Module 10. Variation, Quality, Monitoring

Part II

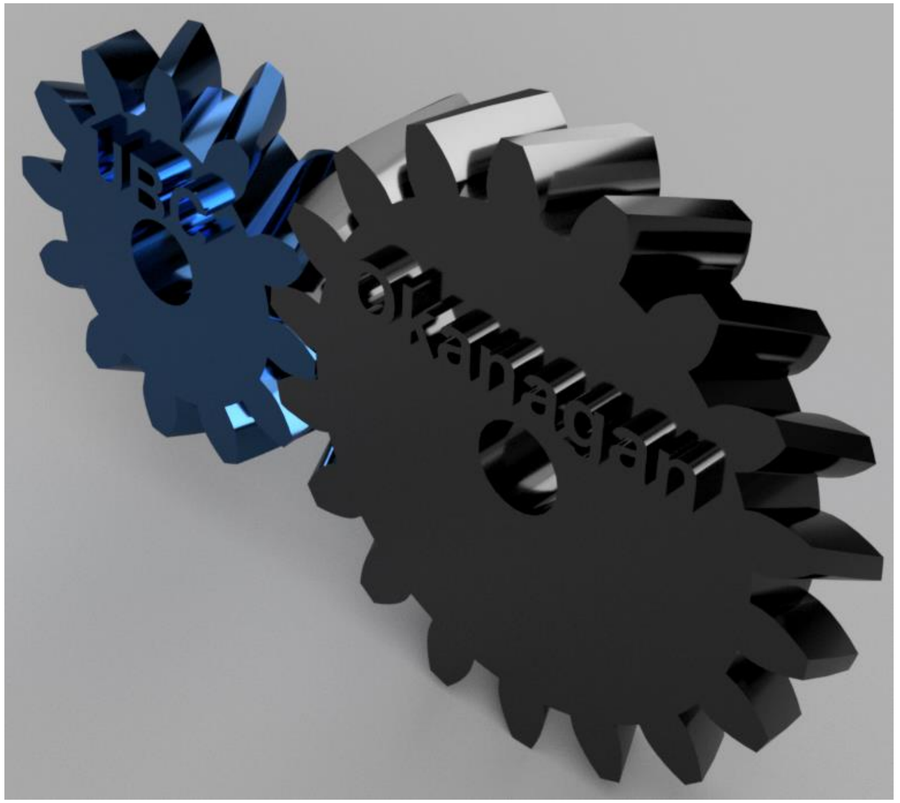
Ahmad Mohammadpanah
PhD, PEng

MONITORING:

- Another aspect of Quality control (QC) is concerned with detecting defects in products and taking corrective action to eliminate it, by inspection/monitoring.
- Advanced technologies in monitoring systems (Laser, CMM, Sensors,…) made obtaining of detailed data possible.
- New data analyses techniques (i.e. Machine Learning) made the data analysis very effective.

CMM (Coordinate Measuring Machine)

https://www.youtube.com/watch?v=A5zXdSv60Ag



AN EXAMPLE
GEAR MANUFACTURING PROCESS MONITORING

GEAR MANUFACTURING:

Gears can be manufactured by a variety of processes, including:

- Casting
- Forging
- Extrusion
- Powder metallurgy
- Blanking
- Machining
- 3D Printing

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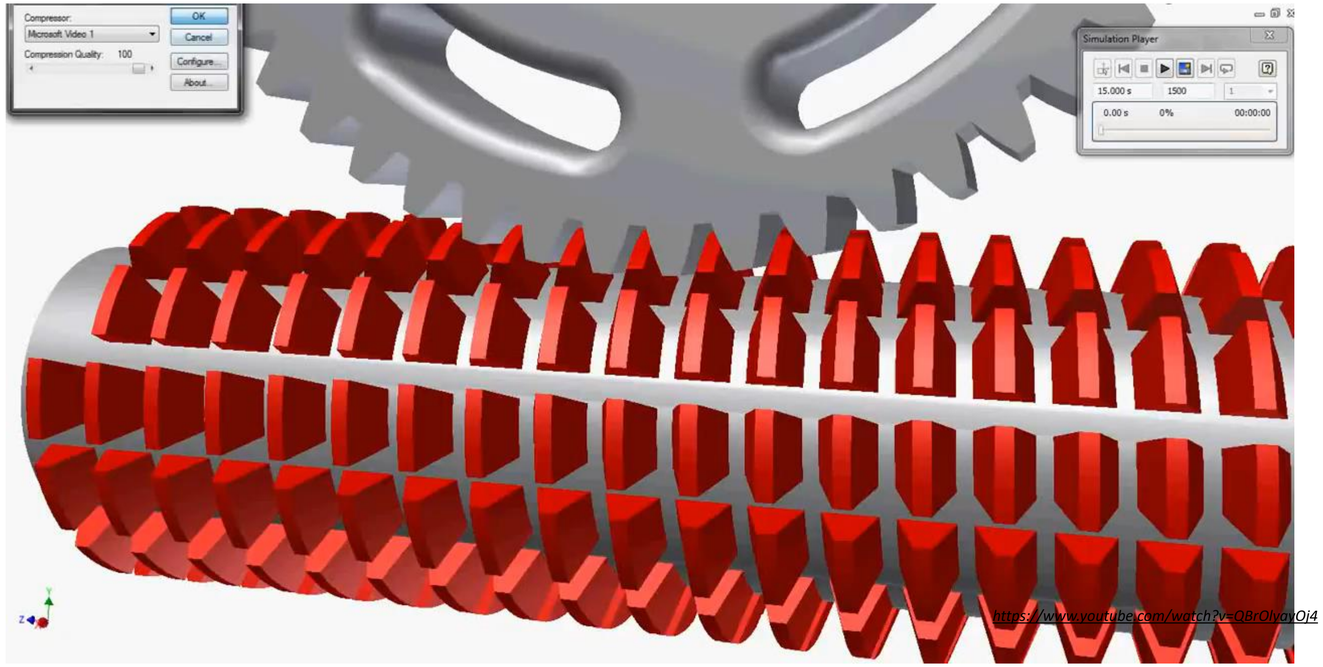
GEAR MANUFACTURING BY MACHINING:



