

Team 11 - TeamName

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## General Description of System

**Task:** Design and develop a system architecture that incorporates an artificial intelligent cognitive assistant combined with mixed reality technology that provides real time visual and auditory feedback to assist users to perform specific tasks. Our team is tasked with focusing on “knowledge transfer.”

This portion of the system deals only with taking information from instructions made for humans and translating it to computer readable instructions so that the Intelligent Assistant, which is the system that contains all the problem areas, can determine when to provide those instructions to the user. It takes information from a database which only contains information that is uploaded by whichever organization uses this Intelligent Assistant. This allows all information to be relevant, useful, and trustworthy when providing it to users.

In translating the information, it determines the type of information and uses APIs to analyze it. After analyzing the information, it converts it into computer readable form in order to allow the rest of the Intelligent Assistant system to determine when and if there is a proper time to provide relevant feedback or direction to the user.

To make the system approachable to the general public where minimal knowledge of utilizing the software will make the task and work flow more efficient, we will implement an admin information user interface. This UI will make input from the client/user seamless and approachable from all backgrounds. The prompt will instruct the user to upload relevant information in the form of instructions, whether that be checklists, training manuals, or videos. With the human instructional input, it will interact with the Database Management Software to send human instructions uploaded by the organization.

The data required for this operation will consist of task graphs stored in the main server database. These task graphs are constructed in the form of an instructional data tree consisting of nodes (instructions) in which the Intelligent Assistant can follow depending on the physical task at hand interpreted from the client/user with the given instructions. The system will traverse through a nodal tree independent of the software architecture which guides the Intelligent Assistant to the correct path in order to receive relevant information from the Database Management Software and return it back to the client/user.

**Users:** General public workforce, primarily occupations that rely on constantly evolving cutting edge technologies, such as the medical or mechanical engineering field. In order to keep up with the research and development of new technologies, this system architecture will be updated to the most recent developments in the field. Doing so will keep the public workforce up to date on difficult and specific tasks.

### Main Functions:

- Receive data from an organization related to various tasks the user could perform
- Translate the data uploaded by the organization to computer readable format
- Store translated and untranslated data on a database for just-in-time guidance

- Provided the translated data to the rest of the Intelligent Assistant system to provide relevant information to the user

## Usage Scenario

### **Scenario 1: Using information from the database**

1. John begins working on cars throughout the day using the Intelligent Assistant system after having already uploaded company manuals and instructions.
2. John begins work on a 1997 Toyota Camry and needs to change the spark plugs.
3. While he's working on the car, the Intelligent Assistant asks the Database Management Software to pull up all information in the manuals on that specific car.
4. The database translates all the relevant information and sends it back to the Assistant.
5. John asks what the gap is for the spark plugs of this car.
6. The assistant pulls up the task graph for replacing spark plugs and pulls information on gapping, including a chart with that tag.
7. The assistant shows this information to John.
8. John uses the gap chart to align his tool and gap the spark plugs.

### **Scenario 2: Administrator updating the database with new manuals after the company receives updated machinery.**

1. Steve receives notice that the company's research department has acquired a new set of advanced, state of the art microscopes, and is asked to update any relevant information in the headset's database.
2. Steve compiles all the manuals included with the microscopes, and scans them into PDF files.
3. Steve opens up the administrator panel, and logs in using his credentials.
4. The panel prompts Steve with a series of options (upload files, remove files, and user administration)
5. Steve clicks on 'upload files'
6. Steve selects the PDF manuals and uploads them using the interface.
7. The panel shows a loading bar, stating that it is parsing the PDF manuals. The database uses their format converter to read all the scanned text and uses the translation software to convert them into computer readable task graphs, before storing them into the company's database.
8. After a short period of time, the loading bar finishes and Steve is sent back to the home screen.
9. Steve logs out of the administrator panel.
10. Steve puts on a headset to check the newly added instructions. He faces one of the new microscopes and asks how to turn it on.
11. The assistant responds in detail to how to turn the microscope on.
12. Steve removes the headset and notifies users that the manuals on the new microscope has been added to the headset's database.

### **Scenario 3: Lead mechanic uploading a safety training video on a specific machine to the database.**

1. Bob decides to create safety training videos for his junior mechanics on a complex machine after a recent workspace incident.
2. Bob records several training videos and saves them as mp4 files.
3. Bob opens the administrator panel, and logs in using his credentials.
4. The panel prompts Bob with a series of options (upload files, remove files, and user administration)
5. Bob clicks on 'upload files' and uploads the mp4 files.
6. The files are uploaded to the server. The server converts the videos into task graphs using the translation and format converter components, and stores them into the database.
7. Bob logs out of the administrator panel.
8. Bob puts on a headset and asks how to operate the machine.
9. The assistant responds in detail about how to operate the machine, and also includes safety precautions that were noted in Bob's safety training videos.

