Project Notes:

Project Title: Designing a Bodysuit to Counteract Wobbling in Cats with Cerebellar Hypoplasia
Name: Choi, Olivia

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
I have knowledge gaps in physics because the device I want to design is based on a cat going side to side.	I could compare a cat to a pendulum to understand the motion surrounding a central equilibrium point.	The Editors of Encyclopaedia Britannica (2025, August 6). pendulum. Encyclopedia Britannica. https://www. britannica.co	10/2

		m/technology /pendulum	
I think I will mainly face knowledge issues, I don't have that much experience in the field of engineering, and I know I will have to learn a lot to be able to make a device like this	Reading a lot of articles and understanding how they built assistive devices so I can apply to my own project.	De Fazio, R., Del Valle-Soto, C., Mastronardi, V. M., De Vittorio, M., & Visconti, P. (2025). A smart glove to evaluate parkinson's disease by flexible piezoelectric and inertial sensors. *Sensors International*, *6*, 100324. https://doi.org/10.1016/j.sintl.2024.100324	10/1
What materials will I be using for my engineering project?	Similar resources stated in my formal meeting's and elevator pitch	In these project notes and my Google Document with my elevator pitch in that.	10/5
How does a self-stabilizing robot work?	Watching Youtube engineering videos	STEM Project Notes	10/21/25
What sensors are necessary for the robot?	Olivia Choi	STEM Project Notes	10/25/25
How can a flywheel be used on a smaller scale?	Olivia Choi	STEM Project Notes	11/6/25
Articles on competitor analysis	Olivia Choi	STEM Project Notes and Grant Proposal	11/14/25

Literature Search Parameters:

These searches were performed between 8/22/25 and 9/30/25.
List of keywords and databases used during this project.

Database/search engine	**Keywords**	**Summary of search**
WPI Gordan Library	cerebellar hypoplasia in cats	Cerebellar hypoplasia is a condition caused by panleukopenia virus that occurs in utero when the mother contracts the virus. This causes the baby to have an underdeveloped cerebellum and results in poor balance and coordination issues.
WPI Gordan Library	smart glove parkinson's disease	Engineers have designed a glove that contain piezoelectric and inertial sensors to evaluate and determine the severity of Parkinson's Disease (PD). Using the MDS-UPDRS-III scale, neurologists can change treatment plans remotely whenever the patient does the MDS-UPDRS-III tests at home.
WPI Gordan Library	learning prediction of alzheimer's disease	Alzheimer's Disease (AD) is a neurodegenerative disorder that is characterized by memory loss and cognitive decline, affecting 1 in 9 people aged 65 and older across the U.S. One study uses machine learning techniques that performs predictive analysis to find key brain regions associated with AD. They do this by using numerical data that is derived by MRI scans.

Tags:

Tag Name	
#cerebellarhypoplasia	#animalcommunication
#biology	#nanomedicine
#engineering	#parkinsonsdisease

Article #1 Notes: Title

Article notes should be on separate sheets

KEEP THIS BLANK AND USE AS A TEMPLATE

Source Title	
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 #1 Notes: These genes can have the opposite effects depending on which parent they came from

Article notes should be on separate sheets

Source Title	These genes can have the opposite effects depending on which parent they came from
Source citation (APA Format)	Fieldhouse, R. (2025, August 7). These genes can have the opposite effects depending on which parent they came from. Nature News. https://www.nature.com/articles/d41586-025-02499-6
Original URL	https://www.nature.com/articles/d41586-025-02499-6
Source type	Secondary source
Keywords	UK Biobank, imprinting disorders, congenital conditions
#Tags	#biology
Summary of key points + notes (include methodology)	There are many variations of what genes can do once a child is conceived. The child inherits two copies of almost every gene from each parent and are generally either turned off or on. But sometimes, a copy can be turned on and expressed, while the other copy is silenced. This can lead to 'imprinting' disorders, which are a group of congenital conditions caused by genomic imprinting, a process where certain genes are expressed differently based on which parent they inherited that gene from. Researchers studying evolution suggest that this silencing of certain genes is because of a conflict surrounding which parent that gene originated from. For example, the expression of paternal genes encourages the offspring's growth, but only because the mother is providing resources for it. Researching the connection between parent-of-origin variants and human traits is difficult because they would need genomic data from that offspring and their parents, which isn't available most of the time. So, to avoid this issue, a research team in Europe and the United States generated a statistical method to infer the genetic variants of the parent of origin by using accessible genomic data from any relatives. They were able to find parental origin of genes for the 109,000 people whose genomic data was in the UK Biobank and they were able to identify 30 variants that would impact growth and metabolism. The reason I chose to read and summarize this article as part of my brainstorming was because I want to do something towards biology and genetics for the research project.

Research Question/Problem/ Need	How can variations of gene expression be controlled to prevent imprinting disorders?
Important Figures	No important figures listed
VOCAB: (w/definition)	UK Biobank – Biobank study in the United Kingdom that stores the de-identified biological/health-related data for half a million people Imprinting disorders – Genetic disorders caused by errors in genomic imprinting, where one gene is silenced and only the other one is expressed Congenital conditions – Conditions present at birth
Cited references to follow up on	No cited references listed.
Follow up Questions	Are there any disadvantages to using a biobank as large as the United Kingdoms? What are the advantages to using that biobank?

Article #2 Notes: The biology of behavior: scientific and ethical implications

Article notes should be on separate sheets

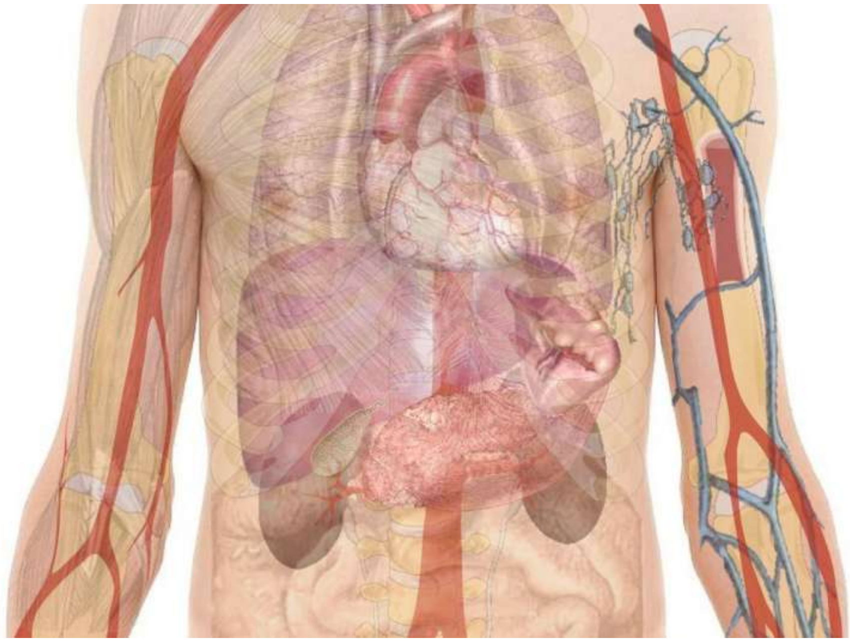
Source Title	The biology of behavior: scientific and ethical implications
Source citation (APA Format)	Stefánsson, H. (n.d.). The biology of behaviour: Scientific and ethical implications. EMBO reports. https://pmc.ncbi.nlm.nih.gov/articles/PMC3327529/
Original URL	https://pmc.ncbi.nlm.nih.gov/articles/PMC3327529/
Source type	National Library of Medicine article
Keywords	Pleiotropy, epistasis, genome
#Tags	#biology
Summary of key points + notes (include methodology)	The brain is a fascinating organ, mediating our behavioral responses with a brilliant structure and higher cognitive function. These are all embedded within the genome and genes, serving as a complete set of genetic information for an organism. Although behavior is mostly influenced by environment or biographical circumstances, there are forms that are inherited through genes. But the real question was how the brain causes this behavior; the lines of how the genes and/or environmental circumstances affect it. Luckily, the research on behavioral genetics continues to flourish as researchers at the seventh European Molecular Biology Laboratory (EMBL)/European Molecular Biology Organization (EMBO) are developing tools to distinguish the complexity between genes and human behavior. Geneticist Pierre Roubertoux stresses that pleiotropy, the expression of multiple traits by a single gene, epistasis, a phenomenon where one's gene expression affects the expression of another gene, and interactions between the gene and the environment can lead to many different aspects of behavior. This article relates to one of my ideas of how genes and genomes can affect the biology of behavior in the cats in an animal shelter I volunteer at. I wanted to understand the biology of behavior in the human brain before diving into the world of cats as cats and humans have about 90% of the same structure.
Research Question/Problem/ Need	If behavior is caused by genetic and/or environmental circumstances, what is the fine line that distinguishes genes and human behavior?

Important Figures	No important figured listed
VOCAB: (w/definition)	EMBL – European Molecular Biology Laboratory EMBO – European Molecular Biology Organization Pleiotropy – The expression of multiple traits by a single gene Epistasis – A phenomenon where one's gene expression affects the expression of another gene
Cited references to follow up on	Only has one reference that is not useful to the topic.
Follow up Questions	What are specific examples of pleiotropy and epistasis seen in human behavior?

Article #3 Notes: Repurposed drugs could calm the immune system's response to nanomedicines

Article notes should be on separate sheets

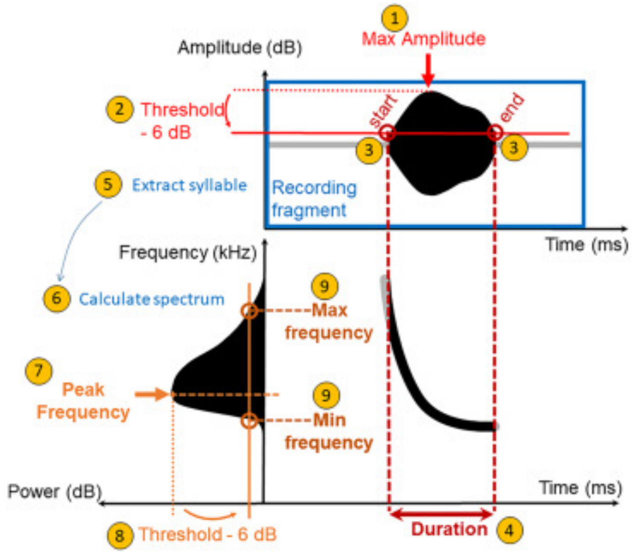
Source Title	Repurposed drugs could calm the immune system's response to nanomedicine.
Source citation (APA Format)	Harley, S. (2025, July 9). Repurposed drugs could calm the immune system's response to nanomedicine. Phys.org. https://phys.org/news/2025-07-repurposed-drugs-calm-immune-response.html/
Original URL	https://phys.org/news/2025-07-repurposed-drugs-calm-immune-response.html
Source type	Website article
Keywords	Nanomedicine, complement system, iptacopan
#Tags	#nanomedicine
Summary of key points + notes (include methodology)	This article is about an international research study that has recognized promising strategies that can boost the safety of nanomedicines, an advanced therapy that applies nanotechnology and nanoscale materials to diagnose, treat, and prevent diseases. They want to repurpose existing medications approved by the FDA to reduce the damaging immune responses when they react to the nanoparticles. When nanoparticles are introduced to the body during nanomedicine therapy or imaging, it can trigger inflammation in the immune system as the complement system, a group of blood proteins that defend the body against pathogens, accidentally target those friendly and helpful nanoparticles as a potential threat. This could have caused various symptoms including skin rashes, respiratory distress, cardiovascular problems, or dangerous anaphylactic reactions. To address these reactions in the immune system, the research team tested medications that adjusted the immune system to reduce immune attacks without heavily weakening it. They found that iptacopan, a drug used to treat rare blood, nerve, and kidney disorders, was most effective in doing just that. It reduced immune responses but also prevented more serious symptoms from occurring.
Research Question/Problem/ Need	How can existing medications be repurposed to reduce the damaging immune responses towards nanoparticles?