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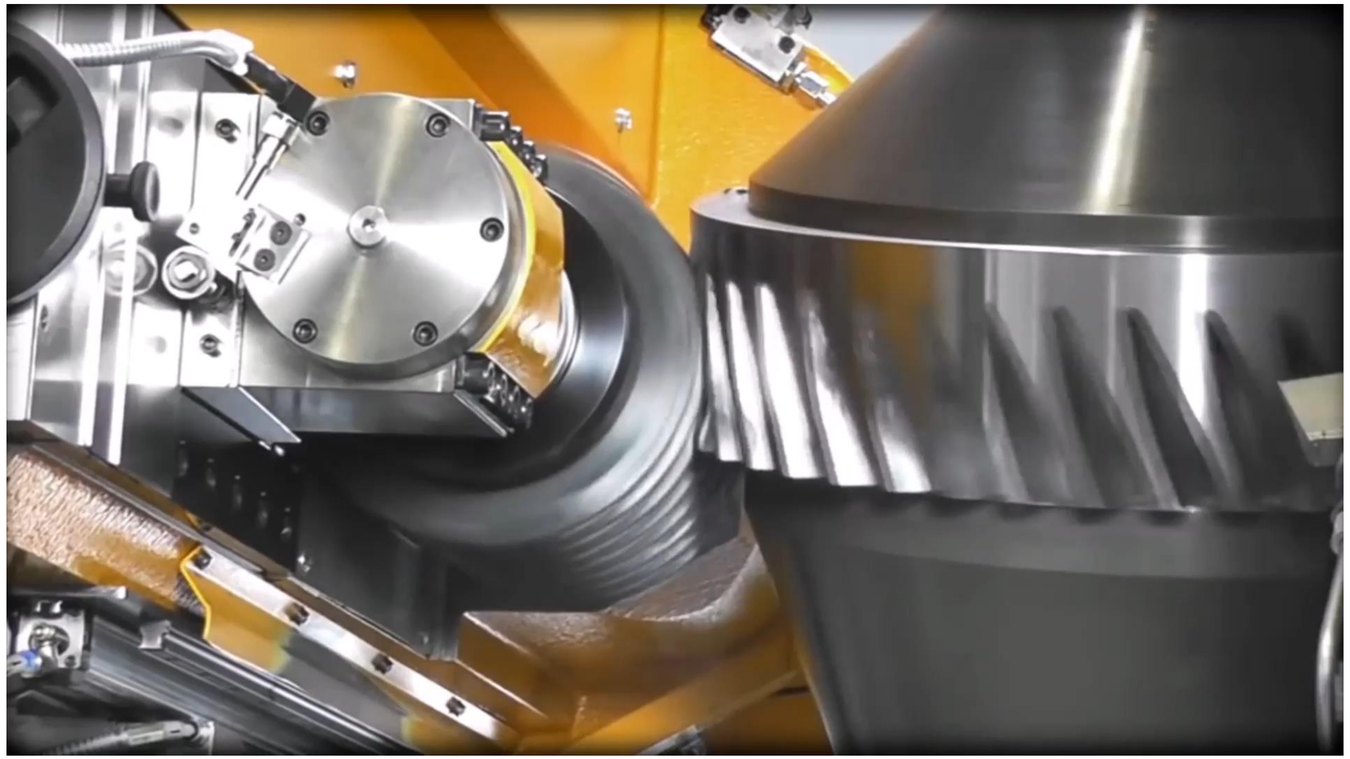
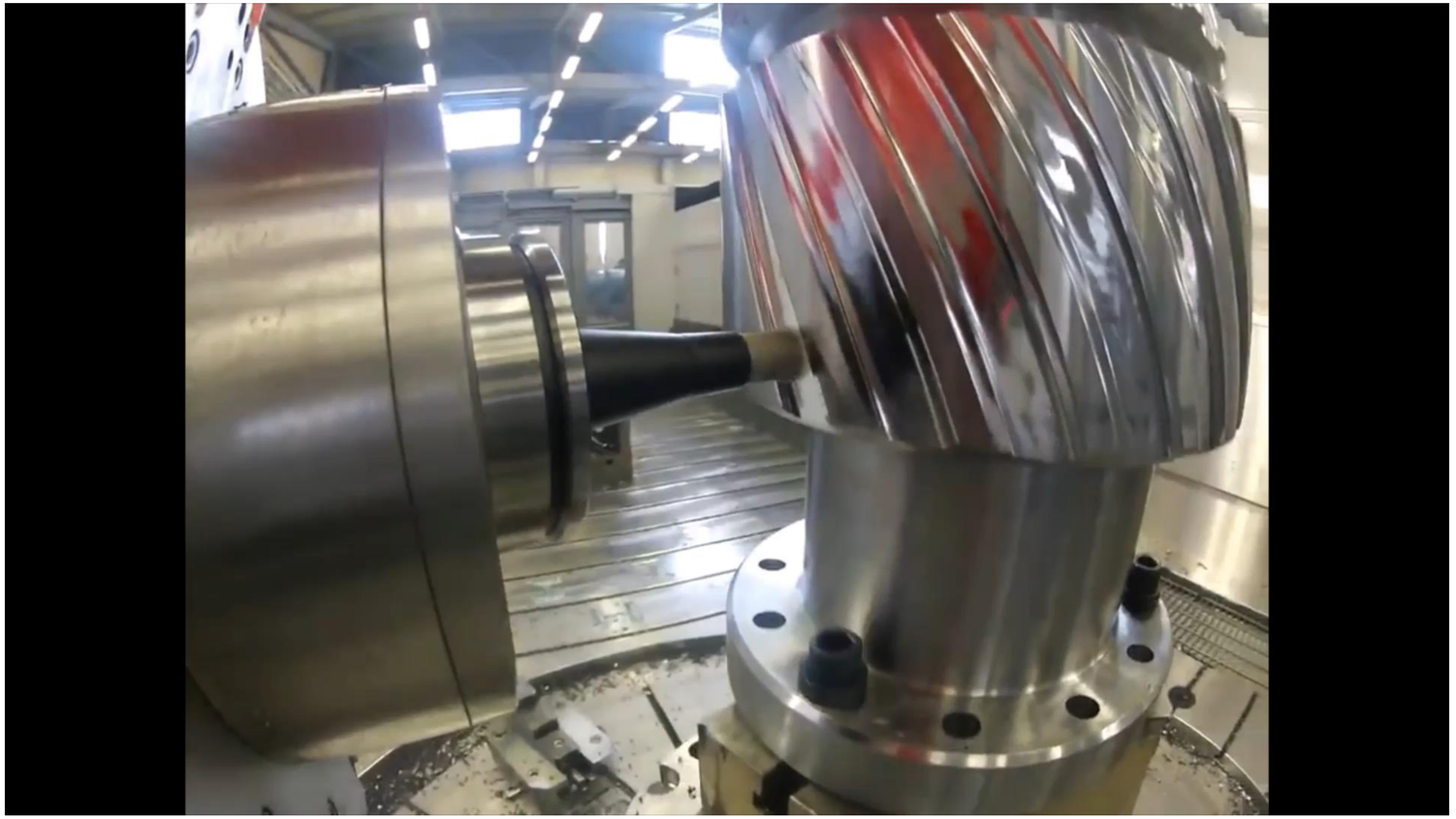


