Project Notes:

Project Title:

Name: Thinagar, Nichelle

Note Well: There are NO SHORT-cuts to reading journal articles and taking notes from them. Comprehension is paramount. You will most likely need to read it several times, so set aside enough time in your schedule.

Contents:

Knowledge Gaps:

This list provides a brief overview of the major knowledge gaps for this project, how they were resolved and where to find the information.

Knowledge Gap	Resolved By	Information is located	Date resolved
Idea validity confirmation	Dr. Ava Lakmazaheri	N/A?	10.11.25 (will be)

Literature Search Parameters:

These searches were performed between 07.13.2025 and 10.10.2025
List of keywords and databases used during this project.

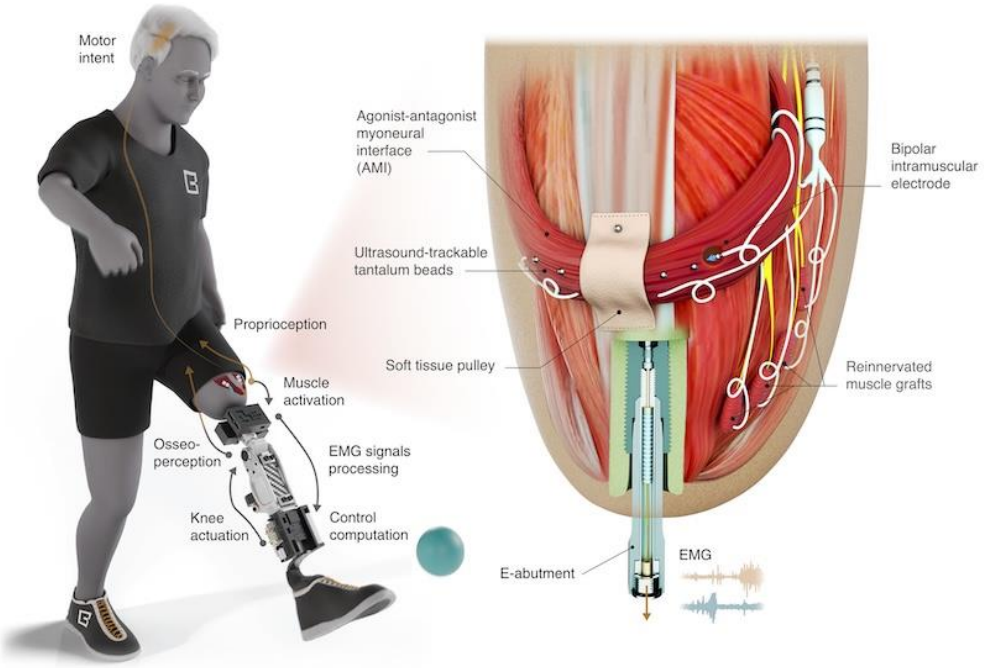
Database/search engine	Keywords	Summary of search
IEEE	Humanoid robot	Got research on various humanoid robot designs and HRI-friendly control systems
IEEE	Semi soft robotic joint	Nothing all too helpful
IEEE	Bellows joint	Got research on pneumatics-based joints with helpful references
IEEE	Continuum actuators	Helpful study on continuum actuators (wanted to full understand what characterizes infinite degrees of freedom)

Tags:

Tag Name	
bellows	soft
actuation	continuum
DOF	omnidirectional

Article #1 Notes: Tissue-integrated bionic knee restores versatile legged movement after amputation

Source Title	Tissue-integrated bionic knee restores versatile legged movement after amputation
Source citation (APA Format)	
Original URL	
Source type	
Keywords	Prosthetics, agonist-antagonist, neural control, amputation, myoneural interface, closed-loop control, osseointegration, reinervation
#Tags	N/A
Summary of key points + notes (include methodology)	This article discusses the development of the Agonist-antagonist Myoneural Interface (AMI), which is a device integrated into a patient's residual limb, specifically the knee at the time of amputation. This device allows two-way communication between the patient and the prosthesis, allowing finer control over the device. The device also includes metal beads embedded in muscle fibers in the region to track the movement (contraction and extension) of the agonist-antagonist muscle pair (quadriceps and hamstrings) to predict intent and help determine the prosthesis's movement.
Research Question/Problem/ Need	Prostheses do not afford patients the same level of control and sensation of their limb as organic tissue and do not have the same closed-loop control.

