Project Notes:

Project Title: Using AI image recognition to detect defects in syringes during the manufacturing process

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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.

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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
Learning how image recognition AI works	Reading articles about image recognition AI	Within articles about image recognition AI	10/9/24
Developing and training a neural network	Read articles or watch tutorials on neural network coding and creation	Within articles or videos about the subject	10/24/24
Creating separate datasets and comparing each other	Most likely read specific articles about the topic of comparing different datasets	Within specific articles about the subject	10/24/24

Literature Search Parameters:

These searches were performed between (Start Date of reading) and XX/XX/2025.
List of keywords and databases used during this project.

Database/search engine	Keywords	Summary of search
Google	Image recognition AI	Papers that contain applications of image recognition
Google	Defect detection image recognition	Explanations of defect detection from a variety of websites. Also, papers that discuss AI defect detection in manufacturing.

Tags:

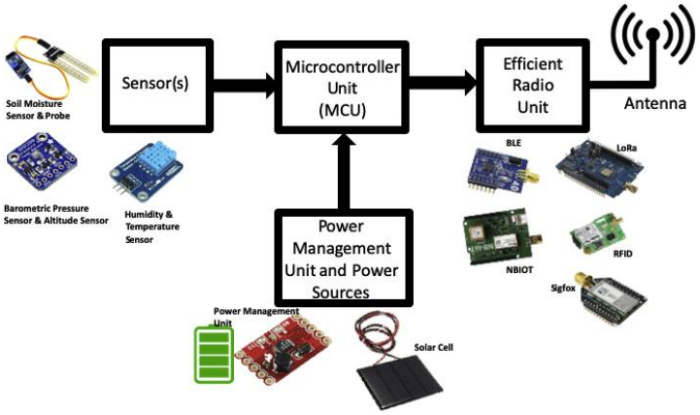
Tag Name	

Article #1 Notes:

Article notes should be on separate sheets

KEEP THIS BLANK AND USE AS A TEMPLATE

Source Title	Internet of Things (IoT): Opportunities, issues and challenges towards a smart and sustainable future
Source citation (APA Format)	Nižetić, S., Šolić, P., López-de-Ipiña González-de-Artaza, D., & Patrono, L. (2020). Internet of Things (IoT): Opportunities, issues and challenges towards a smart and sustainable future. *Journal of Cleaner Production*, *274*, 122877. https://doi.org/10.1016/j.jclepro.2020.122877
Original URL	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7368922/
Source type	Journal Review Article
Keywords	IoT, Smart city, Sustainability, Energy, Environment, SpliTech2020
#Tags	
Summary of key points + notes (include methodology)	Introduction • IoT will bring further progression to many fields like engineering and agriculutre • Potential idea of smart cities introduced • Linkage of IoT devices was identified as a challenge, but extremely important in the overall importance of IoT Application Areas • Smart cities: Allows the interconnection of various data sources in a city and early detection of problems. For example, if an IoT device detects a water shortage, the device could communicate with other devices in other fields to help mitigate the problem. • Industrial Applications • Agriculture: Different sensing and detection techniques using IoT devices • Healthcare: Different medical systems could be interlinked to offer better patient treatment • Transportation: Especially helpful for autonomous vehicles and how they communicate • Discusses the problem of high energy consumption switch to smart grids and how IoT can be important for this • Smart grids can adapt to changes in energy supply and demand, which IoT will be key in

	Hardware • Sensors of different metrics (ex: temperature, soil moisture, altitude) • A microcontroller which processes information • A power unit or power management • An efficient radio unit The article is an overall review of the state of the Internet of Things (IoT) and its growing importance in various fields. After an initial introduction about how devices that belong in the IoT are tightly knit together to complete certain tasks, the article gets into specific fields that IoT could be useful for, such as the medical, civil, industrial, and agricultural fields. FInally, the article discusses how IoT can be used to detect problems in real-time, which could help streamline business processes, making it easy to manage inventory and prevent losses.
Research Question/Problem/ Need	What is a general overview of current-world problems that the Internet of Things can help solve, and how does the Internet of Things work?
Important Figures	 This image is a visual representation of how IoT devices can detect environmental changes, process that using specific hardware, and relay that information to other devices using radio communication
VOCAB: (w/definition)	Internet of Things – The interconnection of devices through the internet, where all devices can share and communicate information with each other. Smart Cities – The use of the Internet of Things for efficient quality control and management of cities
Cited references to follow up on	
Follow up Questions	How will energy consumption be impacted due to the high amount of IoT devices being introduced right now? How is AI and data science helping manage IoT devices? What privacy risks will the interconnection of smart devices bring?

Article #2 Notes:

Article notes should be on separate sheets

KEEP THIS BLANK AND USE AS A TEMPLATE

Source Title	Turning up the heat on next-generation semiconductors
Source citation (APA Format)	Zewe, A. (2024a, May 23). *Turning up the heat on next-generation semiconductors*. MIT News | Massachusetts Institute of Technology. https://news.mit.edu/2024/turning-up-heat-on-next-generation-semiconductors-0523
Original URL	https://news.mit.edu/2024/turning-up-heat-on-next-generation-semiconductors-0523
Source type	News Article
Keywords	
#Tags	
Summary of key points + notes (include methodology)	Introduction • A need for silicon based electronics to handle higher temperatures • Ex: Sending rovers to other planets that have high surface temperatures • Gallium nitride could be a potential alternate for silicon • Scientists found high temps didn't cause much damage to a gallium nitride device's material and contacts Turning up the heat • Scientists don't know nearly as much about the properties of gallium nitride as much as they do about silicon • Contact resistance needs to be tested first as it is an important point

	in making sure the electronics are efficient and fast • Built devices using gallium nitride called transfer length method structures Methodology • Short-term test – device placed on a hot chuck of 500 degrees, and resistance measurements were immediately taken • Long-term test – device placed in a furnace for 72 hours at 500 degrees. Results • Both tests showed positive results, the gallium nitride contact resistance remained constant for 48 hours at 500 degrees. • This info can be used to create high-temperature gallium nitride transistors, which previously couldn't be made because of insufficient knowledge on contact resistance. The article explores the future of silicon in semiconductors, and what alternatives to silicon are being tested so that semiconductors can withstand higher temperatures (for example, sending silicon-based electronics to hotter planets). Materials like gallium nitride are still decades behind silicon in terms of how much scientists understand about them. So, two temperature tests were conducted to measure contact resistance, one short-term and another long-term. During the short-term test, a gallium nitride device was placed on a hot chuck of 500 degrees and resistance measurements were immediately taken. For the long-term test, the researchers found that gallium nitride contact resistance remained constant for up to 48 hours at 500 degrees. The researchers are using this information to implement insulators that can make the nitride last even longer.
Research Question/Problem/ Need	How effective will the use of gallium nitride in semiconductors be in withstanding extreme temperatures?
Important Figures	
VOCAB: (w/definition)	Ohmic resistor – A resistor that obeys Ohm's law: The voltage at the ohmic resistance is directly proportional to the current flowing through it. Contacts – devices that connect semiconductors to other electronics
Cited references to follow up on	
Follow up Questions	What are some other methods and tests that scientists are conducting to learn more about gallium nitride and its properties? What are some other solutions that scientists have proposed for improving how much temperature gallium nitride can withstand? What are some other use cases for high-temperature withstanding semiconductors?

Article #3 Notes:

Article notes should be on separate sheets

KEEP THIS BLANK AND USE AS A TEMPLATE

Source Title	Speech Recognition Algorithm
Source citation (APA Format)	Goddard, W. (2024, September 22). *Speech recognition algorithm*. ITChronicles. https://itchronicles.com/artificial-intelligence/speech-recognition-algorithms/
Original URL	https://itchronicles.com/artificial-intelligence/speech-recognition-algorithms/
Source type	Website
Keywords	
#Tags	
Summary of key points + notes (include methodology)	• Speech recognition algorithms are used to convert voice into text • Advantages i. Work processes can be faster, ex: documents generated more quickly ii. Used to provide basic info on customer service lines

	iii. Helps hearing and visually impaired iv. Easy, hands-free communication • Analog to digital converter • Sound waves are captured to be analyzed in a spectrogram, a graph. i. Each segment is converted into number, successfully digitizing it ii. The converter cannot understand what the sounds mean, so now it goes to the speech recognition algorithm • The hidden Markov model identifies and arranges these phonemes in the right level i. Phonemes represent the slightest alterations of speech that indicate a new word. Ex: Thumb vs dumb, "th" vs "d" ii. HMM first identifies phonemes through the spectogram iii. Then it checks the probability that the phonemes were identified correctly by checking phonemes around each other and seeing if they make sense iv. Then, words near each other are checked to see if it makes sense v. Since there are so many phonemes and combinations, the algorithm is not perfect, and it is not adaptive. • Neural networks can also be used for speech recognition i. A neural network may output something different than expected based on its previous training. The error between the desired output and the actual output is used to train the model, but this takes a lot of inputs to develop a strong model ii. Neural networks aren't the best by themselves for speech recognition because of speech's sequential form iii. Therefore, both neural networks and the HMM are used together in many speech recognition applications today
Research Question/Problem/ Need	Summary: The article discusses the process of how speech is converted into text at a high level. It first talks about how analog data is converted into numbers a computer can understand and then transferred to a Hidden Markov Model or a neural network. Both of them are algorithms that identify words in speech, whether it be through statistical analysis or comparison with a dataset. Both have weaknesses in completing this process, such as low flexibility or a large input necessity. Therefore, the algorithms are often used in conjunction to get the best speech recognition models.
Important Figures	
VOCAB: (w/definition)	Spectrogram – Visual representations of the spectrum of frequencies of a

	signal (sound in this case) Decibel – Logarithmic measurement of volume
Cited references to follow up on	
Follow up Questions	How are digital signals converted into a spectrogram by the Fast Fournier Transform? What are some more specific applications of speech recognition models? How important are speech recognition models for us in the present world?