Important Figures	 This image was provided on the website article, shows the path of iptacopan could take throughout the body
VOCAB: (w/definition)	FDA – Food and Drug Administration Iptacopan – An oral medication used to treat rare blood disorders, and certain kidney disorders Nanotechnology – Creation, design, and application of nanoparticles to create technology with special properties as it isn't on the same size scale of physical, chemical, and biological properties Nanomedicines – Use of nanotechnology to healthcare to diagnose, treat, and fight off diseases
Cited references to follow up on	Yue Li et al, Enhanced Immuno-compatibility and Hemocompatibility of Nanomedicines Across Multiple Species Using Complement Pathway Inhibitors, Science Advances (2025). DOI: 10.1126/sciadv.adw1731. www.science.org/doi/10.1126/sciadv.adw1731
Follow up Questions	Is Iptacopan the only drug that can reduce the immune attacks without heavily weakening it? What specific diseases are these therapies positively impacting the most? What studies are being researched and done today that are working to improve the widespread use of nanomedicines?

Article #4 Notes: Stream noise induces song plasticity and a shift to visual signals in a riverine songbird

Article notes should be on separate sheets

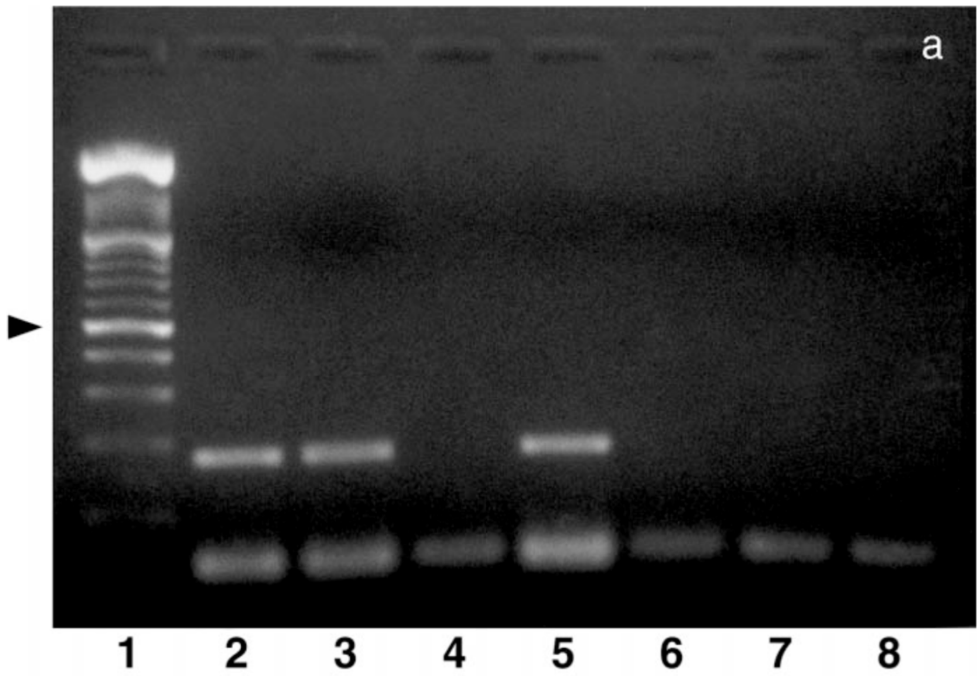
Source Title	Stream noise induces song plasticity and a shift to visual signals in a riverine songbird
Source citation (APA Format)	Framond, L. (n.d.). *Stream noise induces song plasticity and a shift to visual ...* Current Biology. https://www.cell.com/current-biology/fulltext/S0960-9822(25)00958-3
Original URL	https://www.cell.com/current-biology/fulltext/S0960-9822(25)00958-3
Source type	Journal article
Keywords	Songbird, blinking, animal communication
#Tags	#animalcommunication #biology
Summary of key points + notes (include methodology)	Environmental noise, otherwise known as noise pollution, can severely impact acoustic communication by affecting key behaviors: predator avoidance, territorial defense, and reproduction. Multimodal signals, signals that send information across sensory channels, can enhance signal detection in noisy environments, allowing animals such as the white-throated dipper to adjust their songs to an ambient environment by also using their blinking rate, a blinking method that compensates for sound masking in loud areas. The field measurements in blinking rate and song volume showed a negative correlation between the two, indicating that these animals can adapt to fluctuating environmental pressures.
Research Question/Problem/ Need	How does the white-throated dipper adapt to fluctuating environment pressures?

Important Figures	 This figure shows the relationship between the songbird threshold and the frequency at which they are released at.
VOCAB: (w/definition)	Song plasticity – The ability for organisms, especially songbirds, to change their songs to adapt to environmental and social interactions. Multimodal signals – These are specific signals that send information across sensory channels to send a message to another organism
Cited references to follow up on	Grafe, T. U., & Tony, J. A. (2017, October 26). *Temporal variation in acoustic and visual signalling as a function of stream background noise in the Bornean foot-flagging frog, Staurois parvus*. JAMS. https://jea.jams.pub/article/1/1/33
Follow up Questions	• Is the response to the environmental noise similar across different animals, or is it just unique to the songbirds? Although this research is directed towards songbirds, this research could expand and add different animals to see their responses. • Could they go into the more neurological aspects of the responses of acoustic communication? • What were some of the specific examples of the large impact on predator avoidance, territory defense, and reproduction as a result from environmental noise?

Article #5 Notes: Polymerase Chain Reaction (PCR) Amplification of Parvoviral DNA from the Brains of Dogs and Cats with Cerebellar Hypoplasia

Article notes should be on separate sheets

Source Title	Polymerase Chain Reaction (PCR) Amplification of Parvoviral DNA from the Brains of Dogs and Cats with Cerebellar Hypoplasia
Source citation (APA Format)	Schatzberg, S. J., Haley, N. J., Barr, S. C., Parrish, C., Steingold, S., Summers, B. A., deLahunta, A., Kornegay, J. N., & Sharp, N. J. H. (2003). Polymerase chain reaction (PCR) amplification of parvoviral DNA from the brains of dogs and cats with cerebellar hypoplasia. *Journal of Veterinary Internal Medicine*, *17*(4), 538. https://doi.org/10.1892/0891-6640(2003)017<0538:pcrpao>2.3.co;2
Original URL	https://wpi.primo.exlibrisgroup.com/discovery/fulldisplay?docid=cdi_proquest_miscellaneous_902331608&context=PC&vid=01WPI_INST:Default&lang=en&adaptor=Primo%20Central
Source type	Journal article
Keywords	Cerebellar hypoplasia, panleukopenia virus
#Tags	#cerebellarhypoplasia
Summary of key points + notes (include methodology)	Cerebellar hypoplasia in cats is most commonly caused in utero by a feline panleukopenia virus (parvovirus). It was reported that cerebellar hypoplasia (CH) was not very frequent in dogs and more frequent in cats. To see if the parvoviral DNA was present in dogs and cats with CH, they used PCR on extracted DNA from archival, paraffin-embedded, cerebellar tissue from 8 cats and 10 dogs. They cut the archival brain tissue to look at the microscopic structure and to detect viral proteins. However, to actually detect the parvovirus proteins, they rehydrated the tissue in 70% ethanol and blocked it with 0.5% hydrogen peroxide for 10 minutes at room temperature. Then, they incubated the tissue with rabbit polyclonal anti-CPV antibody for 2 hours at 37 degrees Celsius. After secondary antibodies were applied, they examined the samples via light microscopy. All of the test samples that were animals with cerebellar hypoplasia, parvoviral DNA was present in them.
Research Question/Problem/ Need	Can parvoviral DNA be amplified in the feline and canine archival brain tissue of animals with cerebellar hypoplasia?

Important Figures	 This figure shows the PCR amplification for parvoviral DNA, the lower bands represent the
VOCAB: (w/definition)	Etiology – Etiology are the causes or what causes disease/conditions Abiotrophy – A condition where there is premature degeneration of the functions in tissues and cells Archival cerebellar tissue – brain tissue preserved for scientific purposes
Cited references to follow up on	Johnson RH, Margolis G, Kilham L. Identity of feline ataxiavirus with feline panleucopenia virus. Nature 1967;214:175–177
Follow up Questions	Why did the scientists choose to use archival cerebellar tissue instead of fresh, new ones?

Article #6 Notes: A smart glove to evaluate Parkinson's disease by flexible piezoelectric sensors and inertial sensors

Article notes should be on separate sheets

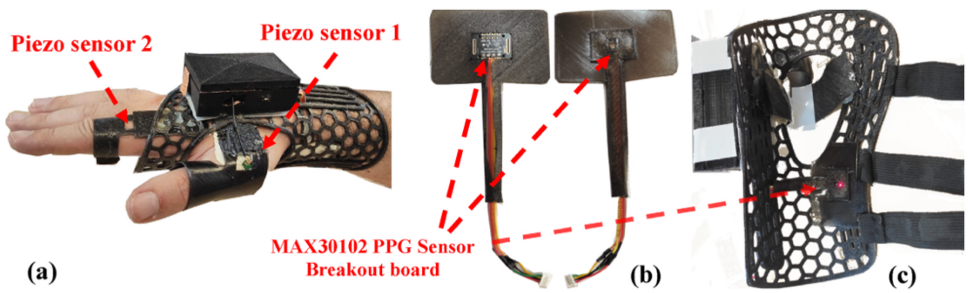
Source Title	A smart glove to evaluate Parkinson's disease by flexible piezoelectric sensors and inertial sensors
Source citation (APA Format)	De Fazio, R., Del-Valle-Soto, C., Mastronardi, V. M., De Vittorio, M., & Visconti, P. (2025). A smart glove to evaluate parkinson's disease by flexible piezoelectric and inertial sensors. *Sensors International*, *6*, 100324. https://doi.org/10.1016/j.sintl.2024.100324
Original URL	https://doi.org/10.1016/j.sintl.2024.100324
Source type	Journal article
Keywords	Parkinson's Disease, piezoelectric sensors, inertial sensors, MDS-UPDRS-III scale
#Tags	#engineering #parkinsonsdisease
Summary of key points + notes (include methodology)	Prior to the presented smart glove, a series of engineers tested different properties of what components could be used in their future model. Combining multiple models, they decided that the new smart glove should have both inertial and piezoelectric sensors and ML algorithms to enhance the efficiency of uploading the data from the MDS-UPDRS-III scale to the cloud database for neurologists so they can adjust treatment plans as needed. There are two piezoelectric sensors within the flexible glove, there is one half-moon shaped sensor at the thumb and index finger in order to pick up all the little signals within the junction. There is also a six-axis inertial sensor in the back of the hand to get data, as having six axis's will allow for the glove to pick up motion in all directions. There is also a PPG sensor at the wrist to measure heart rate and oxygenation levels because PD symptoms can be affected by heart rate and oxygenation levels, and it can exacerbate symptoms or affect movement. Recording heart rate and oxygenation levels allow doctors to determine tremor severity. A microcontroller is also present to read the data from the MDS-UPDRS-III scale and transmit it via Bluetooth through a nRF52840 transceiver so it can get uploaded to the neurologists' cloud databases. Within the glove, there are integrated piezoelectric sensors with flexible TPU filament that have dual-channel conditioning boards used for signal and conditioning so that it

can contain the extra voltages that came from the piezoelectric sensors. Within this board, there is a charge amplifier that boosts output signals, a level shifter, which shifts it to a controlled voltage, and a low-pass filter, which allows the frequency signals to pass through while cutting off higher, larger frequencies.