https://www.youtube.com/watch?v=ssU6yPIfrLE

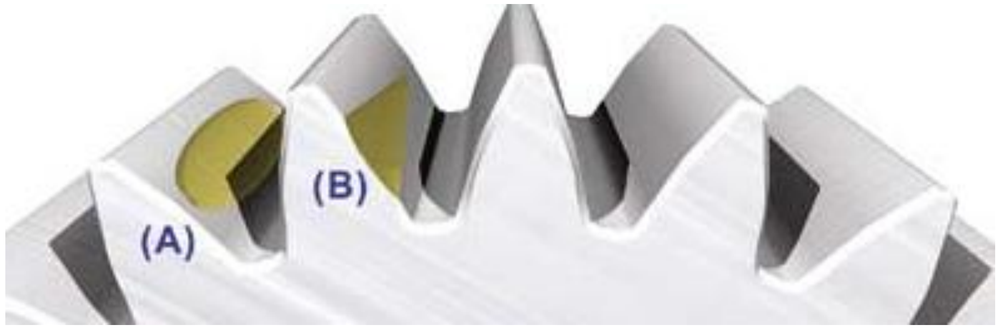
HELICAL GEAR MACHINING BY CNC:



MONITORING THE GEAR MANUFACTURING PROCESS

NOT ALWAYS WE GET THE DESIRED GERA SHAPE OR FINISHED SURFACE! MAYBE BECAUSE OF:

- Dull Tools
- Over Heating
- Wrong Feed or Rotation Speed
- Machine Misalignment



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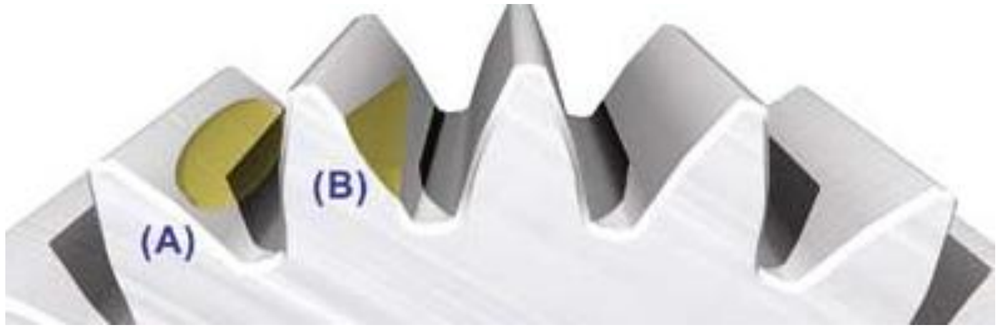

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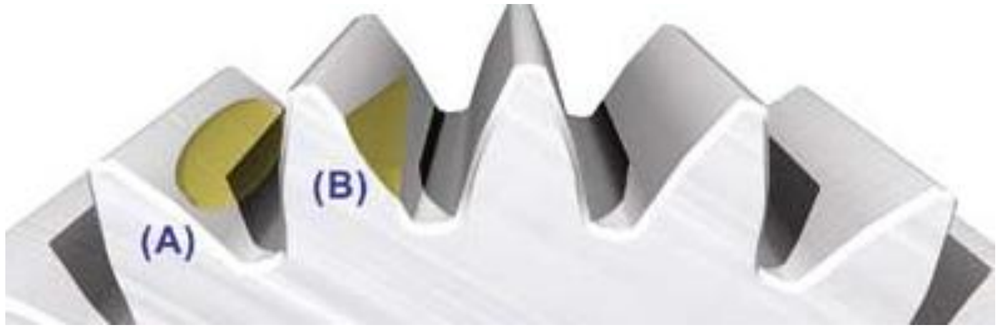

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- Visual
- Caliper

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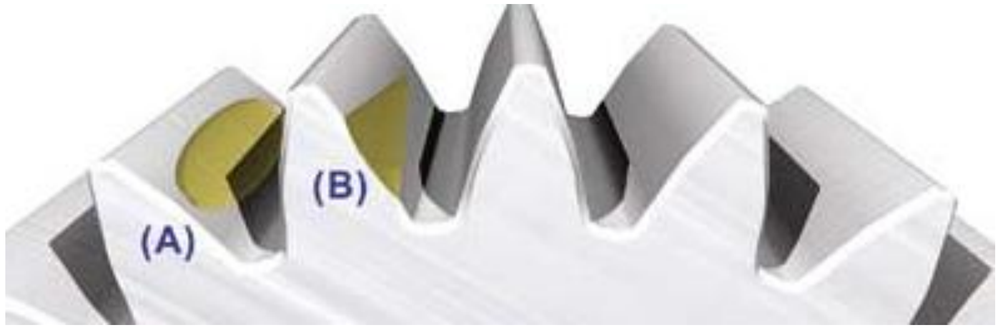

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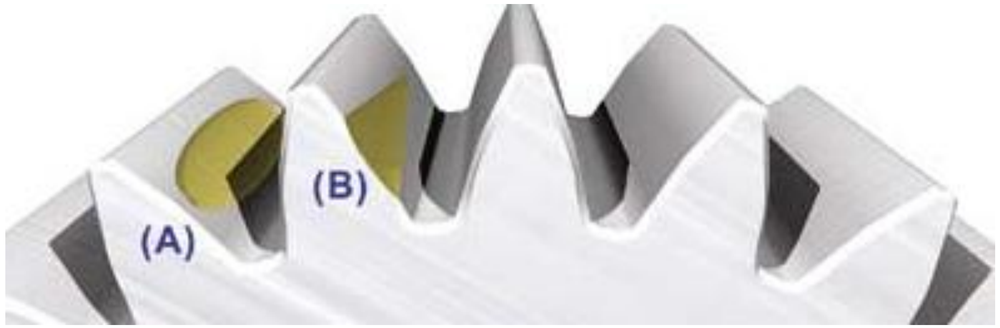

HOW TO MONITOR THE GEAR MANUFACTURING PROCESS?

- Visual
- Caliper
- Optical comparator
- CMM
- Measuring tool temperature
- ???

WHEN WE ASK THE MACHINE OPERATOR:

Q: How would you tell if the machine is working well or not?

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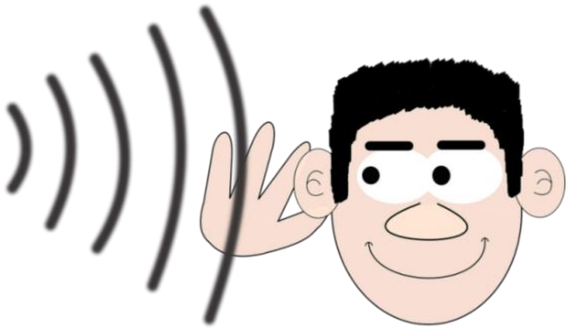
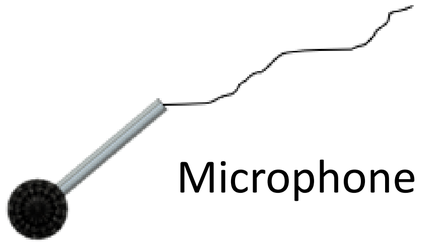


A: “I can hear it!”