Article #4 Notes:

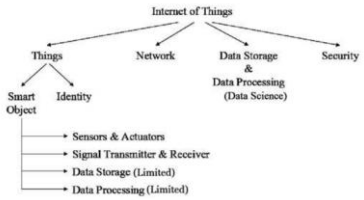
Source Title	Internet of Things: Energy Boon or Bane?
Source citation (APA Format)	Hittinger, E., & Jaramillo, P. (2019). Internet of Things: Energy boon or bane? *Science*, *364*(6438), 326–328. https://doi.org/10.1126/science.aau8825
Original URL	https://www.science.org/doi/10.1126/science.aau8825
Source type	Journal article
Keywords	Internet of Things Energy Consumption

#Tags	Dematerialization Remote Energy Use Energy Use for Communications
Summary of key points + notes (include methodology)	Methodology (N/A) Introduction: • Adding smart functionality to a device will slightly increase energy consumption • Due to the recent skyrocket of devices incorporated into the IoT that use smart functionality, energy consumption will skyrocket as well Factors of energy consumption: • Data communication and processing between devices and servers • Mass manufacturing of new devices (can be mitigated with dematerialization) • User behavior and the rebound effect, where the product is pretty much just so good that the user uses it more which causes increased energy consumption Factor that seems promising in reducing energy consumption: • New devices could be more energy efficient for standby tasks, which is a trend that has been happening with newly released electronic devices for the past few decades. • However, new devices often are less energy efficient for active power use Outlook: • New energy standards could be created for devices • General better use of resources • At the moment, research about effects of specific devices on energy consumption is available, but existing data on behavior and adoption of these devices is not enough to fully understand the large-scale energy implications the IoT will cause. The recent growth of the Internet of Things has caused energy consumption to skyrocket for more reasons than just local IoT device use. IoT devices require data processing and remote data communication for proper function, the improved efficiency of IoT products can "rebound" and increase the usage of the products, and the high demand for IoT devices will cause an increased amount of manufacturing, which can all increase energy consumption. Engineers are looking for ways to reduce energy consumption, perhaps by creating new standards for the efficiency of IoT devices or through a more efficient use of resources.
Research Question/Problem/ Need	Why has the Internet of Things caused a rise in energy consumption, and why are remote data communications and user behavior the leading causes of this?
Important Figures	N/A
VOCAB: (w/definition)	Energy footprint – A measure of how much energy is consumed and its environmental impact Dematerialization – The process of reducing the quantity of materials and

	resources to manufacture a product while not reducing its quality. Usually done to reduce environmental impact and resource use.
Cited references to follow up on	
Follow up Questions	1. Although energy consumption because of data transfer and remote communication has been continuously growing, what are some strategies that can be used to mitigate this? 2. How did the energy used to manufacture certain technologies decrease even though the power of these devices increased? 3. Can the “rebound” effect reach an equilibrium where the efficiency of IoT devices doesn’t increase the usage of these devices significantly? What are some examples of this? 4. The article mentions AI as a related field to the IoT. How impactful will AI-related IoT devices be to human behavior?

Article #5 Notes:

Source Title	Artificial Intelligence in Internet of Things
Source citation (APA Format)	Ghosh, A., Chakraborty, D., & Law, A. (2018). Artificial intelligence in Internet of things. *CAAI Transactions on Intelligence Technology*, *3*(4), 208–218. https://doi.org/10.1049/trit.2018.1008
Original URL	https://ietresearch.onlinelibrary.wiley.com/doi/pdfdirect/10.1049/trit.2018.1008
Source type	Journal Article
Keywords	
#Tags	
Summary of key points + notes (include methodology)	• Lot of repeated information in this article, so I will list key points for notes • Discusssion of subtopics of the internet of things, such as: i. Cognitive science ii. Real time analytics (this is important for me) iii. Big Data Analytics iv. Machine Learning v. Wireless sensor networks vi. Networked Control vii. Software and applications viii. Actuators and motors ix. Embedded systems x. High Performance Computing • Things + Intelligence + Network = Internet of Things • Internet Services + Intelligence = Internet of Services • Internet of Things + Internet of Services = Internet of Everything • Data science is becoming increasingly important because of the large amount of data that is produced because of the internet of things. This also ties back to my previous article about energy footprints because of large amounts of data! • Various examples of smart devices that connect to the internet of things (robots, voice assistants, etc.) • Cyber physical systems – engineered systems that depend on the integration of computational algorithms and physical components. The article then gives a list of examples throughout history of some of these systems, like auto-aiming anti-aircraft weapons in WW2. • Discusses integrating CPSs with each other using IoT, and how a technology called psychological framework can help in analyzing unstructured data, which will be helpful in integrating the two. • Challenges of CPS and IoT are discussed

	i. CPS creates a lot of big data to be cleaned and analyzed ii. Data is always constantly changing, which can make it hard to predict iii. IoT devices need to be able to communicate across the world, which can be hard with certain areas iv. Privacy and ethical concerns v. Scalability of the IoT since there will be so many devices vi. Energy consumption Methodology N/A (Since this is a journal article that discusses the current state of IoT) The article is a general review about the Internet of Things, how it will affect the future of technology and human behavior, and AI's role in analyzing data to improve the Internet of Things. There is frequent discussion about machine learning being developed for analyzing the massive amount of data that will result from the millions of devices that are connected across the world, and how machine learning algorithms can adapt and continuously learn from the given data. The article also discusses some challenges that AI-powered IoT and services face, such as regions of the world that cannot connect to IoT, security and trust concerns, scalability of data, energy consumption, and incredibly large amounts of data.
Research Question/Problem/ Need	How will AI and machine learning affect the future of the Internet of Things and the data management that will come along with it, and what are some challenges that will arise because of it?
Important Figures	 **Fig. 3** *IoT architecture tree* A breakdown of the different components that make up the Internet of Things. The figure eases the process of visualizing vital factors that allow the IoT to function and communicate.
VOCAB: (w/definition)	CPS: Cyber-physical systems – A system of physical objects connected through the internet that have processing capabilities. SO: Smart objects – Physical objects that have communication or processing technologies that can access the internet.
Cited references to follow up on	
Follow up Questions	What is being done to ensure that the future AI-powered IoT devices will not heavily impede user privacy or security? What are some sub-fields of IoT that AI is helping to develop/improve?

	The article describes AI as an immensely powerful tool in analyzing and understanding large amounts of user data. However, can AI become too powerful, and what are companies doing to ensure that it doesn't?

Article #6 Notes:

Source Title	Artificial Intelligence-Based Image Recognition System
Source citation (APA Format)	Paul, M., Vivek, K., Jo Joseph, P., Sharanjith, V., Malik, S., & Rajeev, S. (2023). Artificial intelligence based image recognition system. *Materials Today: Proceedings*, *72*, 3222–3227. https://doi.org/10.1016/j.matpr.2022.12.192
Original URL	https://www.sciencedirect.com/science/article/abs/pii/S2214785322075642?via%3Dihub
Source type	Journal Article
Keywords	Convolutional Neural network VGG16 architecture Labelling Optical character recognition Python Class label accuracy
#Tags	
Summary of key points + notes (include methodology)	Introduction: • Medical industry currently bills entities manually, which can be time-inefficient but also can result in mistakes • Image recognition system could be used instead to accurately and more efficiently bill medicines with the use of a camera and software to process images Methodology:

	• 3D reconstructions of pharmaceutical products guide the convolutional neural network model, which is very important to use for the image recognition system • A total of 100 different types of medication were used, with 30 images taken of each, to conduct the training process • Object detection occurs through bounding box regression. A bounding box is a prediction made by a neural network where a specific characteristic of an image is surrounded by a box by the AI. It is a prediction, which means it is often wrong, but the neural network can learn from its mistake by comparing its predictions of a characteristic with the ground-truth bounding box. • The training dataset and testing dataset are separated. Both datasets have bounding boxes that surround key features on all images. Each bounding box is labelled in a text file which details what the neural network should recognize when looking at a specific bounding box. • To process the information from an image, a neural network is used. A neural network contains an input layer, a bunch of hidden layers that try to identify patterns in the data, and an output layer that returns an output based on the data, which in our case is another bounding box that identifies a certain part of an image as a key feature. Challenges: • Images captured can often be very high res, which can cause processing times to drastically increase and put high stress on the hardware. Therefore, image compression software was used to reduce the resolution of the images without lowering their overall quality by much. Results: • The model is 90% accurate in correctly identifying pharmaceutical products The article explores how organization and recognition of medicine could be more efficient and proposes AI image recognition to help with this. The article details how the AI processes and recognizes these images, which includes classifying the medicines by using a neural network that compares 3D models of the medicines to organize the pictures. The end of the article described the accuracy of the neural network, which was around 90%.
Research Question/Problem / Need	How could a Image recognition machine learning model be used to efficiently classify medicines?
Important Figures	High-level overview of the creation and implementation of an image recognition model used to identify medicines.
VOCAB: (w/definition)	CNN – Convolutional Neural Network – Uses three-dimensional data for image recognition purposes.

Cited references to follow up on	
Follow up Questions	What are some other fields that use image recognition to complete a specific task more efficiently or easily? What knowledge gaps should one fill to be able to create an image recognition model? How powerful should hardware be to run an image recognition model?

