# Mini Project Proposal:
# Low-cost Companion Robotic Pet Dog

**Team Member Names:**

Kai Chuen Tan

Vidya Raghvendra

Sally Lei

**Stakeholder Partner Names:**

Dr. Stacey Vieyra-Braendle

Dr. Christine Grosso

# Project Overview and Motivation

Dementia affects tens of millions of people worldwide and the number is ever-growing. Those affected by dementia gradually lose their cognitive functions whilst developing a stronger sense of confusion as well as disconnection from the world. To help alleviate such symptoms of dementia, sensory stimulus plays a huge role. Sensory stimuli can evoke positive emotions, memories, or thoughts that help those with dementia relate to the present. Sensory stimulation can be brought about by scents, sounds, and various forms of interactions including interactions with small pets. To help provide sensory stimulation to people with dementia, we will be building an interactive robotic pet dog that will mimic a realistic dog for our project. By imitating the behavior of an actual dog, our robotic dog will allow for realistic and positive engagement that will properly stimulate those with dementia and allow them to feel a form of connection with the world. The robotic dog will also be made to appear "alive" with its warmth emitting and heartbeat features. Such features contribute to the realness of the pet and increase the amount of comfort the pet provides. In addition, the pet robot will carry a detachable busy blanket. The busy blanket adds an extra layer of interactivity and can aid in calming anxious and fidgety users. Overall, our robotic dog aims to soothe its user while also providing them with positive stimulus.

# Project Plan

Prior to implementing the features of our robot, we will first design a frame for the robotic pet dog based on the dimensions of the stuffed dog we acquire. From there, we will determine where to add other technical components (controller, motors, and sensor) of the robot to the frame and confirm that the frame along with the added items will fit into the stuffed dog. After creating the frame with either firm cardboard or polystyrene and deciding the placement of technical components, we will move on to adding the interactive and physical features of the robot.

The interactivity of the robotic dog revolves around its reaction to being petted. The dog will react when petted on either the head (between the two ears) or the belly. On the head and belly of the pet, there will be pressure sensors. When an appropriate amount of pressure is applied on either of the two sensors, a content reaction will be invoked in the pet dog. The content reaction consists of the dog wagging its tail, nudging its head (against the user if the user is petting it), and purring to express satisfaction. For the tail to wag, a servo will be added at the end of the robot's skeleton. As the tail starts off at the center, the servo will initially turn about 45 degrees to move the tail in one direction. Then, the following movements will be that the servo will turn 90 degrees in the other direction before turning 90 degrees back in the initial direction again. This process will repeat several times to create the action of tail wagging. On the final

wag, instead of turning 90 degrees, the servo will turn 45 degrees opposite of its current direction to return to its center position. For the head nudging, a servo will be added to the neck of the skeleton of the robot. As the range covered by neck movement is not as great as tail movement, the servo at the neck will spin a smaller number of degrees. Much like the tail, the head of the robotic dog starts at the center of the body. It will initially turn 22.5 degrees in one direction. Then, it will continuously turn 45 degrees in the opposite direction and 45 degrees back in the initial direction again. On the final turn, it will turn 22.5 degrees opposite to the side it is currently on to return to the center position. Finally for the purring feature, a small audio player with a recorded sound of a dog purring would be placed at the head of the robotic dog's frame. This audio will play, pause for about 2 seconds, then play again as the dog is being petted.

The content, happy reaction invoked in the dog comes to a stop when either the user stops petting or when 30 seconds from when the reaction was invoked has passed – whichever of the two occurs first. No matter the reason for the halt, the servos in the pet dog will finish full movements before doing half movements to return the head and tail to the center position. If the dog is purring when called to halt interaction, the audio will finish playing to prevent an unnatural halt in the vocalness of the pet. If the stop was caused because 30 seconds have passed and the user is still continuously petting the pet without having removed their hands, then after 3 seconds of pause, the content reaction will be invoked again. If the pet reaction stopped because the user removed the pressure they were applying on the dog, then the reaction will be invoked again after the user applies an appropriate amount of force to either the head or belly of the pet.