**Scenario 4: Woodworker uses a new machine for the first time and relies on the headset's guidance.**

1. Mark the woodworker gets a new and improved bandsaw, and wants to begin using it.
2. Mark had already uploaded the manuals to his headset's database while setting up the bandsaw.
3. As Mark approaches the machine, the Intelligent Assistant queries the Database Management Software for all the information related to the bandsaw.
4. Mark asks for the instructions on using the bandsaw.
5. The assistant pulls up the task graph of how to operate the bandsaw, and leads Mark through the initial process step by step.
6. Mark begins using the bandsaw.
7. Using the information provided in the safety manual, the Intelligent Assistant recognizes that Mark is putting his hands too close to the blade.
8. The assistant displays a warning to Mark about the safety hazard, and Mark moves his hands further away.
9. Mark finishes using the machine and asks the assistant how to turn it off.
10. The assistant pulls up the task graph for using the machine, and looks for the procedure to shut down the machine.
11. The assistant shows Mark how to turn the machine off.
12. Mark safely turns the machine off.

**Scenario 5: Intelligence Assistant queries data from the server.**

1. The intelligence assistant is currently assisting the user with ship engine repairs on an older ship model.

2. The intelligence assistant sends a request to the server for all related information about the ship engine using a query string containing tags such as the ship model, engine type.
3. The server searches the database for the appropriate information and sends it to the translation software to be turned into computer readable output.
4. The server returns a task graph describing all the procedures and information on the ship engine.
5. The intelligence assistant finishes assisting the user with the repairs, and the user moves onto repairing the ship rudders.
6. The intelligence assistant sends a request to the server for all related information about the ship engine using a query string containing tags such as the rudder type.
7. The server searches the database again for relevant information, sends it through the translation software and returns a task graph describing all the procedures and information on the ship rudder.
8. The intelligence assistant finished assisting the user with the rudder repairs.

## User Stories

### **User Stories 1: Using information from the database**

1.1) As a mechanic, I need to pull up specific and accurate information about a variety of cars that may come into our shop, since I cannot remember every bit of it from the manuals.

1.2) As a mechanic, I need the right information quickly and at the right time in order to continue working in a timely manner.

### **User Stories 2: Administrator updating the database with new manuals after the company receives updated machinery.**

2.1) As an administrator, I need to be able to upload manuals of the machinery my users are working with so they can use the machinery with the help of the headset.

2.2) As an administrator, I need to be able to update information on the database frequently to avoid outdated information for my users.

2.3) As an administrator, I want to update information to all my users quickly so they can begin working without any unnecessary delays.

### **User Stories 3: Lead mechanic uploading a safety training video on a specific machine to the database.**

3.1) As a lead mechanic, I want to upload training videos of certain machinery to show my juniors how to use the machinery safely.

3.2) As a lead mechanic, I want the safety information I upload to be translated clearly to avoid any misunderstandings for the users that could lead to dangerous situations.

**User Stories 4: Woodworker uses a new machine for the first time and relies on the headset's guidance.**

4.1) As a woodworker, I want to upload user and safety information about my machines to the headset so I can work with machines I have little experience with.

4.2) As a woodworker, I want to pull up information about how to use certain machines in my workshop so I can streamline my work process between multiple machines.

4.3) As a woodworker, I want to be notified of any safety issues I encounter so I can stay safe while operating potentially dangerous machinery.

**User Stories 5: Intelligence Assistant queries data from the server.**

5.1) As the intelligence assistant, I want to receive specific information in the form of a task tree from the server so I can assist my user with the tasks at hand.

5.2) As the intelligence assistant, I want to query multiple requests one after the other so I can continue assisting my user for a long period of time.

## Logical Architecture of Software

**Software components:**

Translation Software

- Description
  - This component takes human readable instructions from the Database Management Software and translates them into computer readable task graphs. This software uses the Format Converter in order to translate the data into these task graphs for the computer. It takes the text-based information generated from the Format Converter and parses it to build task graphs that the rest of the system can use to determine when the user might need that information.
    - It sorts the information by various subtasks based around the tags created by the Format Converter and then sends these groupings of task graphs back to the Database Management Software so that it can be stored until needed
- Interactions and relationships
  - Interacts with the Format Converter, sending data over that needs to be converted into a parsable format
  - Interacts with the Database Management Software to receive the data that needs to be translated to a computer readable format
- Identification
  - Translation Sorting Software
    - Subcomponents: Format Converter Software

- Purpose
  - To generate computer-interpretable task graphs
  - To sort the task graphs and send it back to the database
- Interfaces with other components
  - Shares data with the Database Management Software to both receive and send data