APPROACH:



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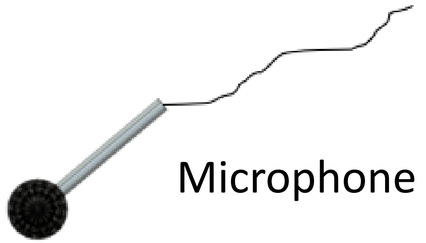

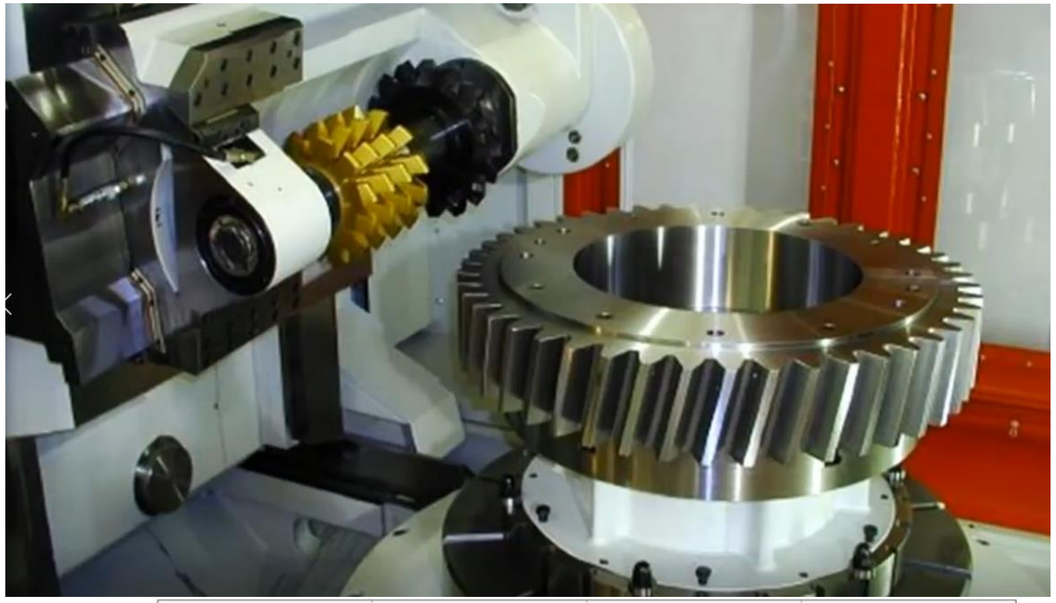

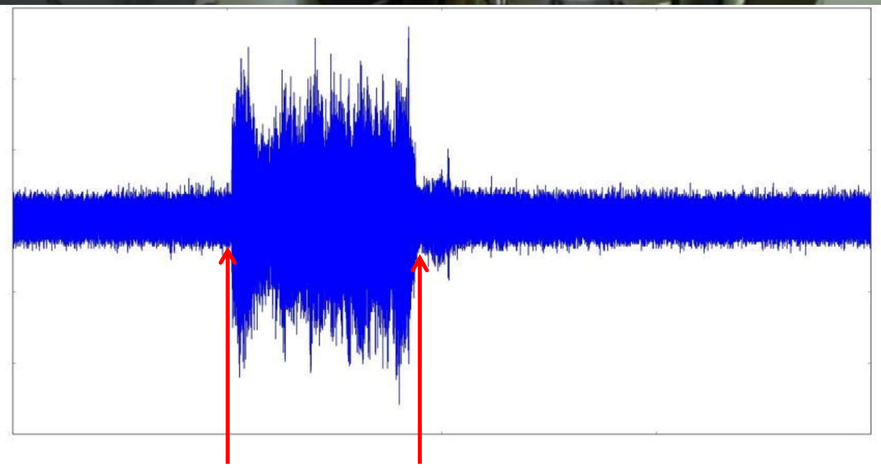

A CRASH COURSE ON FOURIER TRANSFORM:

No Analytical Formula

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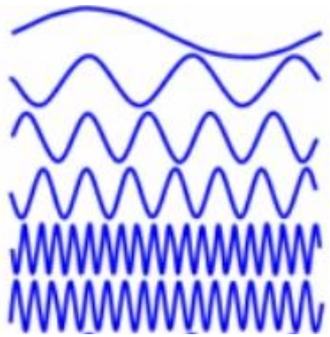

No Analytical Formula

Sum of many sine waves

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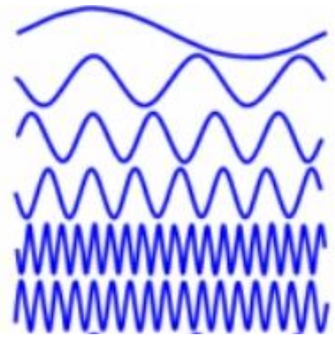

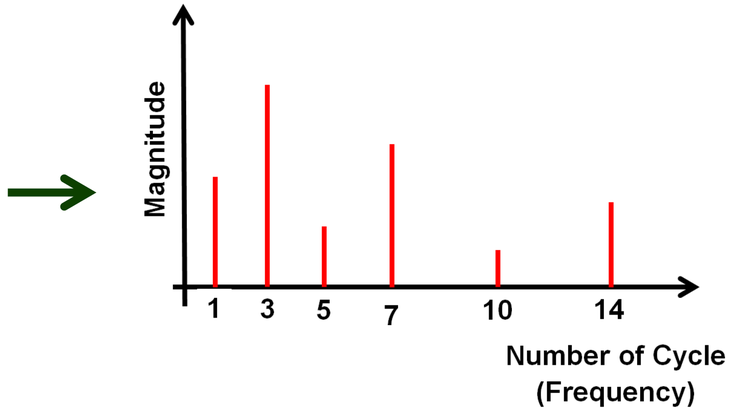

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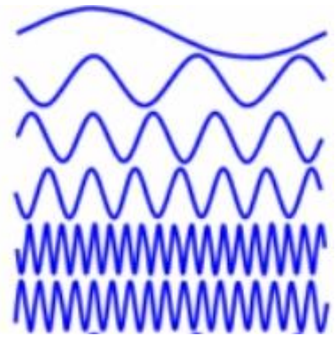