Article #7 Notes:

Source Title	The AI Guardian: Unmasking image processing in defect detection
Source citation (APA Format)	Kolesnikova, I. (2024, August 21). *The Ai Guardian: Unmasking image processing in defect detection*. MindTitan. https://mindtitan.com/resources/blog/defect-detection/
Original URL	https://mindtitan.com/resources/blog/defect-detection/
Source type	Blog Article
Keywords	
#Tags	
Summary of key points + notes (include methodology)	• Defect detection is crucial in quality control and meeting quality standards. It is important in maintaining consumer safety and the reputation of a brand. • The article goes over a high-level explanation of how AI works and how it can be used for defect detection

	• A neural network will be trained on 2 sets of data for defect detection- One contains objects with no defects, and another contains products with defects. This will allow the AI to learn what the differences are between products that have flaws and ones that don't. • Benefits of defect detection with AI - i. Improved accuracy and consistency. Well-trained AI algorithms have high precision detection, reducing the chance of overlooking issues like humans may accidentally do. ii. Real-time detection. This is possible because of AI's ability to quickly process and analyze data. iii. Cost efficiency. AI defect detection can reduce manual labor and cut down on the time used to identify problems in each device. • 3 key goals of AI driven defect detection: i. Object recognition - "What type of defect does this segment of the product show?" ii. Object Detection - "Where are the defects located on the overall product?" iii. Object Tracking - (Only important for continuously moving products, this likely won't be relevant for my project, but good to know just in case) Can track objects as they move (ex: a conveyor belt) and still find defects on them. • Potential of AI driven defect detection in retail i. Real-time shelf management ii. Product quality of fresh produce • In manufacturing i. Quality control ii. Package control • Public transportation and infrastructure i. Vehicle defect detection ii. Infrastructure maintenance • Food an agricultre i. Defect detection in fruits and vegetables (such as fungus or diseases) • Problems in defect detection i. Small sample sizes available for a particular product ii. Imbalanced data: Not enough samples of a product that have defects The article discusses the importance of defect detection and how machine learning can be useful for making the process easier. Machine learning can be useful for object recognition, like what type of defect is present, object detection such as where the defects are located on the object, and object tracking which continuously montiors moving parts. The article also gives examples of how machine learning for defect detection can be useful for many different fields, such as utilities, transportation and public

	infrastructure. It also explores some current problems with defect detection, like small sample sizes and imbalanced data.
Research Question/Problem/ Need	How can machine learning be trained and used in order to increase the efficiency of defect detection and benefit companies?
Important Figures	
VOCAB: (w/definition)	Batch learning – Process of training a machine learning model with a large set of data all at once. Imbalanced data problem – Amount of data related to defects of a problem is low compared to data about non-defected product, causing an imbalance in data
Cited references to follow up on	
Follow up Questions	What are some specific products or fields that require defect detection? Briefly mentioned in the article, how can machine learning training workaround small sample sizes? How much energy and what type of hardware is required for high-level defect detection like in the Hepta Airborne example?

Article #8 Notes:

Source Title	Detection and Segmentation of Manufacturing Defects with Convolutional Neural Networks and Transfer Learning
Source citation (APA Format)	Ferguson, M. K., Ronay, A., Lee, Y. T., & Law, K. H. (2018). Detection and Segmentation of Manufacturing Defects with Convolutional Neural

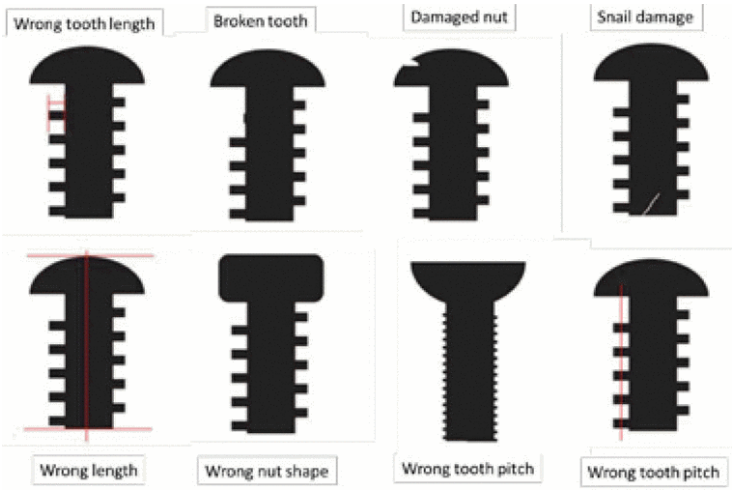
	Networks and Transfer Learning. *Smart and sustainable manufacturing systems*, *2*. https://doi.org/10.1520/SSMS20180033
Original URL	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6512995/
Source type	Journal Article
Keywords	Smart Manufacturing, Transfer Learning, Defect Detection, Casting Defect Detection, Weld Defect Detection, Automated Surface Inspection, Convolutional Neural Networks
#Tags	
Summary of key points + notes (include methodology)	• Use of instance segmentation to improve results more than just object detection • GRIMA database potentially useful for my own research? • Lots of math that seems like advanced calculus. Don't think I need to understand to get the overall picture of the article though. • Feature extraction, region proposal, region-based detector, and masking make up the defect detection system presented in this article. • Biggest problem with this new method of defect detection is that it's slower than the current state-of-the-art model. However, it is more accurate than that model. • 4 stage structure of defect detection to create masks of defects on x-ray i. Feature extraction ii. Region proposal of the mask iii. A region-based detection of defects iv. Creation of the mask • The model surpasses state of the art technology in terms of accuracy, but is not as fast as that system • Variables that could affect results of model i. Data augmentation – modifying existing images slightly to create twice the amount of data than before, potentially improving accuracy ii. General dataset sizes – larger size = potential increase in accuracy, but possibly takes more time to process the set iii. Speed vs. Accuracy tradeoff The article discusses a neural network model that detects defects in X-rays, and proposes a new detection technique that uses instance segmentation alongside object detection to surpass current state-of-the-art detection technology in accuracy. The middle of the article talks about the defect

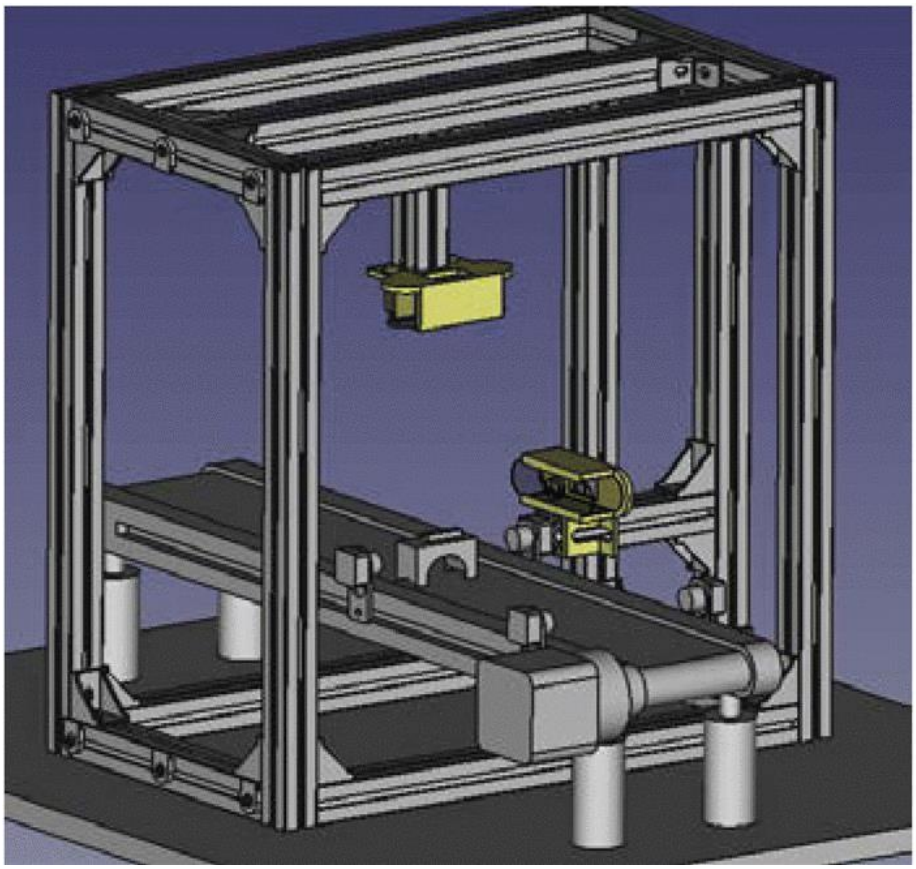
	detection system at a deeper level, such as its 4 stage structure that extracts and classifies features of an x-ray, and the math that happens behind network training and detection. Finally, the article presents results about the accuracy and efficiency of the proposed neural network and compares it to other detection models. Other topics, such as data augmentation, the speed versus accuracy tradeoff, and dataset sizes are discussed as factors that vary results of different models.
Research Question/Problem/ Need	How can instance segmentation be used alongside traditional object detection to improve current defect detection methods in x-rays?
Important Figures	
VOCAB: (w/definition)	Segmentation mask – A mask that will identify defects in images by annotating the corresponding pixels. This can be used by an image segmentation model
Cited references to follow up on	
Follow up Questions	What are some other improvements that can be made to the system to improve accuracy, regardless of time taken to analyze images? What would be the perfect balance of time and accuracy based on the current technology available? Can the 4-stage detection model be abridged or shortened in some way to reduce the time of the procedure without compromising accuracy?