In addition to the features described above, we also propose the implementation of features such as the ability for the robot to play calming music for the user, and also play loved ones' voices. Note that this feature is under consideration but not finalized, as stakeholders pointed out that it might be very useful for some patients and disorienting for others.
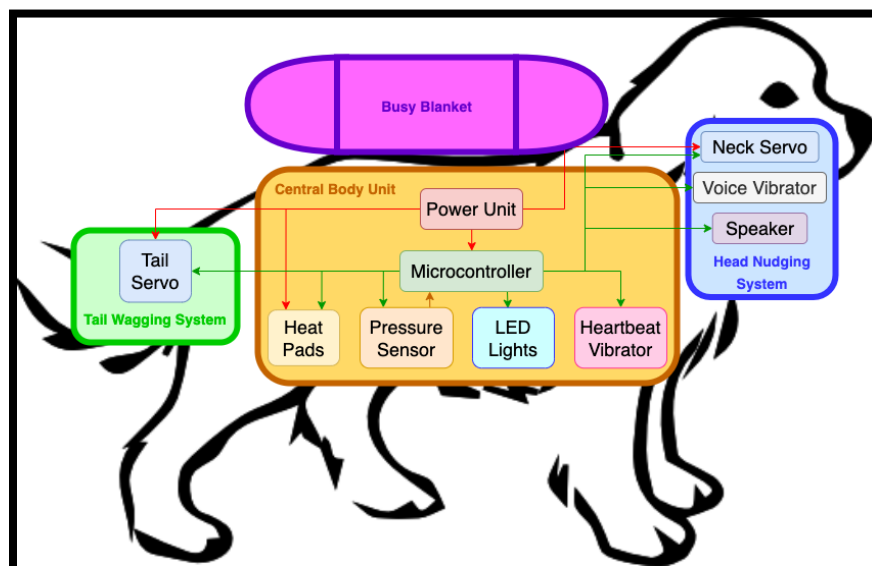
**Figure 1:** *Low-cost Companion Robotic Pet Dog Conceptual Diagram*

*Figure 1* illustrates all of the electronics components needed (i.e., two MG996R high torque servo motors, a 3S Lipo Battery, a 5V voltage regulator, an Arduino UNO microcontroller, four Adafruit electric heating pads, an RGB LED ring lamp light, two vibrating mini motor discs, and a speaker) to build a fully functional low-cost companion robotics pet dog with an add-on detachable, customizable, and personalized busy blanket. The companion robotic pet dog consists of several interesting interactive features including tail wagging, head nudging, and vibrational purring while the user is petting the robot. Furthermore, the companion robotic pet dog can simulate the body heat and heartbeats of a real dog with heating pads and a heartbeat vibrator to enhance users' petting experience. To help patients with neglect post-stroke, the body of the companion robotic pet dog can glow using the RGB LED ring lamp light to catch patients' attention. Last but not least, the patients' favorite busy blanket is strapped to the companion robotic dog pet body, and the busy blanket can be unfolded on top of the companion robotic pet dog body. The purpose of the busy blanket is to help to calm and soothe dementia patients– thanks to the variety of textures that the blanket includes, patients have the opportunity to use their hands, which helps them focus and fidget less.

| Task Name | Description | Leader |
|---|---|---|
| Electronic Circuit Design | Design and implement an electronic circuit system of the companion robot with Fritzing. | Kai Chuen Tan |
| Structural Design | Design the skeleton parts of the companion robot with SolidWorks based on the design of the off-the-shelf stuffed puppy dog. | Kai Chuen Tan |
| Manufacture and Purchase Parts | 3D-print skeleton parts with TPU material (soft and flexible) and purchase necessary hardware. | Kai Chuen Tan |
| Assemble Hardware Components | Assemble the skeleton parts and the electronic hardware. | Sally Lei |
| Design Testing and Software Debugging | Check whether the parts fit perfectly, ensure the robot can function as intended, and improve the overall user experience by re-iterating certain parts of the design and optimizing the software performance. | Sally Lei |
| Busy Blanket Customization and Integration | Buy an existing busy blanket and customize the design of the busy blanket. | Vidya Raghvendra |