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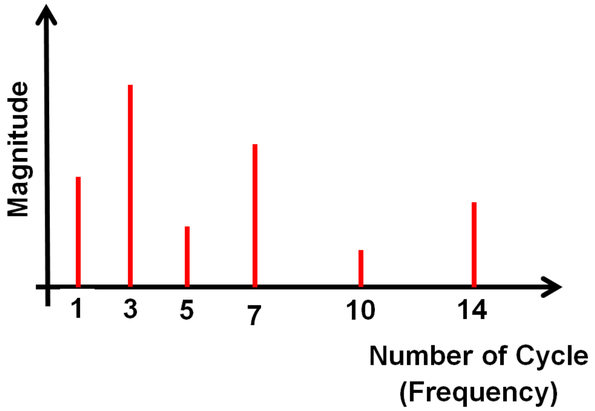
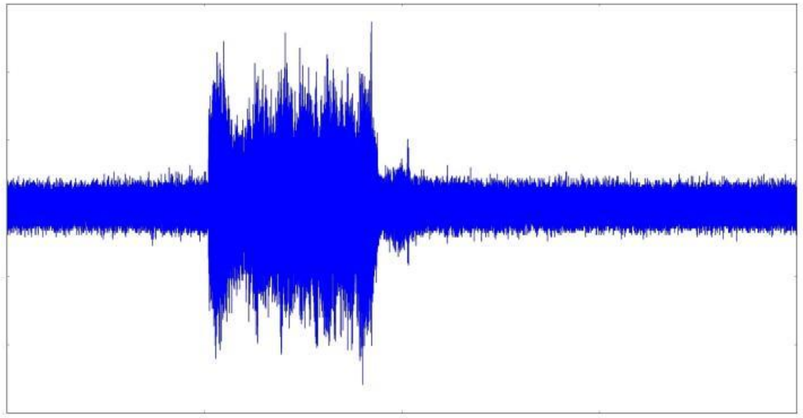


EXAMPLE OF FOURIER TRANSFORM OF RECORDED SOUND



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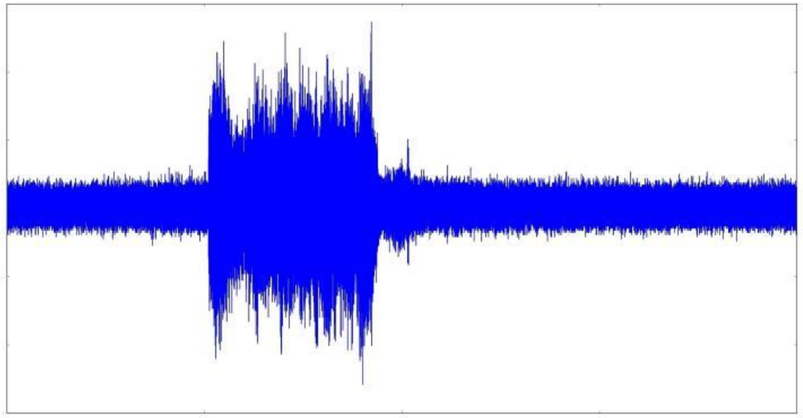

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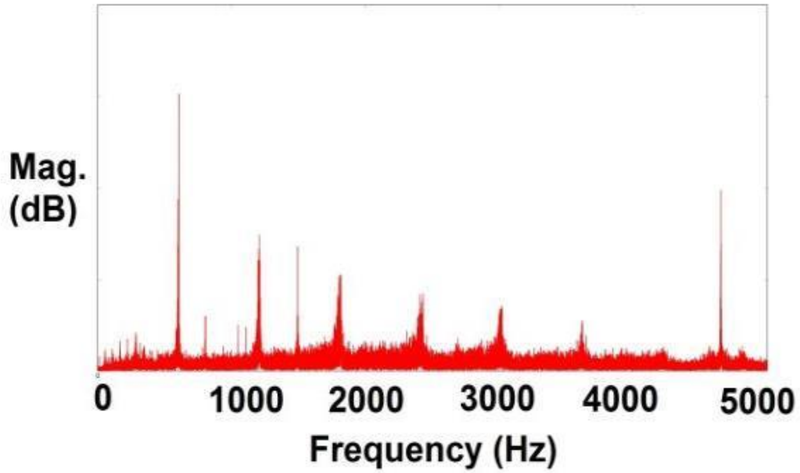

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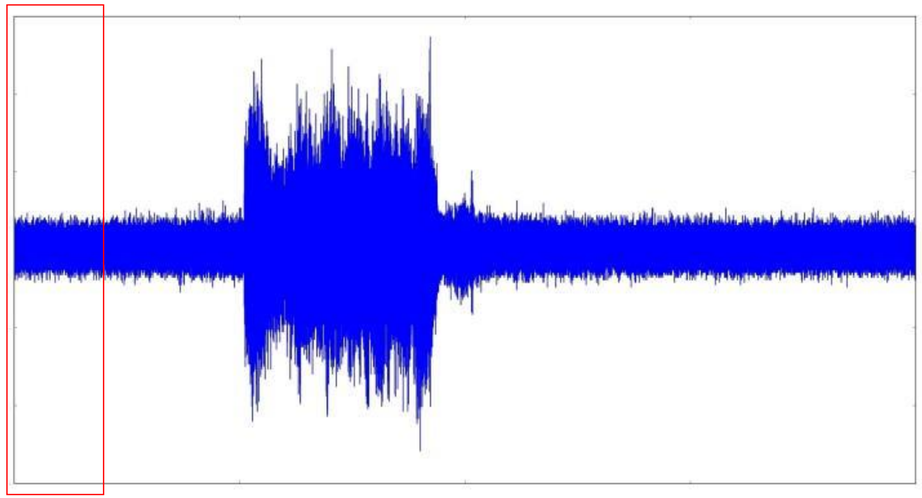

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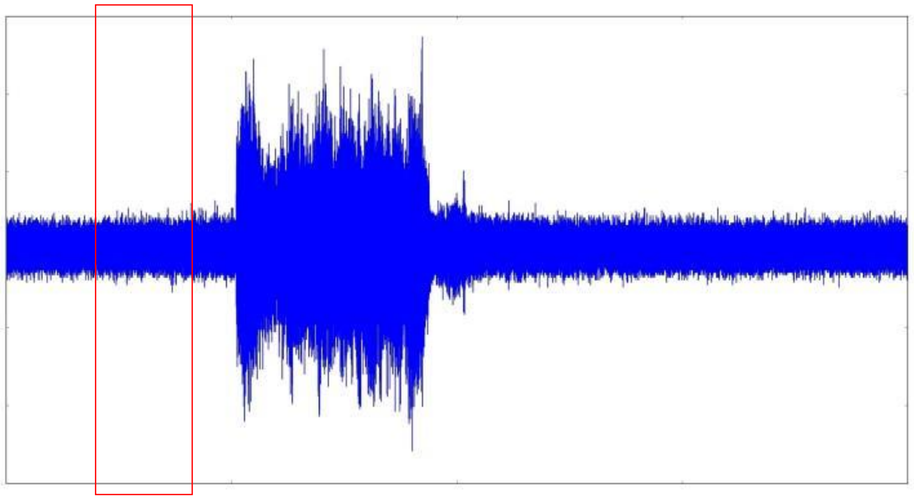