Research Question/Problem/ Need

How can we create a smart glove that uses flexible piezoelectric and inertial sensors, and ML algorithms to evaluate the severity and progression of patients with Parkinson's Disease?

Important Figures



This figure shows what the smart glove looks like

	SCORE 0	SCORE 1	SCORE 2	SCORE 3	SCORE 4	IDLE	UNCERTAIN
SCORE 0	100 %	0 %	0 %	0 %	0 %	0 %	0 %
SCORE 1	0 %	75 %	25 %	0 %	0 %	0 %	0 %
SCORE 2	0 %	0 %	100 %	0 %	0 %	0 %	0 %
SCORE 3	0 %	0 %	0 %	91.9 %	0 %	0 %	8.1 %
SCORE 4	0 %	0 %	0 %	0 %	97.5 %	0 %	2.5 %
IDLE	0 %	0 %	0 %	0 %	0 %	100 %	0 %
F1 SCORE	1.00	0.86	0.93	0.96	0.99	1.00	

(a)

	IDLE	SCORE 0	SCORE 1	SCORE 2	SCORE 3	SCORE 4	UNCERTAIN
IDLE	100 %	0 %	0 %	0 %	0 %	0 %	0 %
SCORE 0	0 %	100 %	0 %	0 %	0 %	0 %	0 %
SCORE 1	0 %	0 %	66.7 %	0 %	0 %	0 %	33.3 %
SCORE 2	0 %	0 %	0 %	100 %	0 %	0 %	0 %
SCORE 3	0 %	0 %	0 %	0 %	100 %	0 %	0 %
SCORE 4	0 %	0 %	0 %	0 %	0 %	100 %	0 %
F1 SCORE	1.00	1.00	0.80	1.00	1.00	1.00	

(b)

	SCORE 0	SCORE 1	SCORE 2	SCORE 3	SCORE 4	UNCERTAIN
SCORE 0	94.4 %	5.6 %	0 %	0 %	0 %	0 %
SCORE 1	3.0 %	97 %	0 %	0 %	0 %	0 %
SCORE 2	0 %	0 %	95.8%	4.2 %	0 %	0 %
SCORE 3	0 %	0 %	0 %	95.8 %	4.2%	0 %
SCORE 4	0 %	0 %	0 %	0 %	100 %	0 %
F1 SCORE	0.96	0.99	0.96	0.94	1.00	

(c)

This is a diagram that shows the accurate prediction from the data picked up from the glove from the actual data conducted in a hospital. The green represents the correct predictions of each MDS test.

VOCAB: (w/definition)

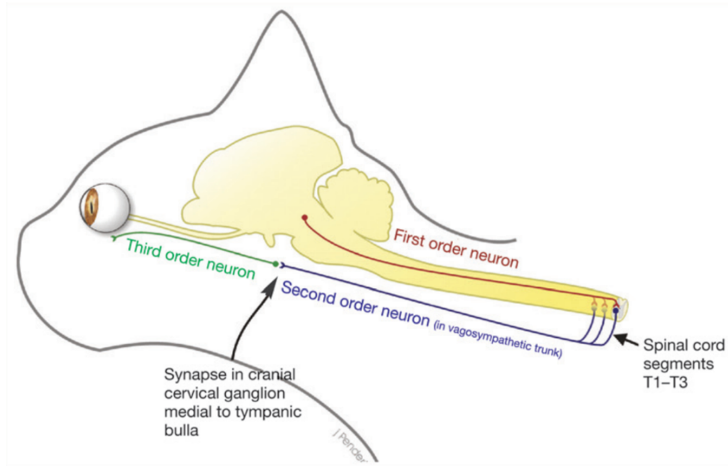
Piezoelectric sensor - Detects mechanical energy and convert into quantifiable electrical energy, easy to integrate into electronics

	Inertial sensor - Measures and detects motion, contains accelerometer and gyroscope ML algorithm – Machine learning algorithm MDS-UPDRS-III - Movement Disorder Society-Unified Parkinson’s Disease Rating Scale, three tests that measures motor and non-motor symptoms of PD to evaluate progression/severity PPG sensor - Sensor that measures heart rate and oxygenation levels
Cited references to follow up on	Yousef, M., Hafizh, M., Sassi, S., & Adeli, G. (2022). Development of a wearable wireless sensing device for characterization of hand tremors through vibration frequency analysis. *Journal of Vibration Engineering & Technologies*, *11*(7), 3109–3120. https://doi.org/10.1007/s42417-022-00734-2 Heijmans, M., Habets, J., Kuijf, M., Kubben, P., & Herff, C. (2019). Evaluation of parkinson’s disease at home: Predicting tremor from wearable sensors. *2019 41st Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*, 584–587. https://doi.org/10.1109/embc.2019.8857717
Follow up Questions	Can the engineers designing this glove make it look as though it is a regular glove? Will this glove be released into the market soon if the accuracy percentage was >95%?

Article #7 Notes: The wobbly cat. Diagnostic and therapeutic approach to generalised ataxia

Article notes should be on separate sheets

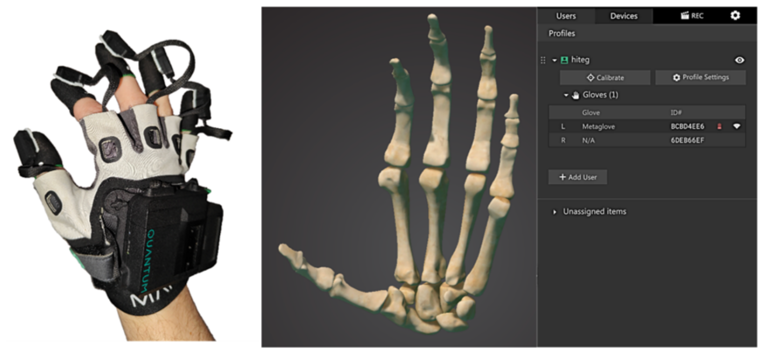
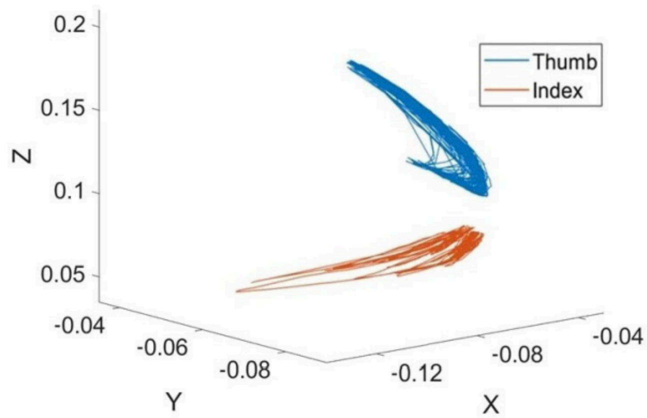
Source Title	The wobbly cat. Diagnostic and therapeutic approach to generalised ataxia
Source citation (APA Format)	Penderis, J. (2009). The wobbly cat. Diagnostic and therapeutic approach to generalised ataxia. *Journal of Feline Medicine and Surgery*, *11*(5), 349–359. https://doi.org/10.1016/j.jfms.2009.03.003
Original URL	https://wpi.primo.exlibrisgroup.com/discovery/fulldisplay?docid=cdi_proquest_miscellaneous_67157622&context=PC&vid=01WPI_INST:Default&lang=en&search_scope=MyInst_and_CI&adaptor=Primo%20Central&tab=Everything&query=any,contains,cerebellar%20hypoplasia%20in%20cats&sortby=rank%7D&mode=basic&offset=10
Source type	Journal article
Keywords	Technology, Parkinson disease, precision medicine, remote monitoring, wearable technology
#Tags	#cerebellarhypoplasia #biology
Summary of key points + notes (include methodology)	The wobbly cat is another name for a cat with cerebellar hypoplasia. First, this article discusses the three different classifications of ataxia present in cats with CH. There is cerebellar ataxia, vestibular ataxia, and sensory ataxia. Cerebellar ataxia is caused by CH, it is located in the cerebellum, and you can tell if it is cerebellar ataxia if there are head tremors or jerky movements throughout the body. Vestibular ataxia is located in the inner ear or the brainstem, and you can tell if that cat has vestibular ataxia if they continuously tilt their head, fall often, or have nystagmus in their eyes. This can be caused by an ear infection that spreads to the skull, or benign growths that start as young kittens. Sensory ataxia is located in the cervical spine, and some causes of this ataxia is having blunt trauma or deformities in that area. You can tell if a cat has sensory ataxia if they have more motor weakness, a normal head position, or a decrease in limp proprioception.
Research Question/Problem/ Need	How can vets determine what type of ataxia a cat with cerebellar hypoplasia has?

Important Figures	 This figure gives a visual of what differs from a cat with ataxia behind the eyes and in connection with the cerebellum
VOCAB: (w/definition)	Ataxia – A neurological condition that is characterized by poor coordination and balance Nystagmus – Rapid, uncontrollable movements in one or both eyes
Cited references to follow up on	*Bradshaw JM, Pearson GR, Gruffydd-Jones TJ. A retrospective study of 286 cases of neurological disorders of the cat. J Comp Pathol 2004; 131: 112–20.*
Follow up Questions	How do you know which classification of ataxia is present just based on its head position?