Article #9 Notes:

Source title	Screw defect detection system based on AI image recognition technology
Original URL	https://ieeexplore.ieee.org/abstract/document/9394116/
Source type	Journal Article
Keywords	Screw defect detection system, image recognition
Source citation (APA Format)	Kuo, H., Xu, J., Yu, C., & Yan, J. (2020). Screw defect detection system based on AI image recognition technology. *2020 International Symposium on Computer, Consumer and Control (IS3C)*, 493–496. https://doi.org/10.1109/IS3C50286.2020.00134

Summary of key points + notes (include methodology)	• Introduction
	  ○ Screw defect detection system based on AI image recognition technology during the molding process
	  ○ Made for large screw manufacturing plant in Taiwan (This is mostly what the introduction is about)
	  ○ Key tech for molding screws is mechanical equipment and mold design.
	• Casting Process and Surface Defects
	  ○ Explanation of how screws are manufactured is provided, the nine steps being pickling, spheroidizing, phosphate treatment, wire drawing, forming, teeth rolling, heat treatment, inspection, and packaging.
	  ○ Types of surface defects that were found on the screws were quenching cracks due to excessive heat treatment, forging cracks, forging bursts, shear busting, cut marks, and wrinkles
	• Methodology
	  ○ The AI image recognition system contains high quality cameras, computers with high-speed image processing capabilities, conveyor belts
	  ○ MobileNet V2 Deep learning model was the best deep learning that they could use for detecting defects in the spiral body
	  ○ Powerful AMD CPU and GPU was used to handle image recognition tasks
	  ○ Series of conveyor belts with cameras set up to easily capture images for the workstation to process
	  ○ All parts are customized to make the overall platform more flexible
	• Results:
	  ○ The image recognition system was 95% accurate in detecting screws with no defects, 97% for screws with thread flaws, 91.42% for screws with surface defects, and 100% for screws with 2 flaws in the screw factory

	Summary: The article discusses a testing platform that was used to detect defects within screws in real-time using image recognition AI. The article doesn't talk too much about the image recognition model itself, but rather the physical aspects of the system that makes capturing images for the model easier and more convenient. Before that, the article talks about different types of screw defects and why detecting defects in screws is important. Afterwards, the article details how a camera with an adjustable field of fiew was used to capture images of the screws, a conveyor belt was used to automate the process, and a powerful computer connected by USB to the camera was used to analyze the images. The results detailed the accuracy of the model, which was above 90% accurate in all fields in the screw factory setting.
Research Question/Problem/ Need	How can a proper physical testing platform be set up in order to incorporate an image recognition AI to find defects in real-time during the screw manufacturing process?
Important Figures	 The image shows visual representations of defects of the screw-body texture.

	 3D model of the testing platform where screws will be imaged.
VOCAB: (w/definition)	Mobilenet – A deep learning model that can analyze image datasets for patterns
Cited references to follow up on	
Follow up Questions	How can a similar testing area be created for medical products? Does making a testing platform help only with the speed of detecting defects in mass produced products, or will it the actual defect detection model more accurate? Is there any leeway for what defects can pass in screws, where the defect isn't enough to cause change in function?

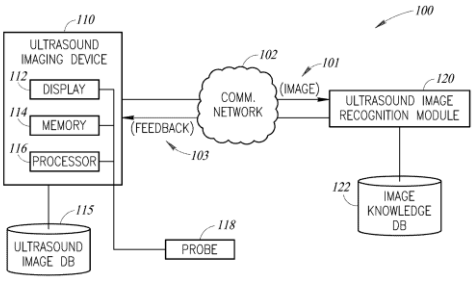
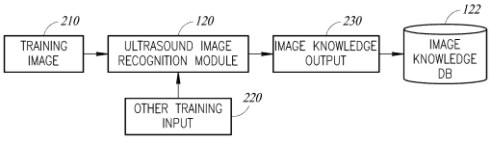
Article #10 Notes:

Source Title	Defect Detection in Products Using Image Segmentation
Source citation (APA Format)	Vinithavn. (2021, May 7). *Defect detection in products using image segmentation*. Medium. https://medium.com/analytics-vidhya/defect-detection-in-products-using-image-segmentation-a87a8863a9e5
Original URL	https://medium.com/analytics-vidhya/defect-detection-in-products-using-image-segmentation-a87a8863a9e5
Source type	Website Article
Keywords	
#Tags	
Summary of key points + notes (include methodology)	Introduction • Defines object detection and gives examples of technologies and everyday products that make use of this feature • Describes some cars as an example of technology that uses object detection. Self-driving cars need to use object detection to analyze its surroundings • The difference between object detection and image segmentation is also explained: Object detection by AI is denoted by bounding boxes, while image segmentation annotates each pixel of an image and sees if each pixel belongs to a specific object that the AI is trying to detect. Methodology • A very common metric in image segmentation is the Intersection-Over-Union score (IoU). The IoU is the area of overlap between the predicted segmentation and the ground-truth segmentation divided by the area of union between the predicted segmentation and the ground-truth segmentation. This metric is good to assess the accuracy of the image segmentation model. A score of 1 would indicate a perfect model. • Two folders were created to organize the dataset into training and testing sets. Each of those sets are separated into its own 2 folders, one containing images of defective products and the other containing objects of undamaged products. • Segmentation maps were created for all of the images. Images with defect products would get each pixel that contains the defected part annotated. Images without defects would have blank segmentation

	maps • Files that contained details about the segmentation maps were already provided before the creation of the masks. The researchers used code to create the segmentation maps based off the files' data, alongside the UNet model. Results • The model was 98% accurate in finding defects. No actual information about specificity of product defects was mentioned
Research Question/Problem/ Need	What is a general image segmentation model that can be used to find defects within images?
Important Figures	
VOCAB: (w/definition)	Intersection over Union – Image segmentation accuracy metric that is calculated by finding the area of overlap between the predicted segmentation and the ground-truth segmentation divided by the area of union between the predicted segmentation and the ground-truth segmentation. This metric is good to assess the accuracy of the image segmentation model.
Cited references to follow up on	
Follow up Questions	What are some ways to easily create segmentation maps instead of spending hours creating them individually? What are some datasets that already have segmentation data? Is using segmentation actually a lot more accurate than just bounding box regression?

Patent #1 Notes:

Source Title	Ultrasound image recognition systems and methods utilizing an artificial intelligence network
Source citation (APA Format)	Pagoulatos, N., Pailoor, R., Goodwin, K. (2021). *Ultrasound image recognition systems and methods utilizing an artificial intelligence network*. (U.S. Patent No. 12062426B2). U.S. Patent and Trademark Office. https://patents.google.com/patent/US12062426B2/
Original URL	https://patents.google.com/patent/US12062426B2/
Source type	Patent
Keywords	
#Tags	
Summary of key points + notes (include methodology)	Description of related art: • Ultrasound imaging is used to create pictures of organs, tissues, and other body features like fluids, bones, and joints. • Using ultrasound imaging technology requires a trained professional to operate the equipment and machinery • Training a professional can take significant amounts of time and be very costly Description of model: • An ultrasound imaging device is used to capture ultrasound images of a patient. Afterwards, the image data is transferred over to an image recognition model that can determine if the organs are clinically desirable. • Positive and negative feedback can then be provided to the patient based on the model's findings • The model is self-service, where the user can specify what view to capture. The model can also be supplied with periodic training updates, which can be • The model is trained through a specific dataset, and the training data can be sent to any imaging device to complete the same process. One dataset contains images showing normal organ function, while another contains images showing pathological organ function • This model was trained using backpropogation, where the weights of a neural network are adjusted by analyzing error rates of a previous iteration of the module. Summary: The patent discusses an ultrasound imaging model that is self-service and doesn't need to be operated by a trained professional. The

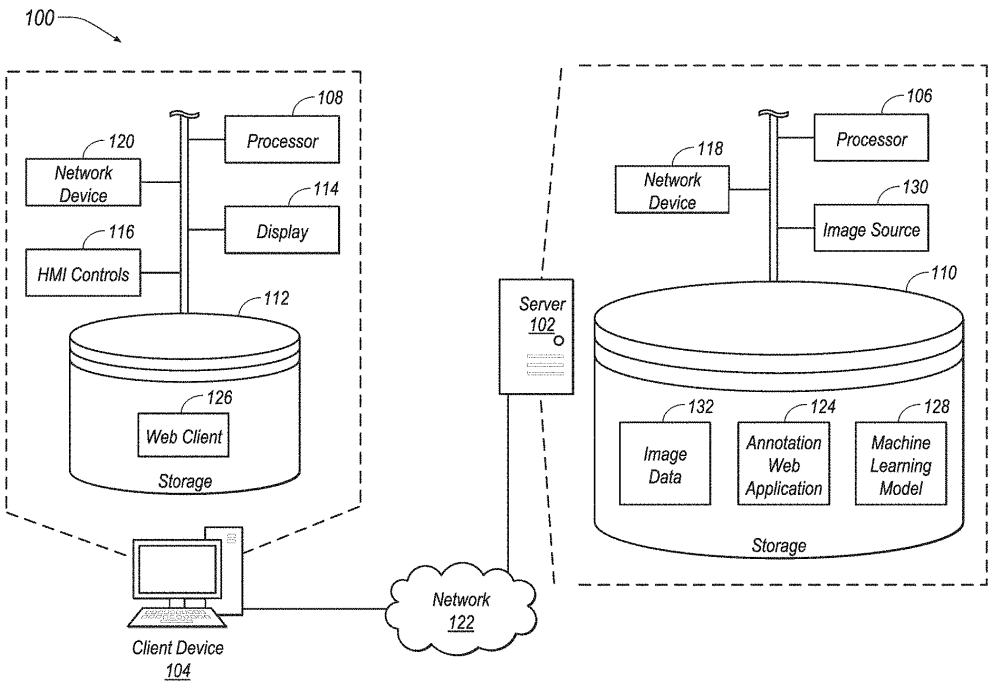
	scanning and analysis of patient organs is instead conducted by an image recognition model that is implemented in the design of the imaging system. The model was trained through 2 datasets, one containing images of normal organs and another containing images of organs that have pathological functions. The dataset can be easily downloaded by any compatible ultrasound imaging system, which makes it easily applicable to many systems.
Research Question/Problem/ Need	How can human training for the use of ultrasound imaging technology be reduced through a use of a self-service ultrasound system that uses an image recognition neural network?
Important Figures	 FIG. 1  FIG. 2 The figure visualizes the training process of the ultrasound image recognition neural network. The image recognition module provides feedback to the imaging device based off knowledge in the image database.
VOCAB: (w/definition)	Backpropogation – A neural network training algorithm where the weights of a neural network are altered based on previous iterations of teh neural network.
Cited references to follow up on	
Follow up Questions	What are some other uses of image recognition in the medical field? How can two datasets be compared separately using software? How can datasets be easily transferred between different ultrasound imaging devices?