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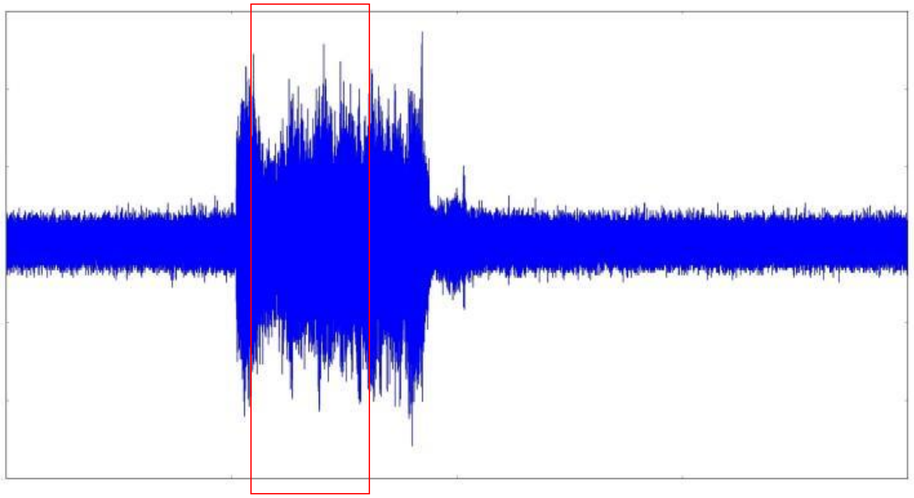

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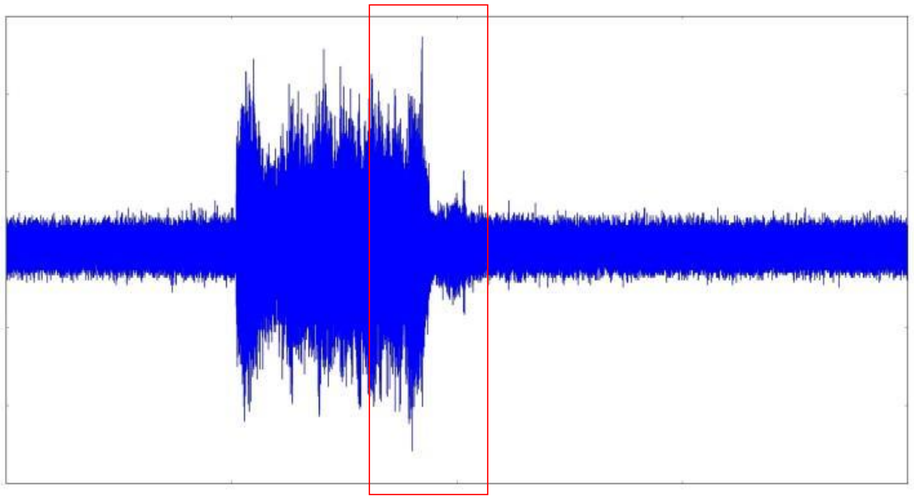

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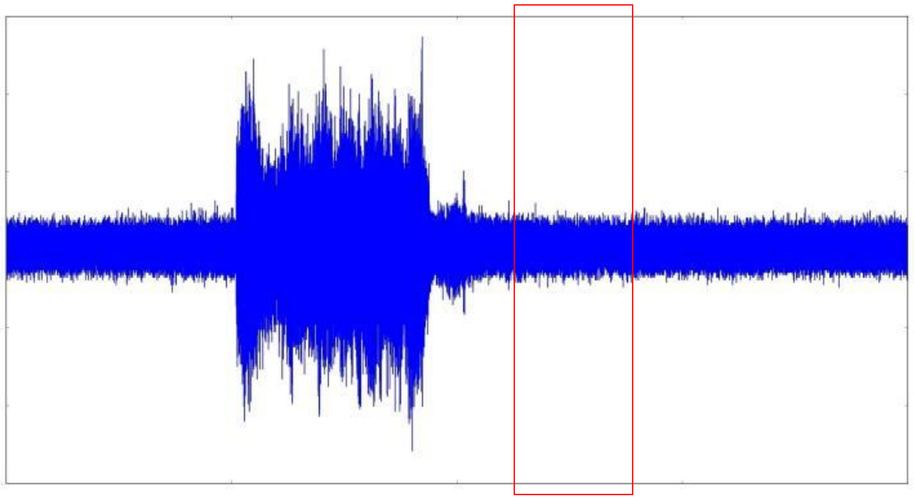

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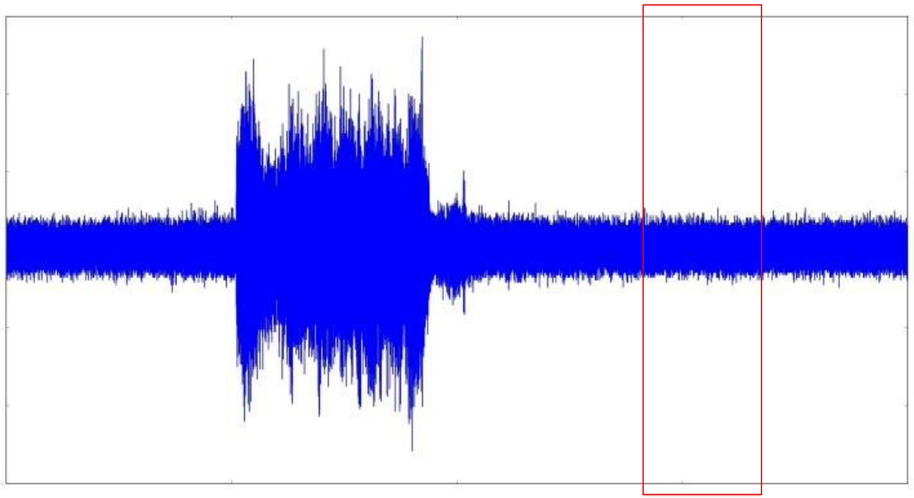

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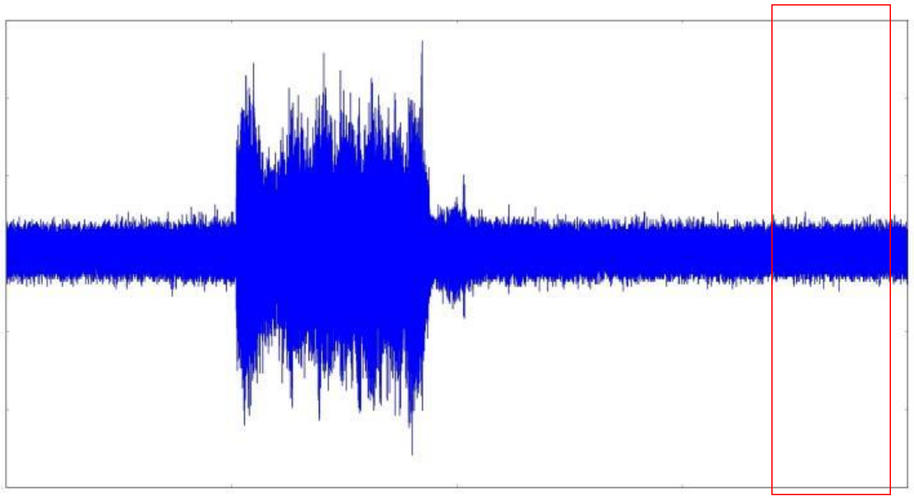

