that the software does not crash frequently and has an easy-to-understand and use user interface. The information should be displayed using dynamic color contrasting graphs which are easy to understand.

- Low productivity
  This application is expected to work well for a large number of sensors, which may be difficult for the user to manage. Furthermore, having 10^6 sensors may result in a significant decrease in productivity over time. It is the development team's responsibility to keep track of the software outputs and ensure their quality.

- Sensor Weakening
  Sensors deteriorate over time due to natural processes such as corrosion, oxidation, dust collection, and saturation. Some sensors used may degrade over time due to exposure to environmental conditions, physical-chemical events, or climatic events. Wind speed sensors, for example, can accumulate dust in dusty conditions, preventing the rods from moving. Copper-based sensors oxidize easily. As a result, the sensors produce inaccurate or inconsistent readings. Because of the sensors' inherent deterioration, they must be replaced on a regular basis.

33 Costs

The costs of developing a high-functioning and highly efficient application are expected to be high.

Here is a breakdown of the estimated costs.

- This project's inputs and outputs should make enough sense for the sensors to function properly.

- At the start, there should be several use case diagrams of this product to estimate the audience of the SIAS application, which will result in an estimate of the cost required to satisfy them.
- The functional requirements should meet everything mentioned in this document; additional requirements can be added as needed to complete our applications. Some of the sensors in our system are quite expensive.
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- The non-functional requirements should meet the above criteria; however, developers are free to change this based on popularity at the time of the SIAS application release if necessary.
- There must be events held to promote the SIAS and draw attention to the project's theme.

34 Waiting Room

The following are implementations that we would like to have but were unable to obtain.

- An alternative to placing sensors with some drone technology.
- Reduce sensor size which can lead to comfortable access.
- Live visualizations using data visualization techniques.

35 Ideas for Solutions

It is strongly advised that SIAS app developers focus on developing a chat bot that assists users in resolving primary issues and connecting to human support if the problem is not resolved. The application's metrics and positioning should be clear to the user and error-free. Provide an additional layer of security to ensure that there is no data breach. To stay competitive, developers and owners should hold in-person feedback sessions on a regular basis to generate new ideas and methods for developing software.

36 Project Retrospective

When it came to software engineering, the people in the group made a difference. We were open enough at the start of the semester to discuss each group member's strengths and weaknesses, which helped us focus on working on the weaknesses. Pair programming was a central theme in our group because it allowed the more experienced coders to teach others. We also collaborated to improve our presentation and writing skills. Our group used SCRUM method, which we all agreed worked best and produced excellent results. We always went back and fixed the report based on the reviews that were given for the development project as well. The one thing we could have done better was time management, which would have helped us relieve some of the stress, but in the end, we were pleased with the turn of events and the knowledge we gained in this course because it will allow us to easily design and develop any type of software application in the future.

V Glossary

1. Abutments- a structure built to support the lateral pressure of an arch or span
2. Strain- Ratio of hange in length
3. Tilt- horizontal displacement between the top and bottom of a structure
4. Load bearing- A structure is a structure in which the weight is transferred from the roof to the walls which transfers to the foundation

VI References / Bibliography

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