Article #8 Notes: A New Geometric Algebra-Based Classification of Hand Bradykinesia in Parkinson's Disease Measured Using a Sensory Glove

Article notes should be on separate sheets

Source Title	A New Geometric Algebra-Based Classification of Hand Bradykinesia in Parkinson's Disease Measured Using a Sensory Glove
Source citation (APA Format)	Saggio, G., Roselli, P., Pietrosanti, L., Romano, A., Arangino, N., Patera, M., & Suppa, A. (2025). A new geometric algebra-based classification of hand bradykinesia in parkinson's disease measured using a sensory glove. *Algorithms*, *18*(8), 527. https://doi.org/10.3390/a18080527
Original URL	https://wpi.primo.exlibrisgroup.com/discovery/fulldisplay?docid=cdi_scopus_primary_2_s2_0_105014397267&context=PC&vid=01WPI_INST:Default&lang=en&search_scope=MyInst_and_CI&adaptor=Primo%20Central&tab=Everything&query=any,contains,parkinson%27s%20disease%20glove&offset=0
Source type	Journal article
Keywords	Geometric algebra; sensory glove; Parkinson's disease; hand motor assessment
#Tags	#parkinsonsdisease
Summary of key points + notes (include methodology)	A new study introduced a new method of geometric algebra-based classification of hand bradykinesia in patients with Parkinson's disease. Current methods of determining the treatment plan tend to only use visuals to assess it and can miss motion changes and introduce variabilities in the data. This study aims to reduce the amount of variety involved and make all data quantitative This study contained 71 patients, and each performed a test from the MDS-UPDRS-III scale (finger-tapping, rolling hand into fist, and resting tremor). This new smart glove uses a series of electromagnetic sensors to measure the dynamic distances between the fingertips during flexion/extension and adduction/abduction. When analyzing data, they did frequency, range of motion, and asymmetry ratios to receive the amplitude and speed of the hand in motion. For geometric algebra features, this study adopted Clifford geometric algebra and calculated the 3 axis motion trajectories and asymmetrical distances.
Research Question/Problem/ Need	How can the new geometric algebra-based classification grow from the current, traditional methods that neurologists use to classify hand

	bradykinesia in patients with Parkinson’s disease?
Important Figures	 (a) (b) **Figure 1.** (**a**) The Quantum Metaglove and (**b**) the graphical interface provided by Manus. This shows what the Quantum Metaglove looks like  This graph shows the position of the thumb and index finger when in use of the Quantum Metaglove
VOCAB: (w/definition)	Hand bradykinesia – The reduced movement of hands Clifford geometric algebra – The universal system for manipulating geometric objects
Cited references to follow up on	Eskofier, B.M.; Lee, S.I.; Daneault, J.-F.; Golabchi, F.N.; Ferreira-Carvalho, G.; Vergara-Diaz, G.; Sapienza, S.; Costante, G.; Klucken, J.; Kautz, T.; et al. Recent Machine Learning Advancements in Sensor-Based Mobility Analysis: Deep Learning for Parkinson’s Disease Assessment. In Proceedings of the 2016 38th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), Orlando, FL, USA, 16–20 August 2016; IEEE: New York, NY, USA, 2016; pp. 655–658.
Follow up Questions	Is there a way to make it more accessible to wear in public? It looks a bit

	clunky in the article as I was reading it

Article #9 Notes: Cerebellar Hypoplasia in Two Juvenile African Grey Parrots (Psittacus Erithacus).

Article notes should be on separate sheets

Source Title	Cerebellar Hypoplasia in Two Juvenile African Grey Parrots (Psittacus Erithacus).
Source citation (APA Format)	Taggers, Akshata, et al. "Cerebellar Hypoplasia in Two Juvenile African Grey Parrots (Psittacus erithacus)." *Journal of Avian Medicine and Surgery*, vol. 36, no. 3, Sept. 2022, pp. 308+. *Gale Academic OneFile*, link.gale.com/apps/doc/A730064161/AONE?u=mlin_c_worpoly&sid=bookmark-AONE&xid=2ee71d4e. Accessed 10 Oct. 2025.
Original URL	https://go-gale-com.ezpv7-web-p-u01.wpi.edu/ps/i.do?p=AONE&u=mlin_c_worpoly&id=GALE%7CA730064161&v=2.1&it=r&aty=ip
Source type	Journal article
Keywords	cerebellar hypoplasia, genetic, abiotrophy, dysplasia, neurologic, avian, African grey parrot, Psittacus erithacus
#Tags	#cerebellarhypoplasia #biology
Summary of key points + notes (include methodology)	This study discusses the condition, cerebellar hypoplasia, in two juvenile African grey parrots, instead of more commonly, cats. The scientists in this study were able to determine if these parrots had CH due to common neurological signs: difficulty standing and walking around without assistance and tremors. After seeing these signs, they tested the parrots and found a cerebellar lesion, an injury to the cerebellum. Postmortem, both parrots exhibited a 40-50% reduction of the size of the cerebellum compared to the cerebrum. Histopathology showed that the granular layer was mostly absent, and there was a complete loss of granule cells in the cerebella. The Purkinje cells were highly disorganized and were scattered throughout the superficial cerebella and was also extended into white matter.
Research Question/Problem/	How does the cerebella of the African grey parrot differ from other

Need	mammals that inherited cerebellum hypoplasia?

Important Figures

Table 1. Neurological examination protocol used for the African grey parrots (*Psittacus erithacus erithacus*) described in this report.

Test	Case: Bird 1	Case: Bird 2	Case: Bird 3	Interpretation
Mentation	Normal	Normal	Normal	The bird is fully alert and aware of its surroundings and reacts quickly to visual and auditory stimuli. Healthy adult birds should always be in an alert state during the veterinary visit. Juvenile birds may sometimes nap during the consultation, and this is considered normal.
Posture	Recumbent	Recumbent	Normal	A normal chick, during an examination, should rest on its legs and tail, holding its head upright.
Movement	Unable to stand without assistance, shivers/tremors	Unable to stand without assistance, shivers/tremors	Normal	Although a normal chick has limited ability to move, it should be purposeful and clearly controlled. Abnormalities in body movement suggest problems in the cerebral, cerebellar, vestibular, or proprioceptive pathways. A lack of fine-tuned coordination suggests cerebellar disease. Intention tremors also suggest cerebellar disease.
Postural reactions				
Drop and flap	Normal	Normal	Normal	The bird is placed on a perch or grasped by the legs and moved downward quickly in a falling motion. The normal reaction is for both wings to extend and flap; the tail may fan outward.
Proprioceptive positioning	Ataxia Falling both left and right	Foot knuckling Ataxia Falling both left and right	Normal	The limbs are extended and allowed to return to a normal position. The toes and foot are flexed so that the dorsal aspect of the foot faces the perch or floor. The bird should return the foot to a normal position almost immediately. Ataxia is lack of muscle coordination without spasticity, paresis, or involuntary movements and can result from lesions involving the proprioceptive or sensory pathways, vestibular system, or cerebellum.
Hopping	Bilaterally abnormal	Delayed left pelvic limb	Normal	One pelvic limb is raised while the patient's weight is shifted laterally over the opposite limb. The bird should respond by quickly replacing the limb under the body as it moves laterally.
Placing (tactile)	Bilaterally abnormal	Bilaterally abnormal	Normal	The bird's eyes are shielded from vision and the feet are brought into contact with a perch or the edge of a table. The normal response is immediate placement of the feet on the perch or table surface to support their weight.
Placing (visual)	Bilaterally abnormal	Bilaterally abnormal	Normal	The bird is permitted to see the perch or table surface. Normal birds will reach for the perch or table before touching it.

This figure shows how neurologists organized how they tested the African grey parrots with CH.

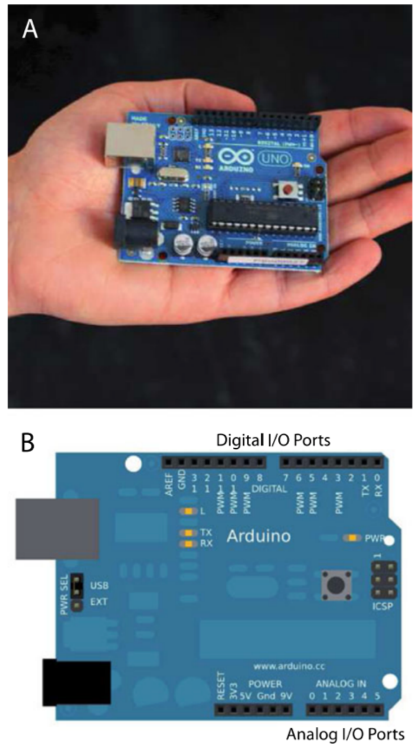
VOCAB: (w/definition)	Dysplasia – Abnormal change in the size, shape, or # of cells in a tissue/organ Purkinje cells – A nerve cell in the cortex of the cerebellum Histopathology – Branch of medicine that studies microscopic examinations of tissues Granular layer – Layer in the cerebellar cortex that is similar to the epidermis White matter – Type of tissue in the brain that consists of axons
Cited references to follow up on	No follow up cited references.
Follow up Questions	What percentage of African grey parrots have CH after these two grey parrots were born? Was it cut off, or did the gene get passed down from their parents to the grandchildren of another child?

Article #10 Notes: Arduino: A low-cost multipurpose lab equipment

Article notes should be on separate sheets

KEEP THIS BLANK AND USE AS A TEMPLATE

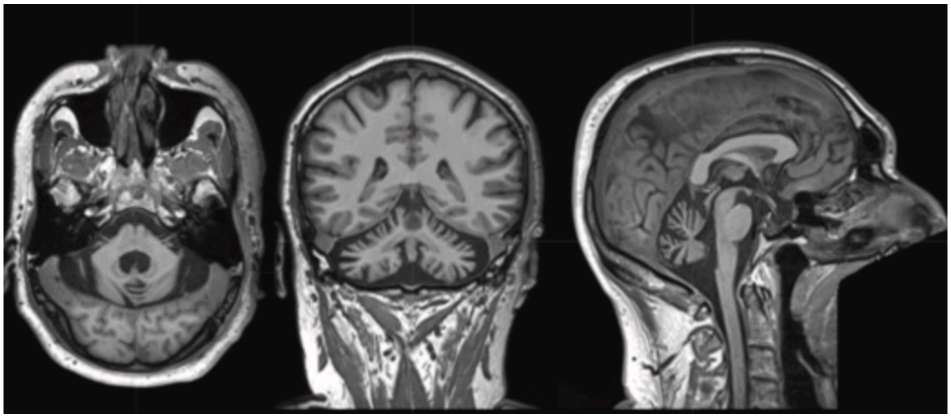
Source Title	Arduino: A low-cost multipurpose lab equipment
Source citation (APA Format)	D'Ausilio, A. (2011). Arduino: A low-cost multipurpose lab equipment. *Behavior Research Methods*, *44*(2), 305–313. https://doi.org/10.3758/s13428-011-0163-z
Original URL	https://link.springer.com/content/pdf/10.3758/s13428-011-0163-z.pdf
Source type	Journal article
Keywords	I/O board. Cheap laboratory equipment. Experimental control. Arduino. TTLs read. TTLs write
#Tags	#engineering #cerebellarhypoplasia
Summary of key points + notes (include methodology)	This article primarily focuses on the advantages to low-cost Arduino boards and how they can be effectively used in software, hardware, and for many psychological and neurophysiological labs. Inside the Arduino, its hardware consists of an open hardware design that mostly come predesigned. There are some several third-party makers that produce shields that allow the Arduino boards to connect wirelessly, and one of the Critical Velocity Shield integrates a 3-axis accelerometer. Arduino hardware uses simplified C++, and Arduino software takes that and complies it so it can be loaded onto the motherboard. Professional timing hardware can take a lot of money out-of-pocket and can still give small errors when recording data even with an inexpensive Arduino sitting right there. D'Ausilio wanted to prove this and conducted 8 tests that would test the synchronization and accuracy of the Arduino Uno board, and the C++ he coded. He coded with multiple output and logic conditions, but the timing was still stable and great, proving that an inexpensive Arduino can work just as good, or arguably better than professional timing hardware.
Research Question/Problem/ Need	Can an inexpensive, low-cost Arduino Uno work just as well or even better than professional timing hardware when in use for psychological and neurophysiological labs?