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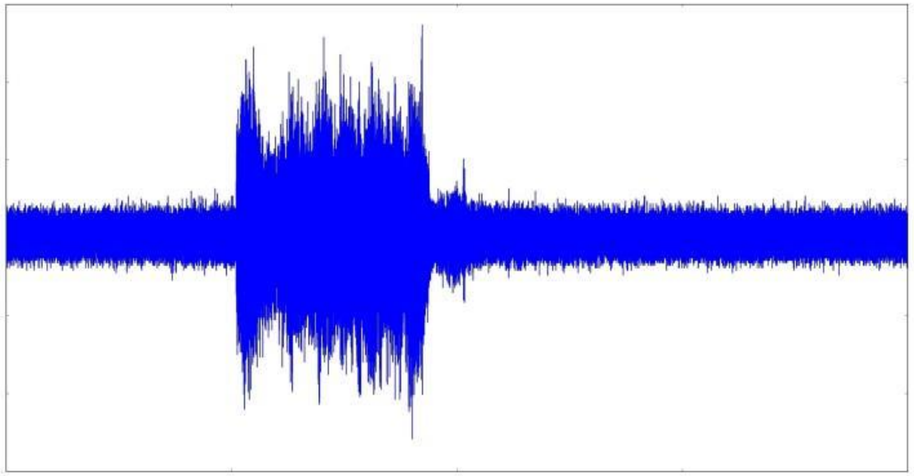
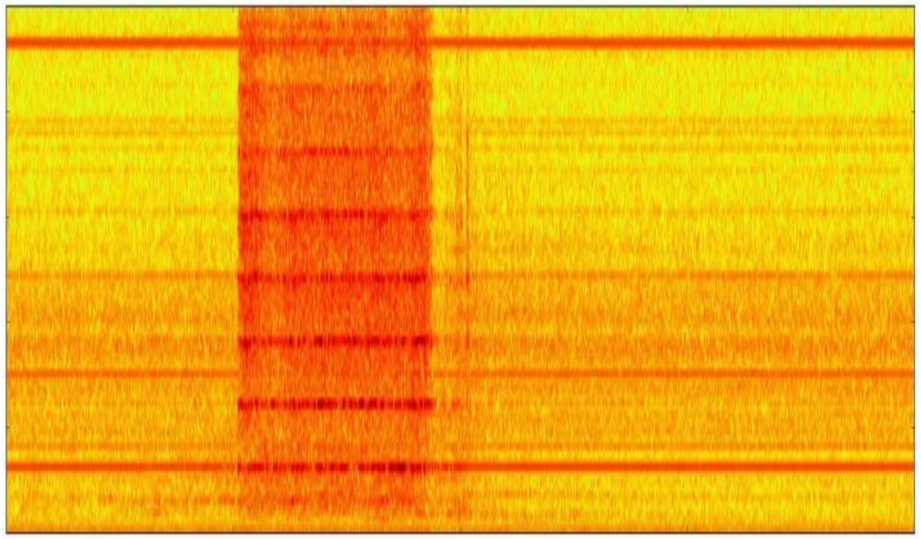


Window FT



Frequency Spectrogram (a 2D image)

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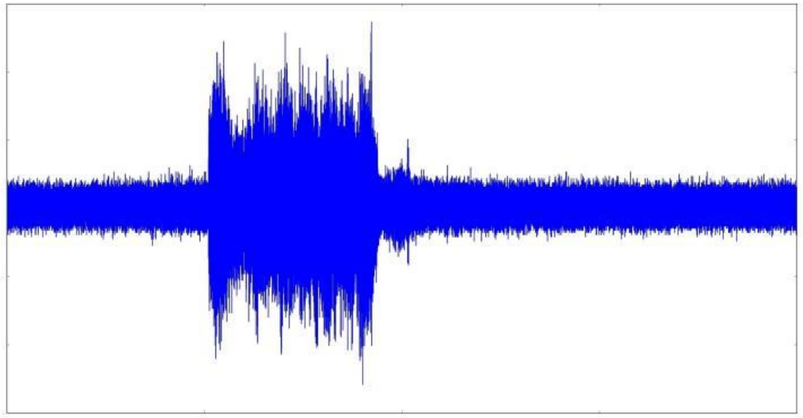

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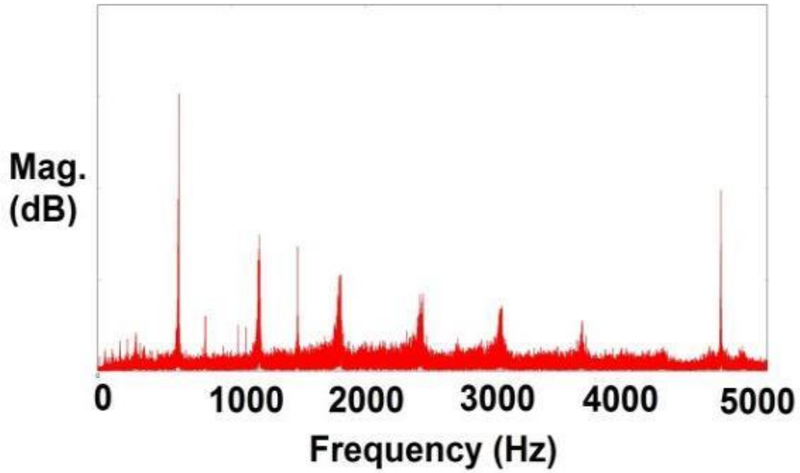