Important Figures	
VOCAB: (w/definition)	N/A
Cited references to follow up on	N/A
Follow up Questions	1. What does the process of reinnervation entail? Does this have to be done at the time of amputation, or is AMI an option for those who are already amputees? 2. Are OMPs an option for upper-limb prostheses? Has this been previously discussed? 3. Can reinnervation apply to the spinal cord? 4. Are there ways to replicate AMI's behavior with SEMG or other less intrusive technologies? 5. Are there any long-term impacts on blood cell production caused by osseointegration?

Article #2 Notes: Seminar on Swarm Robotics and Fairness Consideration in Swarm Mechanics

Source Title	Whole New Worlds: Multi-Agent Systems for Advanced Air Mobility, Aerial Sensing, and More - Prof. Hamsa Balakrishnan
Source citation (APA Format)	Balakrishnan, H. (2025). *Whole new worlds: Multi-agent systems for advanced air mobility, aerial sensing, and more* [Lecture]. Personal communication.
Original URL	N/A
Source type	Lecture/Personal Communication*
Keywords	Swarm robotics, multiplexing tasks, optimization, fairness, efficiency
#Tags	Swarm robotics, swarm mechanics, swarm behavior
Summary of key points + notes (include methodology)	The speaker discussed the current ways of defining swarm mechanics, often to either maximize efficiency (max throughput – most tasks completed) or maximize fairness (greatest balance of tasks). However, these approaches do not allow for high-efficiency swarm mechanics or giving certain tasks more weight. To efficiently and equitably multiplex tasks, this researcher's group developed MOBIUS which uses max-min fairness calculation (tries to balance extremes) and LLMs for task decomposition to get the perfect balance of efficiency and fairness.
Research Question/Problem/ Need	Swarm robotics and swarm mechanics are often optimized for efficiency, however, they rarely account for fairness (balance) between independent tasks, thus resulting in imbalances in how many times a certain task is completed or in what order tasks are completed in.
Important Figures	N/A
VOCAB: (w/definition)	Multiplex: combining multiple functions or tasks onto a single robotic platform or across the entire swarm
Cited references to follow up on	N/A
Follow up Questions	- How can fairness be taken into account in other robotic systems? - Can MOBIUS give preference to tasks based on metrics outside of fairness calculations if in different contexts?

Article #3 Notes: Title

Source Title	Soils: Fascinating (and Sometimes Forgotten) Microbial Ecosystems - Prof. Darcy McRose
Source citation (APA Format)	
Original URL	N/A
Source type	Lecture/Personal Communication*
Keywords	Soil, microbiology, carbon sequestration
#Tags	N/A
Summary of key points + notes (include methodology)	The majority of the world's carbon is fixed underground in soil. Microbes are responsible for cycling plant carbon back into the atmosphere and are thus highly important to carbon sequestration. The speaker of this talk discussed the various needs in the area of microbial research. For example, there is a need for model ecosystems to study microbial interractions in, methods to see into soil, novel gas detection proceses, and ways to observe microbial impacts at a larger scale after studying them at a smaller scale
Research Question/Problem/ Need	N/A
Important Figures	N/A
VOCAB: (w/definition)	Sequestration – storing away, especially carbon
Cited references to follow up on	N/A
Follow up Questions	1. Can technology such as that used in JWST be applied to microbial research?