*Table 1* presents a detailed list of key technical tasks with a brief description that is required to complete to build a successful low-cost companion robotic pet dog prototype. Kai Chuen Tan is mainly in charge of the hardware design of the prototype, which includes the electronic circuit design, structural design, and manufacturing parts. Next, Sally Lei will be in charge of assembling hardware components of the companion robotic pet dog, design testing, and software debugging to ensure the parts fit perfectly and the robot functions as intended. Lastly, Vidya Raghvendra will be responsible for the busy blanket customization and integration to ensure the design of the busy blanket is specifically customized for the stakeholders and can be assembled with the companion robotic pet dog. *Table 2* below shows further detailed descriptions of how testing will happen.

| Module | | Testing Method | Metrics |
|---|---|---|---|
| **Heat Generator** | Generate the body heat of a real dog. | Ensure heating pads generate the body heat of a real dog using a thermometer. | The temperature of the generated heat is between 38.3 °C and 39.2°C. |
| **Heartbeat Generator** | Simulate the heartbeats of a real dog. | Ensure the heartbeat vibrator simulates the normal heartbeats of a dog by measuring and counting with hands. | The normal heartbeat rate of a dog is between 60 bpm and 140 bpm. |
| **Interactive Petting Features** | Wag its tail while it is being petted on the belly. | Verify whether the tail servo is responsive when the pressure sensor senses touch pressure. | Tail wagging speed, and latency. |
| | Nudge its head gently while it is being petted on the belly. | Verify whether the neck servo is responsive when the pressure sensor senses touch pressure. | Head nudging speed, and latency. |
| | Generate friendly purring sounds with vibration. | Verify whether the speaker and vibrator are activated and responsive when the pressure sensor senses touch pressure. | Dog purring sound accuracy, and latency. |
| **Busy Blanket Design** | Detachable and wearable busy blanket for the robot. | Test whether the modified busy blanket can be fitted onto the body of the companion robotic pet dog body. | Style, and fitability |

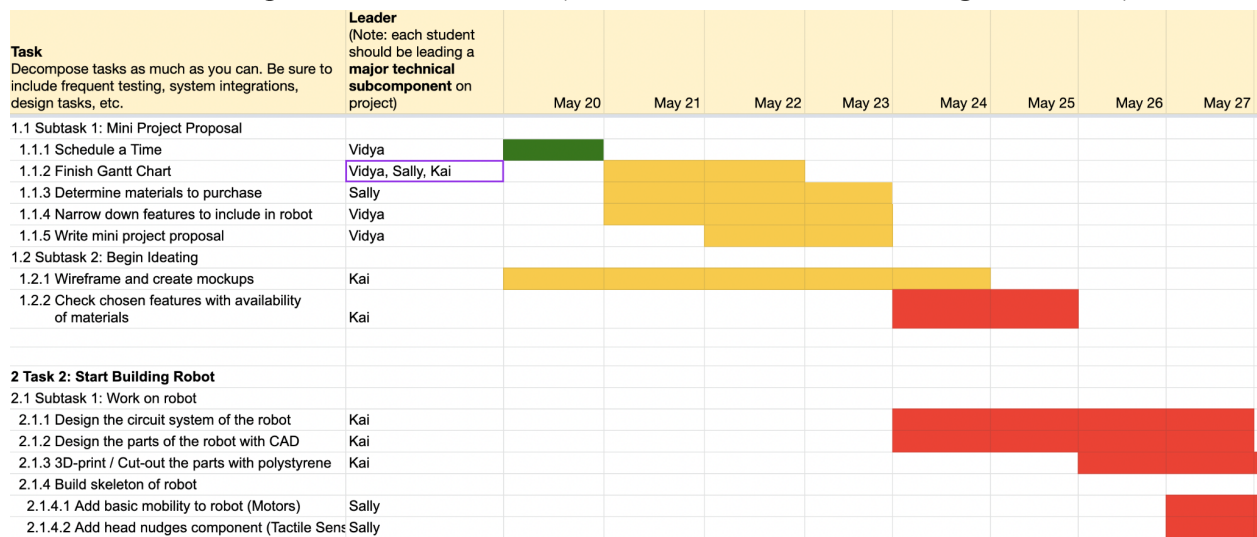| | The body of the robot will glow and blink when it is not petted for a certain amount of time during the day. | Ensure the robot only glows and blinks when it is not petted for a certain amount of period during the day (not night) to keep the user busy. | Accuracy |
|---|---|---|---|
| **Prompt for Attention** | | | |
| **Test Design** | The companion robotic pet dog provides an enjoyable and useful experience. | Ask volunteers and stakeholders to assess the interactive petting experience and the usefulness of the busy blanket design. | Individual impressions, and preferences. |
| | Battery Test | Determine how long the companion robotic pet dog can last. | Battery longevity. |