Important Figures	 This is an image of the Arduino's digital I/O Ports
VOCAB: (w/definition)	Shields – add on boards I/O ports – An interface port that connects computing models to various connectors within the Arduino
Cited references to follow up on	MacInnes, W. J., & Taylor, T. L. (2001). Millisecond timing accuracy on PCs and Macs. Behavior Research Methods, Instruments, & Computers, 33, 174–178. Plant, R. R., Hammond, N., & Turner, G. (2004). Self-validating presentation and response timing in cognitive paradigms: How and why? Behavior Research Methods, Instruments, & Computers, 36, 291–303
Follow up Questions	If an Arduino is very low-cost and still effective, then if it is paired with a professional timing system, will it still work as well than with a lower-cost one?

Article #11 Notes: Motor markers of congenital cerebellar hypoplasia

Article notes should be on separate sheets

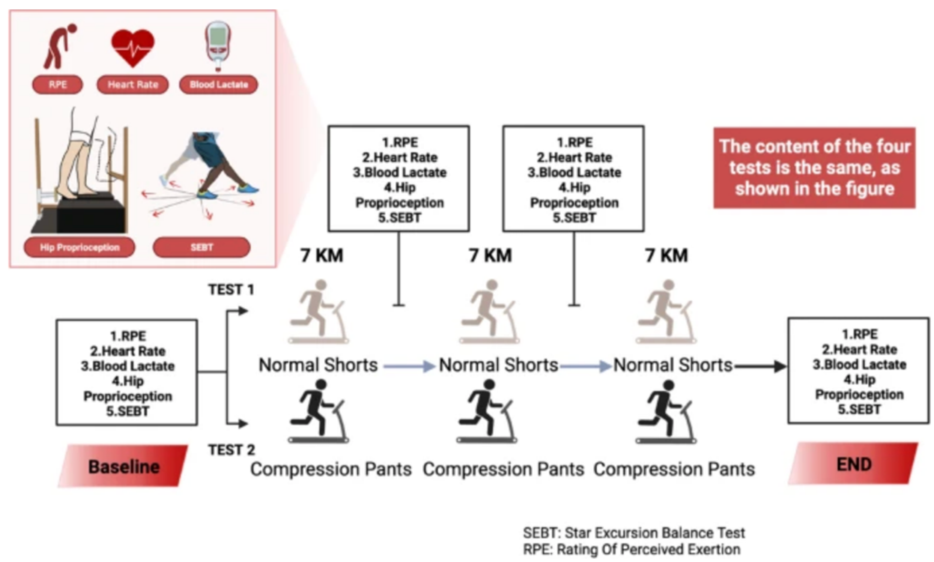
Source Title	Motor markers of congenital cerebellar hypoplasia
Source citation (APA Format)	Straulino, E., Devita, M., Sartori, L., Ravelli, A., De Rui, M., Bendini, M., Pini, L., Spoto, A., Betti, S., Marinuzzi, E., Mapelli, D., Castiello, U., & Begliomini, C. (2025a). Motor markers of congenital cerebellar hypoplasia. *Neuropsychologia*, *211*, 109121. https://doi.org/10.1016/j.neuropsychologia.2025.109121
Original URL	https://www.sciencedirect.com/science/article/pii/S0028393225000569?via%3Dihub
Source type	Journal article
Keywords	Cerebellar hypoplasia, Cerebellar diseases, Biomechanical phenomena, Magnetic resonance imaging, Upper extremity
#Tags	#cerebellarhypoplasia #engineering
Summary of key points + notes (include methodology)	The aim of this study is to characterize the temporal evolution of precision grip movements in patients with cerebellar hypoplasia over 2 years. A 42-year-old adult male participant (LS) was the participant in this study. He has cerebellar hypoplasia and was presented with headache, gait disturbances, visual difficulties, and left dysmetria. He and a control group of 10 healthy male participants of similar age performed a RtG task with their dominant hand towards a thin cylinder. The purpose of this task was to try and prevent the object from falling. They used motion capture with 6-camera SMART-D 3D system, and the markers were placed on the wrist, thumb, and index finger. MRI analysis was also involved to provide imaging of the underdeveloped cerebellum before and after these exercises. Ultimately, these series were able to result that LS exhibited slower RtG movements, which aligns with classic motor markers of congenital cerebellar hypoplasia. Although there was some adaptation from the practice from the test, the smoothness of the movements and control were still impaired.
Research Question/Problem / Need	How does cerebellar hypoplasia affect reach-to-grasp movements? Can reach-to-grasp movements show the motor markers present in patients with cerebellar hypoplasia?

Important Figures	 Brain of patient with congenital cerebellar hypoplasia
VOCAB: (w/definition)	Ataxic syndrome – a neurological syndrome characterized by lack of muscle control and coordination. RtG movement – (reach-to-grasp movement) a human behavior that involves the coordination between the arm (reach) and the hand (grasp) to interact with an object Sensorimotor network – large-scale brain network that processes sensory information and executes motor functions Left dysmetria – condition that causes individual to have lack of control of the movement in their left leg or arm
Cited references to follow up on	GILMAN, S., CARR, D., & HOLLENBERG, J. (1976). Kinematic effects of deafferentation and cerebellar ablation. *Brain*, *99*(2), 311–330. https://doi.org/10.1093/brain/99.2.311
Follow up Questions	Which parameters are most affected to cerebellar hypoplasia?

Article #12 Notes: Effects of compression pants on hip proprioception and dynamic balance during intermittent half-marathon running

Article notes should be on separate sheets

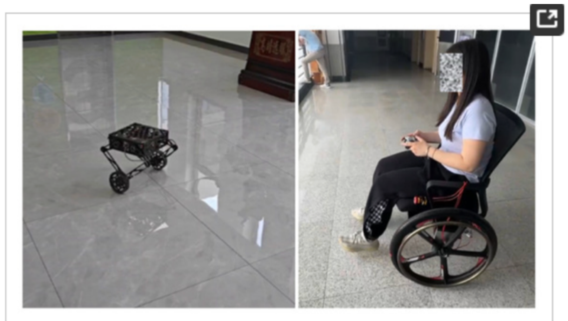
Source Title	Effects of compression pants on hip proprioception and dynamic balance during intermittent half-marathon running
Source citation (APA Format)	Chang, L., Sun, Y., Xue, X., Xu, W., Wu, S., Adams, R., Witchalls, J., Pranata, A., Li, Y., & Han, J. (2025a). Effects of compression pants on hip proprioception and dynamic balance during intermittent half-marathon running. *Scientific Reports*, *15*(1). https://doi.org/10.1038/s41598-025-17704-9
Original URL	https://www.nature.com/articles/s41598-025-17704-9
Source type	Journal article
Keywords	Compression, hip proprioception, dynamic balance, AMEDA
#Tags	#engineering
Summary of key points + notes (include methodology)	The research involved two users running indoors on a treadmill at 16 degrees Celsius to ensure temperature consistency. The participants started at 8 o'clock in the morning and needed to run 21 kilometers while wearing either compression pants or normal shorts. Everyone used their personal running shoes, and they received a break of one week in between the two trials. Those who were wearing the compression pants covered the ankles up to their waists. They were also given normal running shorts as a control variable that exerted no pressure. The participants perceived exertions (RPE) were measured using the Borg 6-20 scale. Hip extension proprioception was evaluated using AMEDA which comprises of three components: a standing platform, horizontal bar position, and a moveable disc. They were instructed to face forward and extend their hip from initial position until their Archilles tendon reverted to its initial position. This test was conducted for both groups in compression pants and normal shorts, and tests showed that in normal shorts, hip proprioception dropped after running 14 km while the proprioception in compression pants held equivalent to the baseline. This shows that compression pants may help maintain hip proprioception during runs up to 14 km.

Research Question/Problem/ Need	Can compression pants improve hip proprioception in half-marathon runners?
Important Figures	**Fig. 1**  Workflow diagram.
VOCAB: (w/definition)	Borg 6-20 scale – A numerical scale from 6-20 that measures physical strain on the body during physical activity Active movement extent discrimination apparatus (AMEDA) – A scientific test used in physical therapy used to measure proprioception, the body's sense of position in movement RPE – A fitness scale used to see how hard your body thinks it's working during activity Proprioception – The body's sense of position during movement
Cited references to follow up on	Van Middelkoop, M., Kolkman, J., Van Ochten, J., Bierma-Zeinstra, S. M. & Koes, B. Prevalence and incidence of lower extremity injuries in male marathon runners. *Scand. J. Med. Sci. Sports* **18**, 140–144. https://doi.org/10.1111/j.1600-0838.2007.00683.x (2008).
Follow up Questions	How can age, gender, height, or past running history affect the impact of hip proprioception if compression pants are worn?