Patent #2 Notes:

Source Title	Artificial-intelligence powered ground truth generation for object detection and tracking on image sequences
Source citation (APA Format)	Kim, J. E., Lin, W., Yu, L., & Rathore, G. (2019). *Artificial-intelligence powered ground truth generation for object detection and tracking on image sequences* (U.S. Patent No. 11126855B2). U.S. Patent and Trademark Office. https://patents.google.com/patent/US11126855B2
Original URL	https://patents.google.com/patent/US11126855B2/
Source type	Patent
Keywords	
#Tags	
Summary of key points + notes (include methodology)	Background: • Ground truths require high precision so an accurate neural network can be created • Humans can find it difficult to create bounding boxes with pixel level accuracy • It can be costly and too time taking for humans to manually create ground truth bounding boxes Overview of model: • Model contains a user interface, a storage configured to maintain raw image data including a video having a sequence of frames, and annotations of the frames that indicate aspects of objects identified in the respective frames; and a processor, in communication with the storage and the user interface.

	• The processor can determine task types for key frames (for both what the task is to be completed for a key frame (ex: what object must be identified) and who is completing that task (the agent type, agents can include a human or an automated process)) • Basically, humans will do some parts of the annotations and machines will do other parts • After this, key frames are selected for review based on a confidence level of the key frame annotations. This can be measured through the performance of the worker, a prediction score determined by machine identification of the annotations, or an analysis of image quality Improvement of the model • The machine side of the annotation process can become more efficient by using transfer learning from machine learnings models from previous annotations. • Retrain the model with previous batches of data overtime Applications • This model can be applied for annotating most objects on the screen, including pedestrians, cyclists, animals, various types of vehicle, etc. Summary: The patent describes a strategy that can be used to lower the human work needed to create ground truth labels of images for machine learning training. Instead, humans can handle the creation of some ground truth labels while a machine learning model can handle many of the other ground truth labels. The machine learning model can check both human and its own labels by using a confidence system that predicts the accuracy of its labels based on a prediction score and the performance of the worker. This can reduce a lot of the cost and time used in creating ground truth labels for object detection.
Research Question/Problem/ Need	How can the workload of humans be reduced during the ground truth labeling process for training through the use of a system where a machine learning algorithm can assist in creating ground truth labels?

Important Figures



The figure is an example annotation system for the capture and annotation of image data.

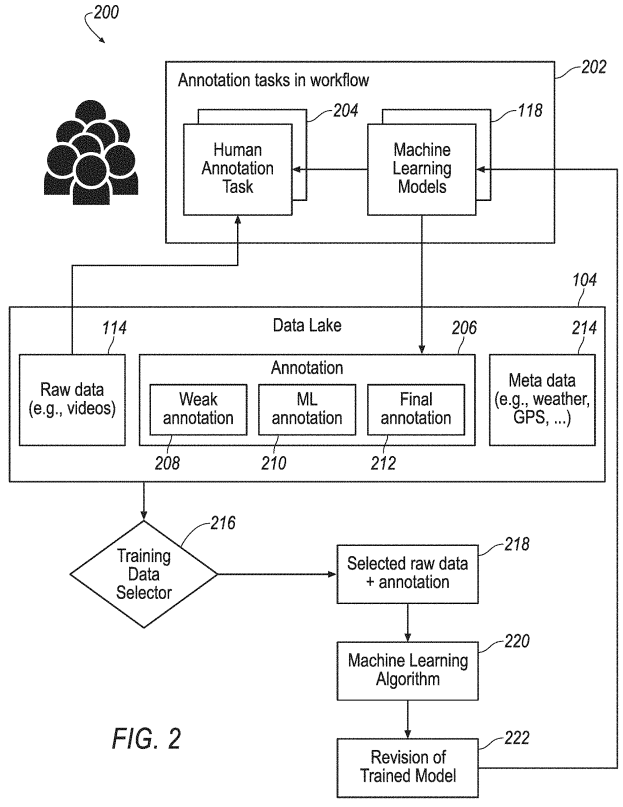


FIG. 2

This figure describes the annotation process of both human annotation of images and the machine learning annotation.

VOCAB: (w/definition)	Transfer learning – Using a pre-trained model for a related task (Ex: Using a model trained on dogs to work with cats by teaching the model what the differences are between dogs and cats. You don't need to retrain the entire model on cats because you can use pre-existing data on dogs that it was already trained on to help it with cats).
Cited references to follow up on	
Follow up Questions	How much would the combination of human and machine learning quantitatively improve efficiency of ground truth labeling? What are the risks involved with using a machine learning algorithm to create ground-truth models? How much would a machine learning model need to be trained to be ready to use for ground truth labeling?

Article #11 Notes:

Source Title	Top Pre-Trained Models for Image Classification
Source citation (APA Format)	GeeksforGeeks. (2024, July 3). *Top pre-trained models for Image Classification*. GeeksforGeeks. https://www.geeksforgeeks.org/top-pre-trained-models-for-image-classification/
Original URL	https://www.geeksforgeeks.org/top-pre-trained-models-for-image-classification/#
Source type	Website
Keywords	
#Tags	
Summary of key points + notes	• Pre-trained modules are already trained on larger datasets before

(include methodology)	they are fine-tuned for more specific tasks. This can reduce computational resources needed and the amount of data.
	• All pre-trained models have multiple layers for analyzing the images: initial layers focus on finding low level patterns in images, while later layers get more specific and look at higher level patterns
	• ResNet
	  ○ Uses residual links that can connect layers that are not directly adjacent in a neural network to prevent the vanishing gradient problem.
	  ○ It can have a very deep architecture (up to 152 layers)
	  ○ Used for object detection and feature extraction
	• Inception
	  ○ Can be used for transfer learning and object detection
	• VGG
	  ○ Fairly deep network with 16/19 layers
	  ○ Can be used for feature extraction and general image classification
	• EfficientNet
	  ○ Can scale depth, width, and resolution (made specifically for low computational resources).
	• DenseNet
	  ○ Every layer is connected with each other to improve gradient flow
	• MobileNet
	  ○ Lightweight and good for mobile devices
	  ○ Can easily be embedded into image classifying items
	• Benefits of Pre-trained NNs:
	  ○ Doesn't need as much training data because they re pre-trained on larger datasets
	  ○ Can be more accurate even with less image data
	  ○ Training time will likely be shortened
	• Cons of Pre-Trained NNs:
	  ○ Might not be able to easily adapt to any new training dataset
	  ○ Overfitting: NN may fail to generalize on unseen data
	  ○ Can be very complex for new NN users to try
	
	Summary: Pre-trained neural networks make the image training process easier for multiple use cases, such as feature extraction, object detection, embedded neural networks, and other general image classification tasks. The article presents many famous pre-trained models and what their benefits and use-cases are. The article also discusses the potential benefits of these models, such as reduced time to train and improved accuracy. Negatives are also discussed, like overfitting data and reduced adaptability to new training data.

Research Question/Problem/ Need	What are some different pre-trained image classification neural network models and what are their individual benefits and use-cases?

Important Figures	
VOCAB: (w/definition)	Gradient – The maximum rate of change that a neural network can train at to reach an optimal solution. Higher gradients are better. Residual links – Normally, layers in a NN are linked sequentially, from one to the next. However, residual links connect a layer to other layers that are not necessarily adjacent, which can improve gradient flow.
Cited references to follow up on	
Follow up Questions	Which of these presented pre-trained models will be best for my defect detection project? How can problems such as vanishing gradient, overfitting, and low adaptability be prevented with pre-trained models? What is the tradeoff that I want to make between accuracy and computational power (I don't have infinite computational power)?

Article #12 Notes:

Source Title	A Practical Guide to Object Detection using the Popular YOLO Framework – Part III (with Python codes)
Source citation (APA Format)	Sharma, P. (2024, July 10). *A practical guide to object detection using the popular Yolo Framework - Part III (with python codes)*. Analytics Vidhya. https://www.analyticsvidhya.com/blog/2018/12/practical-guide-object-detection-yolo-framewor-python/
Original URL	https://www.analyticsvidhya.com/blog/2018/12/practical-guide-object-detection-yolo-framewor-python/
Source type	Website
Keywords	
#Tags	
Summary of key points + notes (include methodology)	Introduction • YOLO is a popular pre-trained model for image classification and object recognition tasks. • It's extremely fast and efficient How it works • YOLO takes an inputted image and separates it into grids • Then, image classification is applied on each grid • More specific: o For each grid, these coordinates are specified: ▪ Whether an object is present or not in the grid ▪ If so, the 4 coordinates of the bounding box to label that object ▪ The other coordinates will be a list of what object we are looking for, ex: pedestrian, bike, car, etc. The object that it actually is will be assigned a "1" while the others will get a "0". o Convolutional filters are applied, where the AI does some math with each pixel of an object to figure out what it's looking at. Different filters can be used when looking for different things. Checking itself • The AI then uses Intersection Over Union to see how far off its prediction of an object is from the ground-truth. The area of intersection of the two bounding boxes is compared to the area of

	their union, and if the value is over 0.5, then the prediction is good enough. • Non-max suppression is also used, to see if a single object was detected multiple times and to prevent that YOLO has been updated many times recently for better accuracy and efficiency, and can be easily implemented in Python. The article discusses the YOLOv7 model in depth, such as how it processes images and checks its predictions. The YOLO model splits up an image into a grid, and analyzes each box in the grid for objects of interest. Convolutional filters are applied where the model does some math with each pixel of an image to figure out what it's looking at. To check its predictions, the intersection over union algorithm is used to see how far off it was from the ground truth and produce accuracy results.
Research Question/Problem/ Need	How does the YOLOv7 neural network quickly and efficiently analyze images for object detection purposes?
Important Figures	
VOCAB: (w/definition)	Convolutional filter – A matrix of values that is applied to the pixels of an image for feature extraction Non-max-suppresion – A technique used by image classification models to prevent duplicate object detections.
Cited references to follow up on	
Follow up Questions	What are some of the features this model has that others don't? Is intersection over union commonly used by other object detection models? What is the purpose of splitting each image up into grids, does this improve time efficiency?