Article #4 Notes: Title

Source Title	Microbial Engineering for Human and Environmental Health - Prof. Ariel Furst
Source citation (APA Format)	
Original URL	https://www.youtube.com/watch?v=njmRqLunlHI&list=PLf9oKp0RkBIy4XB7GMa4FiKchjVfcKVCj&index=11
Source type	Lecture/ Personnal com
Keywords	Microbiology, antibiotic resistance, medicine
#Tags	N/A
Summary of key points + notes (include methodology)	The speaker of this lecture spoke mainly about the various applications of microbiological research. She especially focused on the slowing development of antibiotics and the impacts of a healthy microbial population on the human body. She then went on to dicuss how a newly discussed method for “sheilding” plasmids, sements of DNA that can be inserted into cells via various microbes could be used to modify the body’s production of proteins.
Research Question/Problem/ Need	N/A
Important Figures	N/A
VOCAB: (w/definition)	Antibiotic resistance – developed resistance of microbes to antibiotics
Cited references to follow up on	N/A
Follow up Questions	1. Can microbe shielding potentially be used to maintain healthy internal microbiomes?

Article #5 Notes: Title

Source Title	Leading Innovation: Exploring Optimistic Futures - Prof. Dava Newman
Source citation (APA Format)	
Original URL	https://www.youtube.com/watch?v=JNEJd2vBXU8&list=PLf9oKp0RkBIy4XB7GMa4FiKchjVfcKVCj&index=8
Source type	Lecture/Personal Communication*
Keywords	Space, Space tech, soft sensors
#Tags	N/A
Summary of key points + notes (include methodology)	This lecture discussed the development of various space technologies as there is a renewed drive to reach the moon and further. The first of these was a mobile mars habitat that could be self-sustaining with a rover like design. The one I found the most interesting, though was an innovative space suit made out of an elastic material that would force astronauts to move their limbs as they would on earth by exerting the same amount of force. This suit also has integrated soft sensors to measure the individual's wellbeing.
Research Question/Problem/ Need	N/A
Important Figures	N/A

VOCAB: (w/definition)	N/A
Cited references to follow up on	N/A
Follow up Questions	1. Can this space suit technology be applies to EVA suits?

Article #6 Notes: Title

Source Title	Exploring the Last Spectral Frontier: the Great Observatory for Long Wavelengths (GO-LoW) - Dr. Mary Knapp
Source citation (APA Format)	
Original URL	https://www.youtube.com/watch?v=ghDqLWbeQUA&list=PLf9oKp0RkBIy4XB7GMa4FiKchjVfcKVCj&index=3
Source type	Lecture/Personal Communication
Keywords	Space, satellites, exploration
#Tags	N/A
Summary of key points + notes	This researcher and her team at the Haystack observatory are developing technology that uses a constellation of several satellites to afford improved viewing of extraterrestrial

(include methodology)	bodies. By placing the satellites at lagrange points, they would make the design feasible and sustainable without constant course re-adjustment.
Research Question/Problem/ Need	Can a constellation of satellites that act as a powerful telescope be created?
Important Figures	N/A
VOCAB: (w/definition)	N/A
Cited references to follow up on	N/A
Follow up Questions	1. Can a terrestrial swarm be controlled similarly to this?

Article #7 Notes: Title

Source Title	Hybrid Robotic Manipulator Using Sensorized Articulated Segment Joints With Soft Inflatable Rubber Bellows
Source citation (APA Format)	
Original URL	https://ieeexplore.ieee.org/document/9724119

Source type	Personal communication with author (Shoushan Chiang)
Keywords	Bellows actuator, hybrid manipulator, sensorized soft robot, soft robotics.
#Tags	N/A
Summary of key points + notes (include methodology)	Continuum actuators are actuators with infinite degrees of freedom, which are highly important to soft robotics. This technology was applied in this study using an inverse kinematics approach. Dr. Chiang's group developed soft cable-driven continuum actuators that come in compact, modular 10cm segments. By stacking these actuators, the group made a highly flexible "arm" -like device. In their approach, they wanted to use inverse kinematics, meaning that rather than defining what the robot should do, they would give the robot a location in space that the end effector must travel to, and it would to so. In order to do this, they placed april tags (a standard marker) on the joints of each segment so that a camera could identify the robot's joints' positions in space. From this, it could then decide what series of movements in each joint the robot would have to make to reach its desired target.
Research Question/Problem/ Need	Continuum actuators need to be modeled with an inverse kinematice approach to make them feasible for tasks that define an end result without a definite process to reach this objective.
Important Figures	N/A
VOCAB: (w/definition)	Continuum actuator – an actuator with infinite degrees of freedom
Cited references to follow up on	N/A
Follow up Questions	1. Is an inverse kinematics approach more beneficial in all robotics-based situations? 2. Can continuum actuators come in a rigid design?