## Format Converter Software

- Description
  - This component takes information provided by the Translation Software and converts it into a format that the translator can read and make task models out of. It takes in any type of file format and converts it into a text format which can be parsed by the Translation Software.
    - For video and image content, it will utilize Amazon's AWS Rekognition API. This API provides the capability to analyze images and videos for objects or text/character recognition.
      - For images, it will create tag-based descriptions on the images in order to allow the Translation Software and Database Management Software to organize and reference these tags, and thereby the images associated with the tag
      - For videos, it similarly analyzes each part of the video and generates tag-based descriptions based on various parts of the video. These are time stamped so they can be referenced later by the Translation Software and Database Management Software
      - Each tag based description is generated by AI which recognizes the objects and the text, characters, or shapes in the image or video
    - For manuals and text based content, it will parse the content using Apache OpenNLP API in order to tokenize the text. This will break the text up into parsable segments which allows the Translation Software to organize it. The AWS Rekognition API will be used on any images associated with the text and then use that API to analyze the images.
    - For audio content, it will use the Happy Scribe API, which is an audio transcription software that translates audio into text.
- Interactions and relationships
  - Interacts with the Translation Software, taking data and converting it into text-based format in order to be parsed
- Identification
  - Format Converter
    - Subcomponent of the Translation Software
- Purpose
  - To utilize various APIs in order to translate various files into a text-based format to send to the Translation Software
- Interfaces with other components

- Shares data with the Translation Software, receiving data to be converted and sending back converted data

## Database Management Software

- Description
  - This component is a custom software which interacts with the various other components and manages the information on the database itself. This software connects all the other components together and connects it to the other parts (problem areas) of the Intelligent Assistant system. It keeps track of and indexes the information uploaded by an organizational admin via the Admin Information UI. It passes information off to the Translation Software to be translated into a computer readable format. After the instructions have been translated, they are stored and kept until requested by the Intelligent Assistant to present to the user.
- Interactions and relationships
  - Interacts with the Translation Software by sending the data that needs to be translated over and receiving it back to be stored
  - Interacts with the Admin Information UI in order to receive the human instructions uploaded by the organization or whoever is using the assistant
- Identification
  - Database Management Software
    - Subcomponent: Admin Information UI
- Purpose
  - To receive human instructions from the Admin Information UI and store them
  - To send human instructions to be translated to computer-interpretable task graphs
  - To store task graphs to be accessed when required by the other problem areas
- Interfaces with other components
  - Shares human instructions with the Translation Software
  - Gains human instructions from the Admin Information UI
  - Gains computer readable task graphs from the Translation Software

## Admin Information UI

- Description
  - This component provides the user interface where an organizational admin can upload relevant documents and information to the database, including checklists, illustrated manuals, and training videos. These are only the human instructions that need to be translated to computer readable task graphs so the system can determine when to provide the information.
    - Prompts the user to upload all relevant instructions, whether that be checklists, training manuals, or videos.
- Interactions and relationships
  - Interacts with the Database Management Software to send human instructions uploaded by the organization using the system
  - Interacts with the organization by receiving human information from an admin

- Identification
  - Admin Information UI
    - Subcomponent of the Database Management Software
- Purpose
  - To allow an organization to upload relevant information to the database to be translated
- Interfaces with other components
  - Shares data with the Database Management Software

### **Workflow of Main Function:**

An organization uses the Admin Information UI to upload all training materials, including various videos, manuals, and checklists. The Admin Information UI takes the content uploaded and sends it over to the Database Management Software. The Database Management Software receives the human instructions and sends them over to be translated by the Translation Software. The Translation Software begins sending the various content over to the Format Converter Software in order to make it text-based. The Format Converter Software uses a variety of API to reformat the data into a more computer readable format. It then sends this data back to the Translation Software, which then parses this data into task graphs using the tags generated. It organizes the task graphs and data into groupings and sends it back to the Database Management Software to be stored. The Database Management Software waits for the Intelligent Assistant to prompt it for specific task graphs or information. It then sends that information over to it so that it can display it to the user in the most relevant and helpful way.

## Physical Architecture of Hardware

### **Hardware Components:**

#### Database Server

- Identification
  - Database system using SQL
- Purpose
  - To provide space for the information gathered by the Information software
  - To provide a space where the translation software can translate the stored information into task models for the user
- Software Component it Receives
  - It contains the Translation Software, the Database Management Software, and their subcomponents: the Web Scraper component and the Format Converter component.
- Technical Characteristics
  - Server containing a CPU and 64 GB of RAM for our software to process data
  - Containing 100 TBs of active hard drive space to store all of the information gathered for the user
  - GPU to provide a UI for the database and the Admin Information UI



- 1 Gbps WiFi Card/Ethernet to connect to the Intelligent Assistant and retrieve and supply it with information
- Network Hardware Interfaces
  - It connects to whichever device is managing the other problem areas and the user's device in order to send over the task models for the user

## Justification of Technical Choices

The technical choices made are cost effective, flexible, and maintainable while still being within the scope required for the overall system. The potential costs of hardware and software upgrading is outweighed by the benefit of quick and effective data transfer and conversion into appropriate formats.