Article #13 Notes:

Source Title	Defect Detection in Manufacturing using YOLOv7
Source citation (APA Format)	Pendse, R., Rajput, H., Saraf, S., Sarwate, A., & Jadhav, J. (2023). Defect Detection in Manufacturing using YOLOv7. *International Journal of Research and Analytical Reviews*, *10*(2), 179–185. https://ijrar.org/papers/IJRAR23B2819.pdf
Original URL	https://ijrar.org/papers/IJRAR23B2819.pdf
Source type	Journal Article
Keywords	
#Tags	
Summary of key points + notes (include methodology)	Introduction: • Modern factories produce 100s of items each hour • Defects can be present in many of these items, which can harm welfare of consumers, reduce brand reputation, etc. • Quality assessment is often done by people, but with new AI technology this isn't necessary • CNNs are the best choice for digital identification tasks. • YOLOv7 currently has the fastest real-time object detection (this is very important for detecting manufacturing defects in real time) • YOLOv7 first conducts region-based proposal of objects, where initial bounding boxes are created. • Afterward, classifiers are given to the bounding boxes, non-max suppression is used to remove duplicate predictions Methodology: • YOLOv7 is not sensitive to small target detection, so it needs to be modified • A new feature layer was introduced into the CNN that is more appropriate for small target detection

	• LabelImg is a free and open-source tool, was used to label images for ground-truths
	• Each image labeled generated a txt file that contained details about the labels. The text files were converted so that the YOLOv7 model could read them
	• To prevent overfitting, data augmentation was used, where minor changes were made to existing data to create new data.
	• Training:
	  ○ Use tools like PyTorch or TensorFlow to train the model
	  ○ 250-400 epochs are needed to get good accuracy
	• Testing:
	  ○ 10% of original dataset was used to test the model
	  ○ High quality cameras are mounted above a conveyor belt
	  ○ The YOLOv7 model will be converted into ONNX, so data can be easily used by various applications
	Results:
	• After 600 epochs, the model was found to be 99% accurate, with all incorrect detections being false negatives (missed defects)
	
	Summary: The article discusses the use of a YOLOv7 model that is trained to detect defects in manufactured products in real time. The creation and training of the model is talked about, where the LabelImg tool was used to create ground-truth labels, PyTorch was used to train the model, and a training dataset was run through the model for 600 epochs. The model was found to be around 99% accurate in correctly detecting defects in products.

Research Question/Problem/ Need	Create an industrial setup that can detect defects in real-time of manufactured products using a modified version of the YOLOv7 neural network model.
Important Figures	

	Industrial Setup of the model
VOCAB: (w/definition)	Region-based proposal: The neural network's guess of object locations on an image. mAP – Mean average precision (Overall accuracy)
Cited references to follow up on	
Follow up Questions	Can the industrial setup described in the article be somewhat recreated using DIY materials? What are some disadvantages of using YOLOv7 over other models? Why does this model require so many more epochs than I have seen in other papers and journals? Does it have to do with the model itself?

Article #14 Notes:

Article notes should be on separate sheets

KEEP THIS BLANK AND USE AS A TEMPLATE

Source Title	Custom Object Detection with YOLOv7: A Step-by-Step Guide
Source citation (APA Format)	Soni, S. (2024b, June 23). *Custom object detection with yolov7: A step-by-step guide*. Medium. https://medium.com/@sachinsoni600517/custom-object-detection-with-yolov7-a-step-by-step-guide-fd9d2800bb03
Original URL	https://medium.com/@sachinsoni600517/custom-object-detection-with-yolov7-a-step-by-step-guide-fd9d2800bb03
Source type	Website
Keywords	
#Tags	
Summary of key points + notes (include methodology)	Introduction • YOLOv7 is a model known for its speed and real-time detection capabilities • The article states a general table of contents for the stuff the article will talk about, such as preparing a dataset, training and testing Methodology:

	• For installing required modules
	  ○ Create a virtual environemt to conduct the network
	  ○ Clone the YOLOv7 repository off github and the install all requirements it needs
	  ○ Download the pretrained weights since this is a pre-trained model on a larger dataset
	• Training the model
	  ○ Download a dataset off openimages, or create your own
	  ○ Label the data using LabelImg, which first needs to be downloaded
	  ○ Split data into training and testing datasets, 80% allocated to training and 20% for testing
	  ○ Create a yaml file for configurating the model
	  ○ Start the training process
	  ○ After training is done, a file will be generated that has training weights
	• Testing
	  ○ Run a command that provides a path to your testing data
	  ○ Results will be generated
	
	The article discusses the process for setting up and training and testing with the YOLOv7 model in detail. It first discusses the specifics of creating a virtual environment, downloading the model and its weights in the environment, and setting up a dataset. Afterwards, training is described, where configuration files are created, datasets are separated, and what commands need to be run to initiate training. Finally, the testing process is also described, and results can be gathered from here.

Research Question/Problem/ Need	How can the YOLOv7 model be implemented for detection tasks?
Important Figures	
VOCAB: (w/definition)	Openimages – a website containing datasets of various objects Yaml – a configuration file type for the YOLOv7 model
Cited references to follow up on	
Follow up Questions	How can overfitting be prevented in the YOLOv7 model? What will need to be altered in the yaml file of the model? Is OpenImages a reliable source for datasets?

Article #15 Notes:

Article notes should be on separate sheets

KEEP THIS BLANK AND USE AS A TEMPLATE

Source Title	How Do Conveyor Belts Work?
Source citation (APA Format)	Lindbichler, A. (2024, February 13). *How do conveyor belts work: A guide to conveyors*. How Do Conveyor Belts Work: A Guide to Conveyors. https://www.autostoresystem.com/insights/how-do-conveyor-belts-work
Original URL	https://www.autostoresystem.com/insights/how-do-conveyor-belts-work
Source type	Website
Keywords	
#Tags	
Summary of key points + notes	Introduction

(include methodology)	• Conveyor belts have a belt than loops over 2 pulleys. Used in factories for various reasons. Ex:
	  ○ Transportation
	  ○ Assembly
	  ○ Sorting
	  ○ Loading
	  ○ Unloading
	• They are good for improving speed and efficiency of the manufacturing process
	Detailed explanation
	• Components of a conveyor belt
	  ○ Motor drive: Powers the drive pulley in the conveyor belt to turn. This motor drive can have different sizes, which is reliant on high/low loads or the speed that the load needs to go
	  ▪ Motors are usually electric
	  ○ Drive pulley: The motor rotates the pulley to make the conveyor belt spin in the desired direction
	  ○ Idler rollers: Support the belt and make sure the belt maintains its tension
	  ○ Conveyor frame: Provides support for the belt, rollers, and motor. Made out of a durable metal such as aluminum or steel.
	• The belts are automated using a program which can control many variables:
	  ○ Speed of belt
	  ○ Direction of belt
	  ○ Sensors and feedback mechanisms which can control other variables of the conveyor belt
	Conclusion:
	• Summary of importance of conveyor belt
	• Explain their use in factories
	• General overview of how it works

Research Question/Problem/ Need	What are the different parts that make up a conveyor belt and how do they work together to create a smooth product?
Important Figures	
VOCAB: (w/definition)	Idler roller – Supports the belt and keeps its tension strong Motor drive – Causes the drive pulleys to spin, which in turn make the conveyor belt function and spin as well
Cited references to follow up on	

Follow up Questions	How much would the different parts of this system cost? What are the challenges in making your own conveyor belt? Do only certain conveyor belts have all the controls mentioned in the article?