Article #8 Notes: Title

Source Title	Update on Wind Challenger – Innovation of Wind Propulsion of Ships: May the 'Wind Force' Be with You - Mr. Nobuyuki Onishi
Source citation (APA Format)	
Original URL	https://www.youtube.com/watch?v=a-CEWnzc1Ys&list=PLf9oKp0RkBIy4XB7GMa4FiKchjVfcKVCj&index=1 I ask a question at 46:11 'O'
Source type	Lecture/Personal Communication*
Keywords	Wind-powered vehicles,
#Tags	N/A
Summary of key points + notes (include methodology)	The shipping company Mitsui O.S.K Lines has designed a modern-day sail for cargo ships called wind challenger. This ship uses a tall rigid sail design that seeks to maximize the efficiency boost from the wind and minimize its impact on cargo capacity. In order to maximize the impact of the wind-based technology, versions of the cargo ship design with multiple sails placed in different configurations were also implemented. They chose to use rigid sails as opposed tensile ones mainly to maintain safety, which is their main priority.
Research Question/Problem/ Need	Shipping accounts for 3% of transportation-related emissions, and thus, there is a strong need for green technology that presents benefits to shipping beyond being greener.
Important Figures	N/A
VOCAB: (w/definition)	Tensile – flexible (as a cloth/ rubber ducky would be)
Cited references to follow up on	N/A
Follow up Questions	1. Could similar wind-based technologies be applied to other forms of transport? 2. How can you further minimize the wind resistance caused by sails if implemented in less wind-driven forms of transport such as motor vehicles? 3. Cand wind power-based technologies be scaled down to smaller aerodynamic features that reduce drag, vortices in aircraft, etc.? 4. Can piezoelectric generators be used to harvest energy from the forward-facing component of the sail?

Article #9 Notes: Title

Source Title	Humanoid Robot HRP-5P: An Electrically Actuated Humanoid Robot With High-Power and Wide-Range Joints
Source citation (APA Format)	
Original URL	
Source type	
Keywords	
#Tags	
Summary of key points + notes (include methodology)	
Research Question/Problem/ Need	
Important Figures	
VOCAB: (w/definition)	
Cited references to follow up on	
Follow up Questions	

Article #10 Notes: Title

Source Title	Spatial AI for Robotics
Source citation (APA Format)	
Original URL	N/A
Source type	Lecture/Personal Communication
Keywords	Perception, robotics, spatial AI
#Tags	
Summary of key points + notes (include methodology)	In order to effectively navigate an environment, a robot must be able to observe and interpret it. To do this, robots use data they get from their sensors to make a world model. Oftentimes, this is done through the use of LiDAR, which collects many points from its environment to create a point cloud of all the places that light bounced back off of objects, often called a scene graph. From this, the robot can construct its world model. One such method to collect points and form a world model via this method is called Hydra, which this researcher worked on. However, in addition to very high-level spatial awareness, robot vision must also be able to account for context. For example, a self-driving car's algorithm was confused by a stop sign on a pedestrian's shirt. As demonstrated by this silly prank, robot perception must also take context into account. While developing contextual awareness is fairly simple for a human, it is more complicated in robots. Some used methods are imitation-based learning or experiential learning. Even if the robot's initial detection is false, robust perception must account for this and give the robot the ability to adjust to failure.

Research Question/Problem/ Need	Robot perception is not robust to the context of its observations and thus must be improved.
Important Figures	N/A
VOCAB: (w/definition)	Robot perception – a robot's ability to observe and interpret its environment
Cited references to follow up on	N/A
Follow up Questions	1.

*Part of a series of 1-hour lectures at BWSI that strongly influenced my brainstorming and areas of focus. Oftentimes, these lectures were more of a review of a certain field rather than a review of a single piece of work.