Article #13 Notes: A Unified Control Framework for Self-Balancing Robots: Addressing Model Variations in Wheel-Legged Platforms and Human-Carrying Wheelchairs

Article notes should be on separate sheets

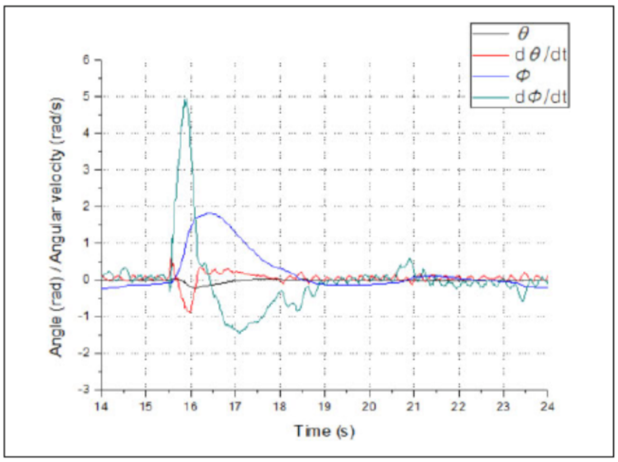
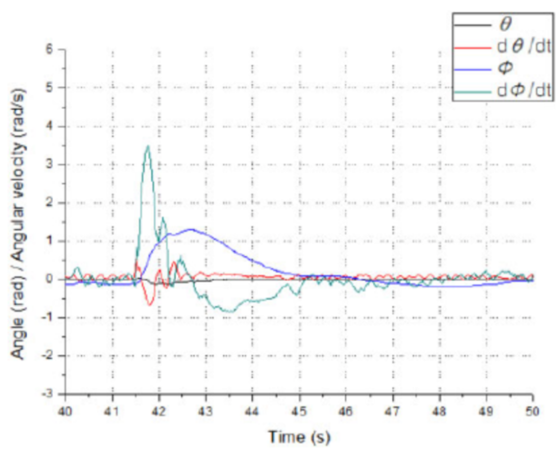
Source Title	A Unified Control Framework for Self-Balancing Robots: Addressing Model Variations in Wheel-Legged Platforms and Human-Carrying Wheelchairs
Source citation (APA Format)	Xin, G., Jin, B., Liu, C., & Jiang, M. (2025). A unified control framework for self-balancing robots: Addressing model variations in wheel-legged platforms and human-carrying wheelchairs. *Sensors*, *25*(23), 7144. https://doi.org/10.3390/s25237144
Original URL	https://www.mdpi.com/1424-8220/25/23/7144
Source type	Journal article
Keywords	Self-balancing robots; wheel-legged robots; LQR
#Tags	#engineering
Summary of key points + notes (include methodology)	This study was conducted to determine the effectiveness of the robots' control systems and highlight the robots' application potential. They developed two types of self-balancing robots: one is a conventional, small-sized wheel-legged robot, while the other is a larger self-balancing robot capable of carrying a person. These robots would use a LQR controller to maintain balance and a PD controller to track rotational speed. For the smaller wheel-legged robot, there would only be a leg controller to address rough terrain and jumps while the one capable of carrying a person had a torque sensor to provide real-time mass and CoM. The wheel-legged robot was controlled by an embedded microcontroller, and it showed that it was able to have stable velocity trackings and had successful jump maneuvers. The human-carrying wheelchair also showed stable velocity tracking's with a human on it and was able to climb a 5 cm step. Carefully watching the changes in mass and CoM allow for the microcontroller to perform reliably and shows that LQR and PD's can handle the functions for both robots.

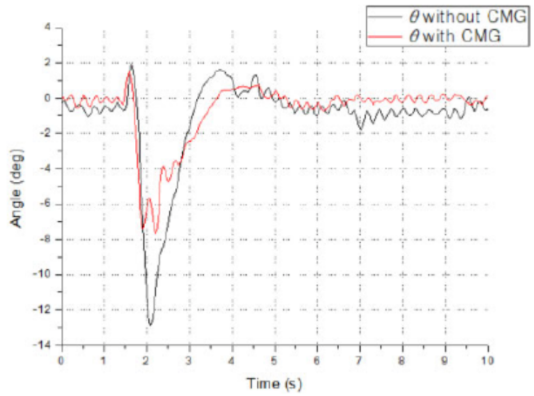
Research Question/Problem/ Need	Can one unified control system keep different types of self-balancing robots stable and safe?
Important Figures	 **Figure 1.** A small wheel-legged self-balancing robot and a large self-balancing wheelchair. See supplementary video [29] for dynamic maneuvers.
VOCAB: (w/definition)	PD controller – PD (proportional-derivative) is a feedback loop that uses the error given and previous feedback to adjust the system to stay in balance CoM – center of mass
Cited references to follow up on	Wang, J. (2023). Path tracking of a two-wheeled self-balancing robot based on multi-objective optimization with artificial immune algorithm. *2023 7th International Conference on Robotics and Automation Sciences (ICRAS)*, 12–17. https://doi.org/10.1109/icras57898.2023.10221649
Follow up Questions	How/does human weight affect control performance?

Article #14 Notes: Development of a self-balancing robot with a control movement gyroscope

Article notes should be on separate sheets

Source Title	Development of a self-balancing robot with a control moment gyroscope
Source citation (APA Format)	Park, J.-H., & Cho, B.-K. (2018). Development of a self-balancing robot with a control moment gyroscope. *International Journal of Advanced Robotic Systems*, *15*(2). https://doi.org/10.1177/1729881418770865
Original URL	https://www.researchgate.net/publication/324838887_Development_of_a_self-balancing_robot_with_a_control_moment_gyroscope
Source type	Journal article
Keywords	Self-balancing robot, control moment gyroscope, disturbance observer, KUWAY
#Tags	#engineering
Summary of key points + notes (include methodology)	Wheeled mobile robots hold a significant advantage over humanoid robots. They are faster so they are able to have greater mobility, better rotation, and speed due to a balance controller that is embedded in the majority of self-balancing robots. Due to this, they have increased popularity as the Segway and the Ninebot, scooter-like self-balancing robots, are major successes across the market. However, increased use also increases probability of injury or death. The balance controller's knowledge of when to generate counter-torque is solely determined by feedback. This causes the controller to be unable to generate counter-torque in a quick enough time, resulting in vast fluctuations in angular tilt and velocity to stabilize itself, increasing the chance of injury to other objects and potential user on the robot. Therefore, the CMG was developed to be integrated into systems like this. The KUWAY, the self-balancing robot presented in this article, consisted of sensors, microcontroller, and a CMG subsystem. The IMU, gyro sensor, and rotary encoder measures tilt angle, angular velocity, and rotational motion. The microcontroller takes this data into account and decides how much corrective action should be taken to give to the CMG subsystem. The CMG itself is made up of DC motors, flywheels, a gimbal stabilizer, and a PID controller. The DC motors generate rotational motion and convert it into kinetic energy. The flywheels take that kinetic energy and continuously spin in order to store the energy in the form of angular momentum. The gimbal stabilizer takes that

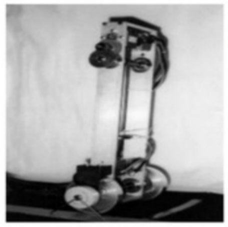
	momentum to stay charged to constantly tilt the box the CMG is stored in to generate counter torque perpendicular to the disturbance force. To test the KUWAY, a 10 kg weight was dropped from a 25 Degree angle to test the disturbance force with and without a CMG. The figures presented below showcase the results, and the CMG was most effective in stabilizing the robot when presented with a disturbance force.
Research Question/Problem / Need	How can a control movement gyroscope (CMG) achieve better mobility and rotation in a self-balancing robot to lower safety and stability risks?
Important Figures	 Figure 1: without the CMG  Figure 2: with the CMG

	 Figure 3: comparison of CMG and no CMG
VOCAB: (w/definition)	Disturbance force – A kick to the robot, a rock thrown, any force that hits the robot Flywheel – A flywheel takes mechanical energy to power itself to spin and store energy Flywheel DC motor – Generates rotational motion as the robot moves Gimbal stabilizer – takes the energy from the flywheel and stores it in the form of angular momentum, producing countertorque where needed PID controller – acts as a checker, smooths any unwanted overcorrection
Cited references to follow up on	Choi, D., Kim, M., & Oh, J.-H. (2012). Development of a rapid mobile robot with a multi-degree-of-freedom inverted pendulum using the model-based zero-Moment Point Stabilization Method. *Advanced Robotics*, *26*(5–6), 515–535. https://doi.org/10.1163/156855311x617489
Follow up Questions	How could the use of CMG's in self-balancing robots lead to lower power consumption devices? How could the use of CMG's be further analyzed to reduce the amount of velocity so it does not have to lean in the direction it was correcting?

Article #15 Notes: Control Strategies for Two-Wheeled Self-Balancing Robotic Systems: A Comprehensive Review

Article notes should be on separate sheets

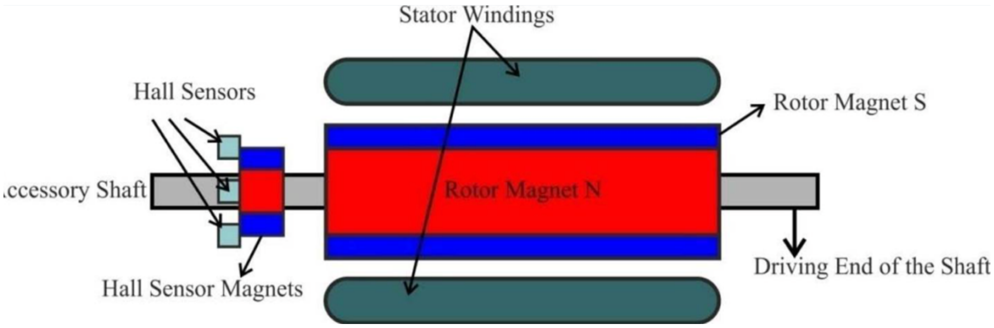
Source Title	Control Strategies for Two-Wheeled Self-Balancing Robotic Systems: A Comprehensive Review
Source citation (APA Format)	Zhang, H., & Mohamad Nor, N. (2025). Control Strategies for two-wheeled self-balancing robotic systems: A comprehensive review. *Robotics*, *14*(8), 101. https://doi.org/10.3390/robotics14080101
Original URL	https://www.mdpi.com/2218-6581/14/8/101
Source type	Journal article
Keywords	Control theory; linear control; nonlinear control; intelligent control; adaptive control; two-wheeled self-balancing robot
#Tags	#engineering
Summary of key points + notes (include methodology)	Two-wheeled self-balancing robotic systems (TWSBRs) are slowly beginning to substitute humans in hazardous and challenging environments because they are able to effectively complete difficult missions without having to worry about safety concerns. In the late 1980s, Professor Kazuo Yamato proposed the concept of a TWSBR, as seen in Figure 1a. He designed a two-wheeled balance as opposed to a multi-wheeled mobile robot because the TWSBR holds many advantages that allows them to hold dynamic balance continuously, complete all tasks while taking up minimal space, and recent studies show their rapid development in transportation, entertainment, and service sectors. In these applications, signal processing techniques such as observers, differentiators, and filters play a crucial role in keeping the robot stable. Because in real-time, these techniques are what is constantly updating the robot by sending messages of the current angular velocity and filtering the signal noise of the sensors, ensuring stable and precise control. However, in order for these techniques to be effective, there needs to be extensive consideration of the robot's dynamics, sensor performance, and control algorithms to meet the expectations of the system. Jmel et al. proposed an adaptive observer-based output feedback control method, that primarily focused on estimating the state and weight of the robot, while still being complemented by a PID controller in order to generate the precise control signals needed to keep the TWSBR stable.

Research Question/Problem/ Need	What control strategies can be applied to TWSBRs to optimize their ability to complete difficult tasks while still remaining in balance?
Important Figures	 (a) The concept. Figure 1a.
VOCAB: (w/definition)	Dynamic balance – the ability to control and steady while in motion PID controller – A control loop mechanism controller that is constantly calculating and adjusting the power output of the robot's motors to restore it back to its original speed and position with minimal overcorrection.
Cited references to follow up on	Jmel, I., Dimassi, H., Hadj-Said, S., & M'Sahli, F. (2021). Adaptive observer-based sliding mode control for a two-wheeled self-balancing robot under terrain inclination and disturbances. *Mathematical Problems in Engineering*, *2021*, 1–15. https://doi.org/10.1155/2021/8853441
Follow up Questions	Are there strategies to mitigate some risks in case of sensor failure or large disturbance forces?