Article #16 Notes:

Source Title	10 common reasons why syringes leak and what you can do
Source citation (APA Format)	Crafton, B. (2023, December 8). *10 common reasons why syringes leak and what you can do*. World Precision Instruments. https://www.wpiinc.com/blog/post/10-reasons-syringes
Original URL	https://www.wpiinc.com/blog/post/10-reasons-syringes
Source type	Website

Keywords	
#Tags	

Summary of key points + notes (include methodology)	Introduction
	• Syringe leakages can be a big problem during the administration of syringes
	• The article explains how it will list 7 possible reasons why your syringe may be leaking
	Body
	• Loose Luer Lock
	  ○ The luer lock may not be properly sealed when syringes are set up
	  ○ This can cause an introduction of air into the syringe, which can cause loss of sample or air pockets in the injected area.
	  ○ To fix this, try ensuring a tight seal, or just discard the syringe
	• Needle Misalignment
	  ○ The needle can sometimes be off-center from the needle hub
	  ○ This is only a problem for some syringe types
	  ○ Adjust the needle's position or discard the syringe
	• Barrel Crack/Damage
	  ○ A glass syringe can be damaged. These damages could be hairline cracks, debris, or scratches.
	  ○ This is also possible for plastic syringes, as they could have scratches on them.
	  ○ Discard the syringe if damage is present, as this could potentially cause harm
	• Overfilling
	  ○ This isn't directly manufacturing related, but overfilling a syringe could add pressure to the plunger
	  ○ This could cause leaking of the syringe
	  ○ Be more mindful during syringe usage
	• Incorrect needle size
	  ○ (Not directly stated by article, but an inference) Could be caused by slight needle bends
	  ○ This is only for syringes where needle length can be altered to fit different volumes and viscosities
	• Poor Quality
	  ○ This sounds general, but is referring to the manufacturer or vendor of the syringe
	  ○ Syringes can be inappropriately manufactured/calibrated based on the vendor
	  ○ Buy from a good vendor
	
	The article discusses the various defects that syringes could have, while also including some solutions to these problems and potential reasons for why

	they might happen. Some of the defects discussed are needle misalignment, barrel cracks, and a defective plunger seal. Most of the solutions include just discarding the syringe as a whole, which can mean the waste of a costly product.
Research Question/Problem/ Need	What are some specific defects that could be found on syringe, and how can they be dealt with?
Important Figures	
VOCAB: (w/definition)	Plunger – The part of a syringe that can feely move up and down to either eject liquid from the syringe or suction liquid into it Barrel – The main body of the syringe and houses the plunger Luer lock – Only found on specific syringes, but by twisting it, allows for the needle to be locked into place so that it doesn't disengage accidentally during usage
Cited references to follow up on	
Follow up Questions	How can these defects be prevented at the manufacturing level? What are some other defects that are more universal for all types of syringes? Could potential automatic fixes be implemented during manufacturing that could fix some syringe defects without entirely discarding the syringe?

Article #17 Notes:

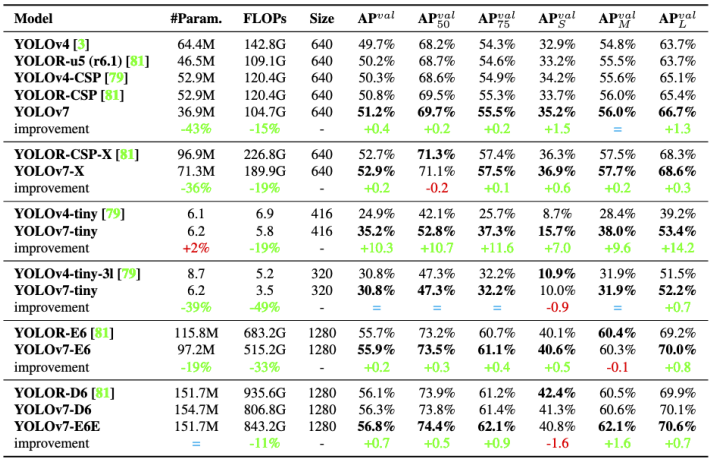
Article notes should be on separate sheets

KEEP THIS BLANK AND USE AS A TEMPLATE

Source Title	YOLOv7: Trainable bag-of-freebies sets new state-of-the-art for real-time object detectors.
Source citation (APA Format)	Wang, C., Bochkovskiy, A., & Liao, H.-Y. (2022). YOLOv7: Trainable bag-of-freebies sets new state-of-the-art for real-time object detectors. *IEEE/CVF Conference on Computer Vision and Pattern Recognition*. https://doi.org/10.1109/CVPR52729.2023.00721
Original URL	https://arxiv.org/pdf/2207.02696
Source type	Journal Article
Keywords	
#Tags	

Summary of key points + notes (include methodology)	Introduction:
	• Real time object detection is crucial for various applications such as autonomous driving, multi object tracking, robotics, and medical image analysis
	• A requirement for this is efficient computation on CPUs, GPUs and NPUs (Neural Processing Units)
	• The proposed object detector will be able to support mobile GPUs and GPUs from edge to cloud
	• Focus is shifting to efficient architecture design for real time object detection
	• Optimization methods will be introduced to increase the accuracy of object detection without reducing inference time, and these methods will be called a trainable bag-of-freebies
	• Model re-parametrization improves network efficiency by modyfying layers for better gradient propagation.
	  ○ However, re-parametrixing modules for different output layers in multi output architectures is a challenge
	  ○ Re-parameterization strategies must be optimized
	Related work:
	• YOLO is a state of the art object detector that is very accurate and fast
	• For re-parametrization, multuple modules must be merged together during inference
	• Model scaling must be used, where a model can be scaled up or down to work in different computational devices. Factors such as

	resolution, depth (number of layers), width (number of channels) can be modified for this Architecture: • E-Elan (Extended efficient layer aggregation networks) • The network's learning capability should improve without altering the gradient transmission path • Main modifications are made within the computational block • Depth will be scaled, but this will alter the width of the next layer Bag of Freebies: • RepConv will be used, as it is already known to be strong in other models such as VGG • The identity connection will be removed from it as it interferes with residual and concatenation connections in ResNet and DenseNet respectively • Deep supervision will be used to add extra auxiliary heads Experiments • The COCO dataset will be used to test the object detection method (same as me) • The model will be trained from scratch • Various models were developed and optimized for different hardware environments. YOLOv7 was the primary model used for this. • These models were copared with YOLOv4 and YOLOR as baselines. o YOLOv7 has 75% fewer parameters, 36% less computation and 1.5% improvement in accuracy over YOLOv4 • Comparisons were also made against state of the art object detectors used on both mobile and general GPUs. o Various configurations were tested against various state of the art detector models such as YOLOv5. • The YOLOv7 model was determined to have better accuracy and efficiency over multiple devices over other state of the art detectors. The model is a new benchmark. The article talks about advancements in optimization techniques for CNNs, and discusses methods such as depth scaling and re-parameterized convolution. When scaling depth in concatenation models, adjustments need to be made to other variables such as width, so a compound scaling method can be implemented that balances both depth and width. Results showed improved performance on object detection tasks, and these new methods could help increase accuracy and efficiency.
Research Question/Problem/ Need	Develop a new state of the object detection model that improves the model's accuracy and efficiency without reducing inference time.

Important Figures	Table 1: Comparison of baseline object detectors.  Figure 1: This is a comparison of the proposed model versus other baseline models
VOCAB: (w/definition)	Model scaling – The depth and width of a model must be modified in order to work on different devices Auxiliary – Classifier heads attached to layers before the end of the network
Cited references to follow up on	
Follow up Questions	Has this model been improved since the time this was made? What are some improvements that can be realistically made to this model? Are there other solutions other than re-parametrization that can be used to improve accuracy without sacrificing inference time?

Model	#Param.	FLOPs	Size	AP^{val}	AP^{val}_{50}	AP^{val}_{75}	AP^{val}_{S}	AP^{val}_{M}	AP^{val}_{L}
YOLOv4 [3]	64.4M	142.8G	640	49.7%	68.2%	54.3%	32.9%	54.8%	63.7%
YOLOR-u5 (r6.1) [81]	46.5M	109.1G	640	50.2%	68.7%	54.6%	33.2%	55.5%	63.7%
YOLOv4-CSP [79]	52.9M	120.4G	640	50.3%	68.6%	54.9%	34.2%	55.6%	65.1%
YOLOR-CSP [81]	52.9M	120.4G	640	50.8%	69.5%	55.3%	33.7%	56.0%	65.4%
YOLOv7	36.9M	104.7G	640	**51.2%**	**69.7%**	**55.5%**	**35.2%**	**56.0%**	**66.7%**
improvement	-43%	-15%	-	+0.4	+0.2	+0.2	+1.5	=	+1.3
YOLOR-CSP-X [81]	96.9M	226.8G	640	52.7%	**71.3%**	57.4%	36.3%	57.5%	68.3%
YOLOv7-X	71.3M	189.9G	640	**52.9%**	71.1%	**57.5%**	**36.9%**	**57.7%**	**68.6%**
improvement	-36%	-19%	-	+0.2	-0.2	+0.1	+0.6	+0.2	+0.3
YOLOv4-tiny [79]	6.1	6.9	416	24.9%	42.1%	25.7%	8.7%	28.4%	39.2%
YOLOv7-tiny	6.2	5.8	416	**35.2%**	**52.8%**	**37.3%**	**15.7%**	**38.0%**	**53.4%**
improvement	+2%	-19%	-	+10.3	+10.7	+11.6	+7.0	+9.6	+14.2
YOLOv4-tiny-3l [79]	8.7	5.2	320	30.8%	47.3%	32.2%	**10.9%**	31.9%	51.5%
YOLOv7-tiny	6.2	3.5	320	**30.8%**	**47.3%**	**32.2%**	10.0%	**31.9%**	**52.2%**
improvement	-39%	-49%	-	=	=	=	-0.9	=	+0.7
YOLOR-E6 [81]	115.8M	683.2G	1280	55.7%	73.2%	60.7%	40.1%	**60.4%**	69.2%
YOLOv7-E6	97.2M	515.2G	1280	**55.9%**	**73.5%**	**61.1%**	**40.6%**	60.3%	**70.0%**
improvement	-19%	-33%	-	+0.2	+0.3	+0.4	+0.5	-0.1	+0.8
YOLOR-D6 [81]	151.7M	935.6G	1280	56.1%	73.9%	61.2%	**42.4%**	60.5%	69.9%
YOLOv7-D6	154.7M	806.8G	1280	56.3%	73.8%	61.4%	41.3%	60.6%	70.1%
YOLOv7-E6E	151.7M	843.2G	1280	**56.8%**	**74.4%**	**62.1%**	40.8%	**62.1%**	**70.6%**
improvement	=	-11%	-	+0.7	+0.5	+0.9	-1.6	+1.6	+0.7

Article #18 Notes:

Article notes should be on separate sheets

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Source Title	Soundless trouble: Syringe pump malfunction and the hypotension threat.
Source citation (APA Format)	Sravani, J., Panda, C., Agha, M., Vijapurkar, S., & Sandeep, G. (2024). Soundless trouble: Syringe pump malfunction and the hypotension threat. *Cureus*, *16*(3). https://doi.org/10.7759/cureus.56996
Original URL	https://pmc.ncbi.nlm.nih.gov/articles/PMC11045474/
Source type	Journal Article
Keywords	
#Tags	

Summary of key points + notes (include methodology)	Introduction
	• Syringe pumps are important for drug delivery in the ICU setting, and they must be operated carefully as to prevent patient injury
	• Leaks should not occur during the administration process.
	• The article will go on to list a few cases where these infusion pumps were not working properly
	Cases
	• Case 1: A 53 old lady had urosepsis and septic shock, and she had blood pressure fluctuations
	  ○ These ranged from 90/50 to 200/140 over short time periods
	  ○ This was found to be caused by high driving pressure by the infusion pump, and so there was an error in the infusion pump's system
	  ○ The problem was resolved by changing the syringe

	• Case 2: A 27 old man was having mitral valve replacement when he also had blood pressure changes.
	  ○ During the administration of dobutamine and noradrenaline, he faced large changes in blood pressure
	  ○ This was again found to be caused by a high driving pressure in the infusion pump
	  ○ The syringe was replaced and the problem was resolved
	Discussion
	• First, what could be causing this was discussed.
	  ○ Syringe pumps have an accuracy of give or take 5%
	  ○ There can be a time delay between the pump start and delivery
	• How this could be prevented:
	  ○ Minimize infusion lines length
	  ○ Take standard care of syringe pumps
	
	Safety and precision must be ensured by syringe pumps in the ICU environment. Two cases of refractory hypotensions were reported on by the article, where in one a 53 old lady suffered changes in blood pressure due to a defective infusion pump. In another, hypotension occurred in a 27 year old man who had his mitral valve replaced. Therefore, the infusion pumps should be better maintained in the hospital environment by staff. For my project, this could potentially be controlled by making sure infusion pumps are properly manufactured in factories using my neural network.

Research Question/Problem/ Need	What are some examples of how syringe infusion pumps can be defected and how can that be prevented?
Important Figures	
VOCAB: (w/definition)	Refractory hypertension – Uncontrolled blood pressure even through the use of antihypertensive drugs Infusion pumps – Medical device used to deliver fluids to the patient
Cited references to follow up on	
Follow up Questions	What are some other ways infusion pumps can potentially be defected? Are these specific to a certain type of syringe? Can this be prevented at the manufacturing level.

Article #19 Notes:

Article notes should be on separate sheets

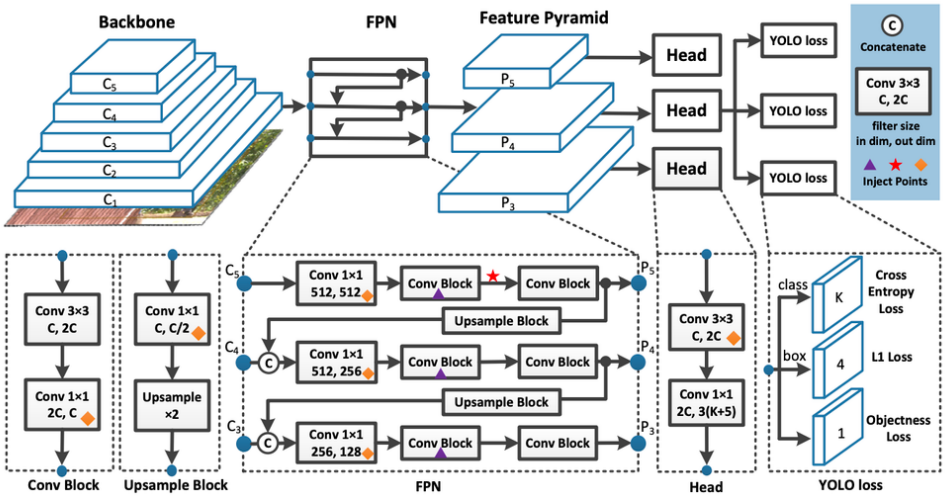
KEEP THIS BLANK AND USE AS A TEMPLATE

Source Title	What is YOLOv7? A complete guide
Source citation (APA Format)	Solawetz, J. (2024, April 15). *What is yolov7? A complete guide.* Roboflow Blog. https://blog.roboflow.com/yolov7-breakdown/
Original URL	https://blog.roboflow.com/yolov7-breakdown/
Source type	Website
Keywords	

#Tags	

Summary of key points + notes (include methodology)	Introduction
	• This is the latest official iteration of YOLO models.
	• It is faster and has greater accuracy than its previous versions
	• It is a state of the art model
	• The article will go on to discuss the inner workings of the model
	Body
	• Image frames are analyzed through a backbone
	• The features are combined in the neck
	• The head of the network then predicts the classes and location of the objects in the image
	  ○ Non-max suppression is then performed to remove duplicate predictions, and then the output is created and delivered
	• The artcle then talks about the story of YOLOv7's authors, which is not important for the purposes of this project
	• The advantage to YOLOv7 is that it has better bounding box accuracy while still being equally as fast as other models
	• E-ELAN was used for the final layer aggregation
	• YOLOv7 was specifically made so that it could scale for different hardware (discussed in a previous article as well).
	  ○ This is done through re-parametrization
	• Auxiliary heads are in the network in the middle because predictions are so far downstream the network.
	Conclusion:
	• YOLOv7 is one the best state of the art models for object detection as of now, and it provides excellent scaling capabilites
	
	The YOLOv7 model is the newest official state of the art model that increases bounding box regression accuracy while not compromising on inference times. The YOLOv7 model was also built with scalability in mind, so re-parametrization was used so that different values of the model can be changed according to the hardware it runs on. Overall, the YOLOv7 model is a great fit for fast inference times with good accuracy.

Research Question/Problem/ Need	How is the YOLOv7 model more efficient than other models? What are some additional factors that make it stand out from other models?

Important Figures	 Figure 1: YOLOv7 model inference diagram  Figure 2: Bounding box regression example
VOCAB: (w/definition)	Inference – The processing of images by the neural network. E-ELAN – A better version of ELAN, which is a good architecture that the model learns off of.
Cited references to follow up on	
Follow up Questions	What is the purpose of a backbone, neck, and head structure? What are some other models that also use these features? How does this model's accuracy compare to other models?

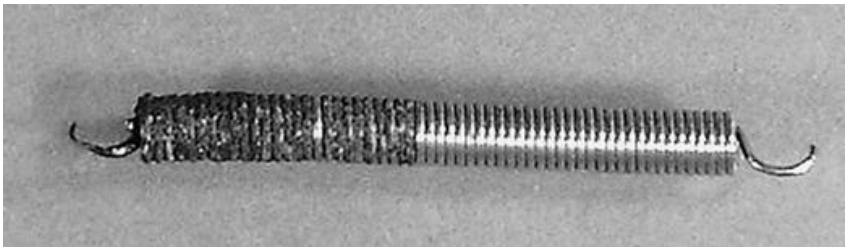
Article #20 Notes:

Article notes should be on separate sheets

KEEP THIS BLANK AND USE AS A TEMPLATE

Source Title	Malfunction of Syringe Pump Caused by Fluid Infiltration
Source citation (APA Format)	Takashina, M. (2002). Malfunction of Syringe Pump Caused by Fluid Infiltration. *Anesthesiology*, *96*(2), 520–520. https://journals.lww.com/anesthesiology/fulltext/2002/02000/malfunction_of_syringe_pump_caused_by_fluid.52.aspx
Original URL	https://pubs.asahq.org/anesthesiology/article/96/2/520/39933/Malfunction-of-Syringe-Pump-Caused-by-Fluid
Source type	Journal Article
Keywords	
#Tags	

Summary of key points + notes (include methodology)	Introduction
	• Syringe pumps that have defects in them, especially syringes that are used to administer high level drugs, can heavily threaten patients
	Problem Description
	• In the author's example, he has 19 syringe pumps, of which 3 are defected
	• These 3 syringe pumps had defects in the size sensory spring component
	  ○ The pumps were all Graseby 3500 pumps
	• 2 potential problems were found to be the cause of the defected syringes:
	  ○ Corrosion in the size sensor spring
	  ○ The power supply had short circuited
	• This was found because there was residual liquid between the syringe size sensor and the power supply, which indicated liquid leakage into the system.
	• The syringe is marketed as drip proof, but this indicated that the syringe was not as waterproof as marketed
	Solutions and Discussion
	• The material of the syringe spring can be changed so that it does not corrode because of the electrolytes in the fluid the syringe is containing.
	• The seal between the pump's body and the plunger can be improved
	• The syringe should be more waterproof in general
	• The proposed solution by Graseby actually had some legal complications, so the solutions proposed by the author are better for preventing these defects (this isn't really important, but was stated by the article)
	
	Syringe pump malfunction's can potentially get defected, which can be a severe risk to

	patients especially when administering high-level drugs. In the author's case, some of his syringes had leakages into the syringe housing because of the infusion pumps. This was due to corrosion in the syringe spring. The author suggests that the syringe springs are manufactured from a material that does not get degraded by electrolytes in the fluid.
Research Question/Problem/ Need	How can corrosion in syringe springs due to electrolytes in fluid be prevented?
Important Figures	 Fig 1: Example of corroded size sensor spring.
VOCAB: (w/definition)	Corrosion – A process that converts a refined metal into a more chemically stable oxide
Cited references to follow up on	
Follow up Questions	How do the electrolytes in the syringe affect the spring when they meet. Is there any way to scientifically prevent this from happening?