**Table 2:** *Plan for How the Functionality and Usability of the System will be Tested.*

# Gantt Chart

Gantt Chart:
https://docs.google.com/spreadsheets/d/16Fd_LOSANa664yL1ZhnGjdAvpOIzxt57i72JWegn4os/edit#gid=0

Screenshot of small part of the Gantt chart (since the whole chart is too large to include):

# Supply Needs

Supply order spreadsheet:
https://docs.google.com/spreadsheets/d/1EKlJy5drCle3xalmxJRjPFYi3WrqHj09wVjdhP0zv4k/edit#gid=0

| Object | Have or Need | Who has it? |
|---|---|---|
| Arduino | Have | Kai, Sally, and Vidya |
| Servo motors | Have | Kai, Sally, and Vidya |
| LEDs | Have | Kai, Sally, and Vidya |
| Adafruit Electric Heating Pad | Need | https://www.amazon.com/Adafruit-Electric-Heating-Pad-ADA1481/dp/B00SK6M0AO |
| Aurora World Inc. Plush Dog | Need | https://www.amazon.com/Aurora-World-Flopsie-Goldie-Labrador/dp/B00124X5YQ/ref=sr_1_3?keywords=aurora%2Bgolden%2Bretriever&qid=1653097522&sr=8-3&th=1 |
| Adafruit Square Force-Sensitive Resistor | Need | https://www.adafruit.com/product/1075 |
| Fabric Squares | Need | https://www.amazon.com/Fabric-Squares-Organic-Patterns-Pictured/dp/B08GYFLLVY/ref=sr_1_6?keywords=tactile+fabric+swatches&qid=1653231107&sprefix=taqctile+fabric+%2Caps%2C153&sr=8-6 |

| | | |
|---|---|---|
| Yarn | Need | https://www.amazon.com/Lily-Sugarn-Cream-Ombres-Creamsicle/dp/B002PNNO44/ref=sr_1_15?crid=2NQB7UEV323Y5&keywords=yarn&qid=1653291788&refinements=p_85%3A2470955011&rnid=2470954011&rps=1&sprefix=yarn%2Caps%2C140&sr=8-15# |
| Assorted pom poms | Need | https://www.amazon.com/Assorted-Colorful-Pompoms-Creative-Decorations/dp/B085L6D7R4/ref=sr_1_7?crid=1DOVDWY7VELI7&keywords=pom+poms&qid=1653087673&refinements=p_85%3A2470955011&rnid=2470954011&rps=1&sprefix=pom+poms%2Caps%2C163&sr=8-7 |
| Buttons | Need | https://www.amazon.com/Buttons-Assorted-Sewing-Childrens-Painting/dp/B09MQLX5RG/ref=sr_1_9?crid=T1AIVNW7LSZ9&keywords=assorted%2Bbuttons&qid=1653087212&refinements=p_85%3A2470955011&rnid=2470954011&rps=1&sprefix=assorted%2Bbuttons%2Caps%2C138&sr=8-9&th=1 |
| Small pet blankets | Need | https://www.amazon.com/luciphia-Blankets-Premium-Blanket-Flannel/dp/B07DF6DDNM/ref=sr_1_2?crid=2L6MT5LAWCTC4&keywords=small%2Bblanket%2Bpet&qid=1653087006&sprefix=small%2Bblanket%2Bp%2Caps%2C121&sr=8-2&th=1 |