Article #16 Notes: Position and Speed Control of Brushless DC Motors Using Sensorless Techniques and Application Trends

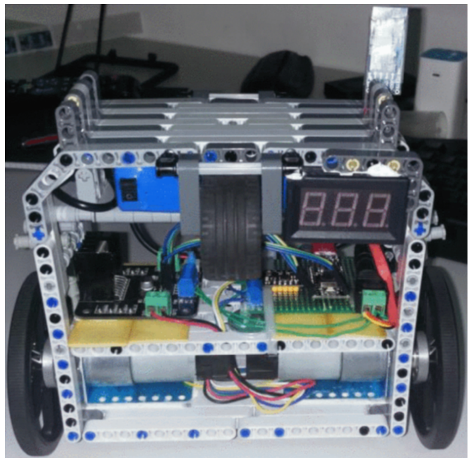
Article notes should be on separate sheets

Source Title	Position and Speed Control of Brushless DC Motors Using Sensorless Techniques and Application Trends
Source citation (APA Format)	Gamazo-Real, J. C., Vázquez-Sánchez, E., & Gómez-Gil, J. (2010). Position and speed control of brushless DC motors using sensorless techniques and application trends. *Sensors*, *10*(7), 6901–6947. https://doi.org/10.3390/s100706901
Original URL	https://pmc.ncbi.nlm.nih.gov/articles/PMC3231115/
Source type	Journal article
Keywords	BLDC, back-EMF, sensorless, position, speed, estimator, Hall-effect sensors, electronic processors
#Tags	#engineering
Summary of key points + notes (include methodology)	The brushless DC motor (BLDC) is a synchronous electric motor that looks very similarly to a regular DC motor. They both have a linear relationship between voltage, electric current, torque, and revolution per minute (used for rotational speed). However, the brushless DC motor has an electronically controlled commutation system instead of a mechanical commutation, which is more common in brushed motors. The BLDC is most useful in aerospace applications as the ratio of the delivered torque to the size of the motor is higher, which causes noiseless operation, higher speed ranges, and longer operation life. Their control can be managed through sensorless or sensor mode, but to reduce the costs of actuating devices, sensorless control mode is primarily used. All electrical motors that do not require electrical connections are considered brushless permanent magnet machines (PM motors). Because of the power density, reliability, efficiency, maintenance free nature and silent operation, PM motors have been vastly used for industrial automation, computers, aerospace engineering, military, and household products.
Research Question/Problem/ Need	What are methods to effectively open the way for full penetration of PM motors into all low cost, high reliability, and large volume applications?

Important Figures	 A diagram of the BLDC motor
VOCAB: (w/definition)	Electronically controlled commutation system – uses electronic devices to transmit any voice, video, text over a large distance Mechanical commutation – the traditional method where the DC motor presses against a commutator (split rings) PID controller – A control loop mechanism controller that is constantly calculating and adjusting the power output of the robot's motors to restore it back to its original speed and position with minimal overcorrection BLDC motor – an efficient electric motor that uses magnets and electromagnets for longer life and higher power density
Cited references to follow up on	Iizuka, K., Uzuhashi, H., Kano, M., Endo, T., & Mohri, K. (1985). Microcomputer control for sensorless Brushless Motor. *IEEE Transactions on Industry Applications*, *IA-21*(3), 595–601. https://doi.org/10.1109/tia.1985.349715
Follow up Questions	What sensorless techniques would be the most practical for real-world deployments?

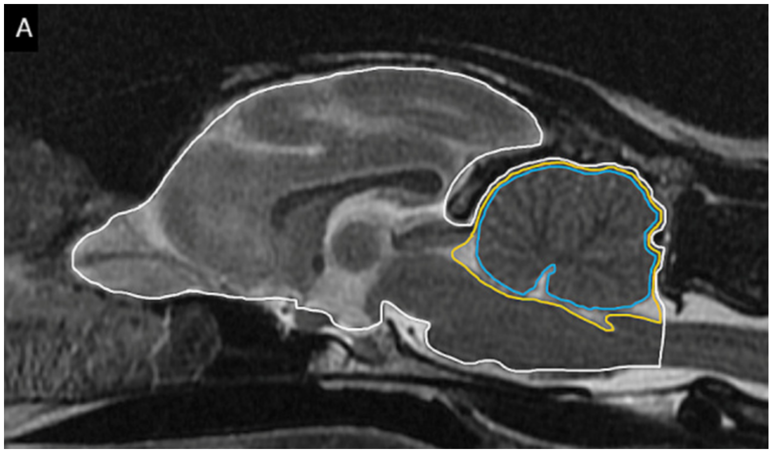
Article #17 Notes: Control system for a self-balancing robot

Source Title	Control system for a self-balancing robot
Source citation (APA Format)	Martins, R. S., & Nunes, F. (2017). Control system for a self-balancing robot. *2017 4th Experiment@International Conference (Exp.at'17)*, 297–302. https://doi.org/10.1109/expat.2017.7984388
Original URL	https://ieeexplore.ieee.org/document/7984388
Source type	Journal article
Keywords	PID, Kalman filter, Roll angle, Bimbo navigation, IMU, Control system, self-balancing robot
#Tags	#engineering
Summary of key points + notes (include methodology)	The control of a two-wheeled robot is a topic that many people find fascinating due to its large impacts on society. People have been studying this to find the perfect math model and structure characteristics in a helper robot. A PID (Proportional-Integral-Derivative) controller is one of the most commonly used control systems because it's not necessary to know their model equations. Most robots have this controller to mitigate the unstable effects of those without one as it considers the error given and compares it to past experiences to adjust accordingly. The Bimbo robot is a lego-based robot that has precise geometry and robustness. It contains an MPU6050, Kalman filter, various motors that control different variables, a PID controller, an Arduino, and several encoders. After these electronics were integrated into the robot, multiple trials were run on Matlab, creating an algorithm to show the variations on time/signal graphs. One of the more important components in this Bimbo is the Kalman filter. It is used for state estimation to determine and adjust the quality of the sensor measurements from the MPU6050 and IMU to fix the angle of the robot more accurately. It allows enough counter torque to be produced without giving the robot too much overcorrection. It ensures careful adjustment using the PID controller and the Kalman filter.
Research Question/Problem/ Need	What could support the PID controller in maintaining a stable environment for self-balancing robots?

Important Figures	 Fully assembled Bimbo Robot
VOCAB: (w/definition)	MPU6050 – A gyroscope and an accelerometer in one, it measures speed across three axes IMU – measures rotational velocity and tilt, ensures enough feedback is getting sent to the rest of the robot body
Cited references to follow up on	Chan, R. P., Stol, K. A., & Halkyard, C. R. (2013). Review of modelling and control of two-wheeled robots. *Annual Reviews in Control*, *37*(1), 89–103. https://doi.org/10.1016/j.arcontrol.2013.03.004
Follow up Questions	Why did the engineer choose to use a PID controller rather than a more advanced one?

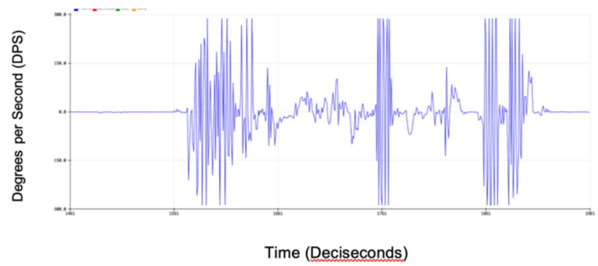
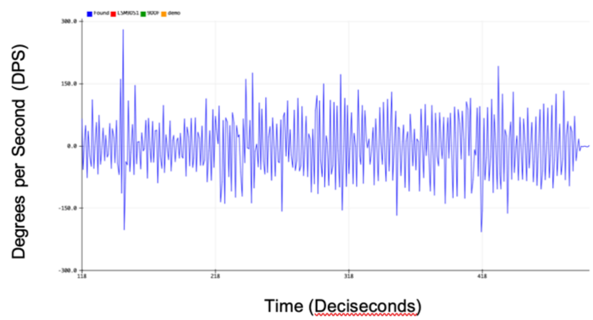
Article #18 Notes: Clinical, imaging, and histopathological characterization of a series of three cats with cerebellar cortical degeneration

Source Title	Clinical, imaging, and histopathological characterization of a series of three cats with cerebellar cortical degeneration
Source citation (APA Format)	Giron, C., Hélie, P., Parent, J., Boutin, M., & St-Jean, G. (2024b). Clinical, imaging and histopathological characterization of a series of three cats with cerebellar cortical degeneration. *BMC Veterinary Research*, *20*(1). https://doi.org/10.1186/s12917-024-04127-3
Original URL	https://pmc.ncbi.nlm.nih.gov/articles/PMC11186075/
Source type	Journal article
Keywords	Purkinje cells, Cerebellar cortical degeneration, Genetic, MRI, Inherited
#Tags	#biology #cerebellarhypoplasia
Summary of key points + notes (include methodology)	Inherited neurological diseases are relatively rare in domestic animals, particularly cats. However, cerebellar hypoplasia is one of the most common neurological conditions that is caused when the mother cat is infected with a panleukopenia virus (parvovirus) when the kittens are in utero. But other than cerebellar hypoplasia, infectious disease such as toxoplasmosis and feline infectious peritonitis are less rare, but the chance of remaining meningoencephalitis turning into cerebellar cortical degeneration becomes larger. Cerebellar cortical degeneration is one of the most common neurodegenerative diseases present in domestic animals. In this study, there are multiple cases of domestic animals that have infectious diseases that developed into cerebellar degeneration including two male and one female shorthair cat. Case 1 was the female cat, she had cerebellar ataxia across all of her limbs, and her nystagmus was less severe on the left side of her body. Case 2 was the male cat, and his hopping reactions were delayed with exaggerated responses. Case 3 is the other male cat, a cat with cerebellar degeneration who had a consistent decline for his health. Although the severity of the diseases was different across all animals, their mental status was appropriate, their gait was hypermetric, and intention tremors were heavily present. Some of the highlights throughout cases was that for the first case, it was already suspected that the cat had cerebellar cortical degeneration. Also, the MRI and pathology observations across all three cases are grouped for future sections.

Research Question/Problem/ Need	What are the normal and clear signs of cerebellar cortical degeneration in cats based on the three cases conducted on these cats?
Important Figures	 Photo of the measurements from the MRI
VOCAB: (w/definition)	Hypermetric – something that exceeds normal measure
Cited references to follow up on	Passantino, A., & Masucci, M. (2016). Congenital and inherited neurologic diseases in dogs and cats: Legislation and its effect on purchase in Italy. *Veterinary World*, *9*(5), 437–443. https://doi.org/10.14202/vetworld.2016.437-443
Follow up Questions	Why did the pathologists necessarily need the histopathology in order to diagnose cerebellar cortical degeneration when there are other ways of determining it?