### Translation Software

This software component is necessary because of its interaction with other essential components of the larger system. For the transfer of knowledge, the data being transferred must be readable by every component of the system, therefore a software that takes human readable instructions and translates them into computer readable task graphs is required for the larger system to run effectively and efficiently.

### Format Converter Software

This software component is necessary because the data uploaded to the database and sent over to the Translation Software might be in a variety of formats. The APIs deployed here allow the organization to upload any and all materials they have in any format. It transcribes them all into a text-based format which is easier to parse and create a more computer readable task graph. The APIs are chosen because they are known for being highly efficient and can provide the services needed for all the format types. Amazon's AWS Rekognition does cost some money but it is pay per use so therefore it isn't a subscription and is cost efficient in the long term. The Apache OpenNLP API is free and is able to implement everything necessary to parse text content, such as articles and manuals, and token them into a referenceable format. Happy Scribe API is one of the more reliable transcription softwares out there. It's pricing model makes it so that it's only \$0.20 for every minute of content, which is relatively cheap compared to other software which average over \$1 per minute.

### Database Management Software

This software component is necessary because storing and organizing a large amount of data is important when it needs to be referenced quickly by other system components. It provides a single entity to be called upon for the knowledge transfer and creates a single efficient pipeline to all components.

### Admin Information UI

This software component is necessary to provide a space that an organization or user can upload their relevant instructions. This allows the user to ensure that the information is credible and accurate. A user can provide as much information as they want to the database since it is

built to hold a lot of data, which can be referenced by the user using the Intelligent Assistant in the most relevant and helpful way.

Database Hardware

The technical hardware characteristics for the database were chosen based upon research into real world databases. There needed to be a massive amount of memory usage so 64 GB of RAM was chosen in order to allow the database to run all the software at once. Each software component, and particularly the Translation Software, require lots of RAM in order to manage that much data. In order to store the massive amount of data required for this database, 100 TBs allows the organization to provide as much information as it wants. The database also holds both translated and untranslated information therefore having that amount of storage is necessary to hold all that information. There also must be high speed internet connections for communication between the rest of the Intelligent Assistant system and the database so 1 Gbps was chosen for the wifi card and ethernet capabilities. A CPU and GPU are also required in order to run the database and allow it to be managed by the organization.

Traceability Matrix (attached separately as well)

Components	User Requirements (User Stories)				
Database Management Software	1.2 As a mechanic, I need the right information quickly and at the right time in order to continue working in a timely manner.	5.2 As the intelligence assistant, I want to query multiple requests one after the other so I can continue assisting my user for a long period of time.	2.3 As an administrator, I want to update information to all my users quickly so they can begin working without any unnecessary delays.		
Format Converter Software	2.1 As an administrator, I need to be able to upload manuals of the machinery my users are working with so they can use the machinery with the help of the headset.	3.1 As a lead mechanic, I want to upload training videos of certain machinery to show my juniors how to use the machinery safely.	4.1 As a woodworker, I want to upload user and safety information about my machines to the headset so I can work with machines I have little experience with.		
Translation Software	1.1 As a mechanic, I need to pull up specific and accurate information about a variety of cars that may come into our shop, since I cannot remember every bit of it from the manuals.	3.2 As a lead mechanic, I want the safety information I upload to be translated clearly to avoid any misunderstandings for the users that could lead to dangerous situations.	4.3 As a woodworker, I want to be notified of any safety issues I encounter so I can stay safe while operating potentially dangerous machinery.	4.2 As a woodworker, I want to pull up information about how to use certain machines in my workshop so I can streamline my work process between multiple machines.	5.1 As the intelligence assistant, I want to receive specific information in the form of a task tree from the server so I can assist my user with the tasks at hand.
Admin Information UI	2.1 As an administrator, I need to be able to upload manuals of the machinery my users are working with so they can use the machinery with the help of the headset.	2.2 As an administrator, I need to be able to update information on the database frequently to avoid outdated information for my users.	4.1 As a woodworker, I want to upload user and safety information about my machines to the headset so I can work with machines I have little experience with.		
Database Hardware	1.2 As a mechanic, I need the right information quickly and at the right time in order to continue working in a timely manner.	2.3 As an administrator, I want to update information to all my users quickly so they can begin working without any unnecessary delays.			