Article #19 Notes: Lending a Hand for Parkinson's: Reducing Tremors with a Glove

Source Title	Lending a Hand for Parkinson's: Reducing Tremors with a Glove
Source citation (APA Format)	Kaul, A. (2020). Lending a Hand for Parkinson's: Reducing Tremors with a Glove. *Massachusetts Academy of Math and Science at Worcester Polytechnic Institute*.
Original URL	Source given by Dr. Crowthers.
Source type	Literature Review
Keywords	Parkinson's Disease, assistive device, tremor frequencies, glove, neurodegenerative disease, Arduino,
#Tags	#engineering
Summary of key points + notes (include methodology)	Parkinson's Disease is a neurodegenerative disease that degrades motor function over time and can decrease a patient's quality of life. One symptom that decreases that quality of life is the number of tremors patients experience on their day-to-day life. Therefore, engineer Anaya Kaul chose to deisgn an assistive glove that could prevent this using an Arduino Uno, gyro-accelerometer, and a gyro-device. A sensor circuit was constructed using an Adafruit 9-DOF Accel/Mag/Gyro+Temp Breakout Board-LSM9DS1 that is compatible with an Arduino UNO board. This sensor can detect tilt, temperature, and changes in rotational motion. It was hooked up to a laptop where four wires were soldered onto the breadboard to keep the pins and wires in place while the application was running. A battery pack was also used and connected to an ESC which tells the hard drive to constantly spin which is consisted of a disk and a brushless motor. The hard drive is covered with an old metal cover and attached with two screws to prevent the disk from touching the user's skin. Data collection from the sensor circuit before and after the activation of the gyro device shows a 67% difference of tremor frequencies. Before wearing the glove, these frequencies averaged around 30.9 tremors for an interval of 20 seconds. After wearing the glove, tremors were able to reduce to 10.1 tremors for an interval of 20 seconds, showing that this assistive device was effective in combating the tremor symptoms present in Parkinson's Disease.

Research Question/Problem/ Need	How can an assistive device be designed to help mitigate the tremors present in Parkinson’s Disease while still maintaining low-costs?
Important Figures	Figure 1  Figure 1: Degrees per second (DPS) vs. Time (deciseconds - 1/10 of a second) before Glove Wearing Figure 2  Figure 2: Degrees per second (DPS) vs. Time (deciseconds - 1/10 of a second) during Glove Wearing
VOCAB: (w/definition)	Gyro-device – measures orientation and angular velocity Brushless motors – high-efficiency. Motor that uses electronic commutation instead of manual brushes Gyro-accelerometer – measures the acceleration across multiple axes as the machine moves
Cited references to follow up on	Khan, E., & Panchal, A. (2015). Mechanical movement aid to nerve damaged and parkinson’s using pressure & Frequency Detection (Pseudo Arm Controller). *2015 International Conference on Communications and Signal Processing (ICCSP)*, 1544–1548. https://doi.org/10.1109/iccsp.2015.7322775
Follow up Questions	Are there alternatives to using an Adafruit sensor circuit if you want to collect data on multiple axes?

Article #20 Notes: Review of modelling and control of two-wheeled robots

Source Title	Review of modelling and control of two-wheeled robots
Source citation (APA Format)	Chan, R. P., Stol, K. A., & Halkyard, C. R. (2013). Review of modelling and control of two-wheeled robots. *Annual Reviews in Control*, *37*(1), 89–103. https://doi.org/10.1016/j.arcontrol.2013.03.004
Original URL	https://www.sciencedirect.com/science/article/pii/S1367578813000060?casa_token=WNfWkg578t0AAAAA:DvGQCQA-uCk4KSeRv9hlkGGjn2NiOOcpvMD9w1dUXA1PSYkz65ks4_RZEKyAjS76M-EnA_9p
Source type	Journal article
Keywords	Nonlinear dynamics, two-wheeled robots, self-balancing robots, control strategies, stabilization control, feedback control, feedback loops
#Tags	#engineering
Summary of key points + notes (include methodology)	Two-wheeled robots hold significant advantages over other mobile robots. Their wheel configuration makes it easier for them to turn on the spot, rotate quicker, and carry out smaller tasks more efficiently. When a robot turns, there are two points for the yaw angle. If you ignore the change of inertia in the yaw axis, it can simplify derivation as the tilt angle changes. A black-box model of system dynamics can be found, too. It allows for model coefficients to be solved through least-square algorithms that solves to independent white noise. To track a certain speed or trajectory, wheel encoders, IMUs, and a Kalman filter is used to estimate the tilt of the robot in the case that the IMU isn't properly working to perform as that accelerometer needed to provide information to the rest of the body. This article also explores a bit into those self-stabilizing robots that have more than two wheels. Because of the weight and increased stability necessary to maintain balance, a suspension system is needed. A suspension system is a network of springs, shock absorbers, linkages, and tires that connect the body of the robot to its wheels.
Research Question/Problem/ Need	What control methods have been modelled and developed to take more precise control of a two-wheeled self-stabilizing robot?

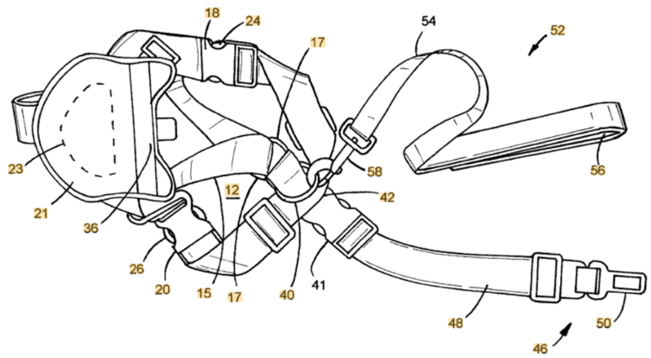
Important Figures	 Figure: Two-Wheeled Robot
VOCAB: (w/definition)	Yaw angle – the rotation of an object around its vertical axis
Cited references to follow up on	Moore, S. M., Lai, J. C. S., & Shankar, K. (2007). ARMAX modal parameter identification in the presence of unmeasured excitation—I: Theoretical background. *Mechanical Systems and Signal Processing*, *21*(4), 1601–1615. https://doi.org/10.1016/j.ymssp.2006.07.003
Follow up Questions	Why are so many studies reliant on simulations versus testing in real-time in real life?

Patent #1 Notes: Animal harness

Source Title	Animal harness
Source citation (APA Format)	Thorne, R. (2020, July 24). *US9241474B2 - Animal Harness*. Google Patents. https://patents.google.com/patent/US9241474B2/en?q=%28cat%2Bharness%29&oq=cat%2Bharness
Original URL	https://patents.google.com/patent/US9241474B2/en?q=(cat+harness)&oq=cat+harness
Source type	Patent
Keywords	Harness, adjustable straps, chest panel, girth panel, leg openings
#Tags	#engineering

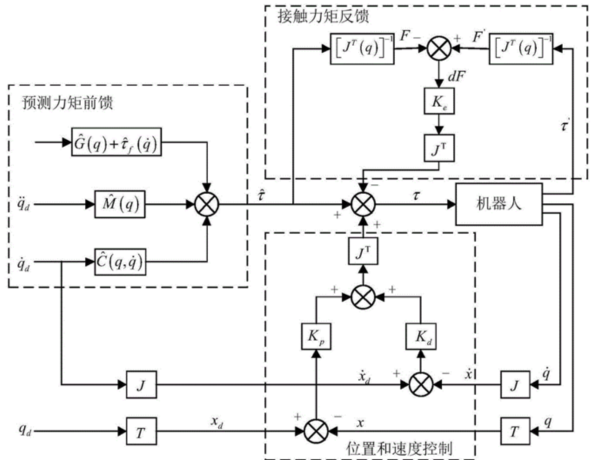
Summary of key points + notes (include methodology)	This patent is an animal harness made for dogs, cats, and other domestic animals. It includes:
	• Loop of webbing
	  ○ Goes through the animal's neck, shoulders, back
	  ○ The webbing is comprised of any suitable material, such as nylon or the like.
	• Pouch and the pulsating device
	  ○ Pulsated Device: this device simulates a heartbeat in a way that the pulsations transmitted are very near the heart of the animal it is on
	  ○ The pouch is in direct contact with the chest of the animal and is fixed to the torso belting
	• Buckle seatbelt latch
	  ○ The harness also has a leash that can be converted for different uses, such as seatbelts for travelling
	  ○ This latch allows for safe travel and decreases the likelihood of injury if there is a sudden drop

Research Question/Problem/ Need	How can a pulsating device affect an animal's stress or safety in its everyday life while still securing the animal?

Important Figures	 FIG. 1 is a plan view of a harness in accordance with the present invention;
VOCAB: (w/definition)	Vocab listed above in the summary section.
Cited references to follow up on	N/A
Follow up Questions	Does the pulsating device have any special effects such as reducing anxiety in domestic animals versus regular harnesses? If so, is it a substantial decrease?

Patent #2 Notes: Robot self-adaptive impedance control system based on dynamic model

Source Title	Robot self-adaptive impedance control system based on dynamic model
Source citation (APA Format)	Ying, Z., Xuejun, Z., Bo, L., & Guoqiang, L. (2020, September 18). *CN110065070B - robot self-adaptive impedance control system based on dynamic model*. Google Patents. https://patents.google.com/patent/CN110065070B/en?q=%28self%2Bbalancing%2Brobot%29&oq=self%2Bbalancing%2Brobot
Original URL	https://patents.google.com/patent/CN110065070B/en?q=(self+balancing+robot)&oq=self+balancing+robot
Source type	Patent
Keywords	Robot, dynamic model, adaptive control, feedback loop
#Tags	#engineering
Summary of key points + notes (include methodology)	This patent primarily wants to solve the issue that industrial robots should be more precise, flexible, and safe because they work with humans everyday. They struggle with unexpected external environmental changes, overcorrection, and maintaining accuracy when handling delicate jobs for humans. This control system uses dynamic modelling to predict how the robot will move while the adaptive impedance controller adjusts the behavior of the robot so it can respond to any form of force quickly. Impedance controller: • Ensures the robot moves with more fluidity, reducing the margin of error and chance of injury Adaptive control strategy: • Monitors the position, velocity, and force to make quick changes depending on what conditions it is met with • Reduces the need for extra sensors to carry more work because it's adaptive, so it constantly is looping through a feedback loop to improve it's sense of position and direction
Research Question/Problem/ Need	How can adaptive impedance control help these robots to move more safely and smoothly?

<table>
<tr><td>Important Figures</td><td>
</td></tr>
<tr><td>VOCAB: (w/definition)</td><td>Vocabulary listed above in the summary section.</td></tr>
<tr><td>Cited references to follow up on</td><td>N/A</td></tr>
<tr><td>Follow up Questions</td><td>Quantitatively, how much can the robot improve its performance when adjusting the force response in real time?</td></tr>
</table>