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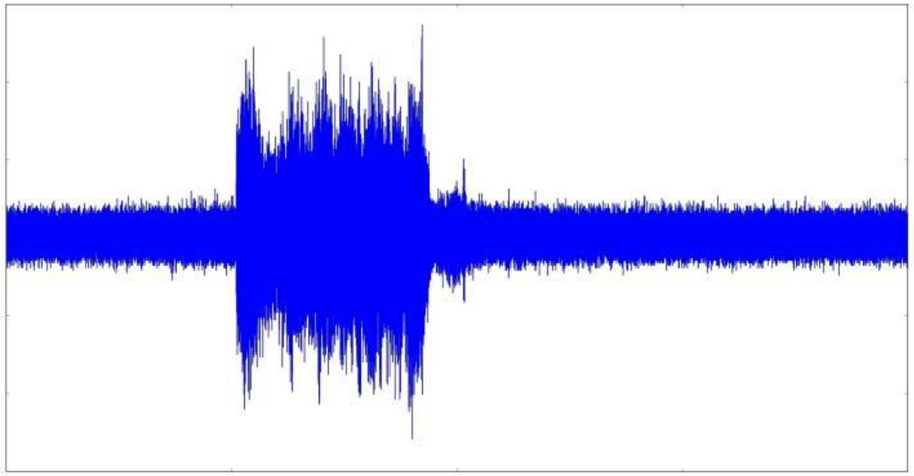

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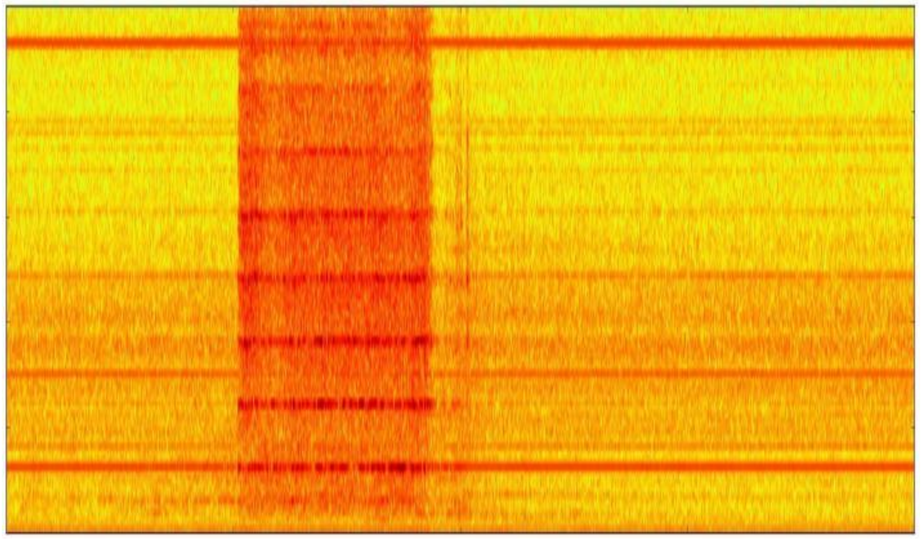

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ACTUAL DATA

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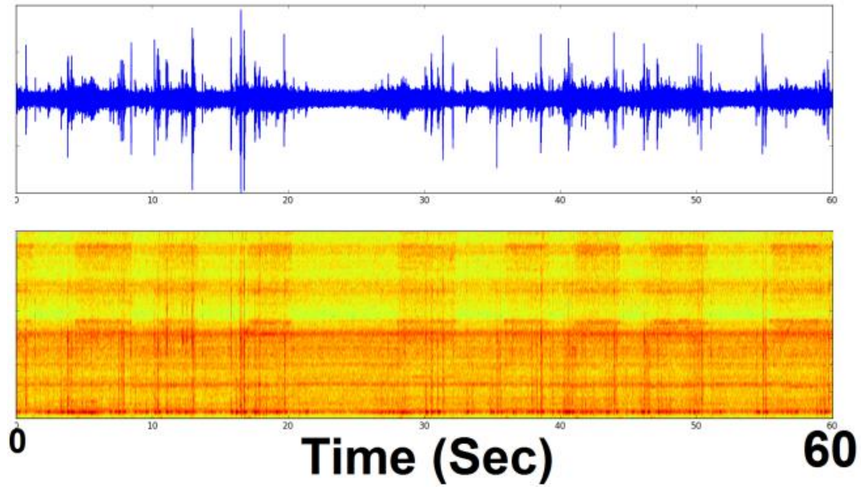

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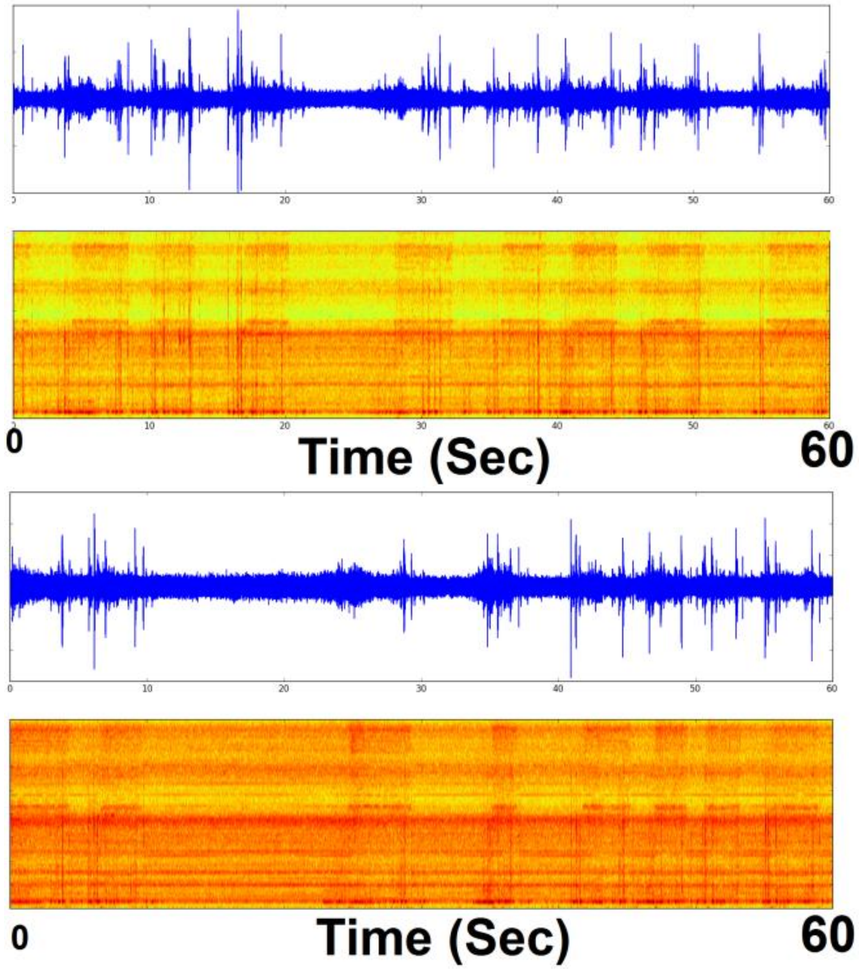

Gear Okay.

Something is wrong

MACHINE LEARNING:

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- **Supervised**
- **Unsupervised**

A FUN EXAMPLE ON APPLICATION OF MACHINE LEARNING:

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- We have 10000 Images of Cats and Dogs.

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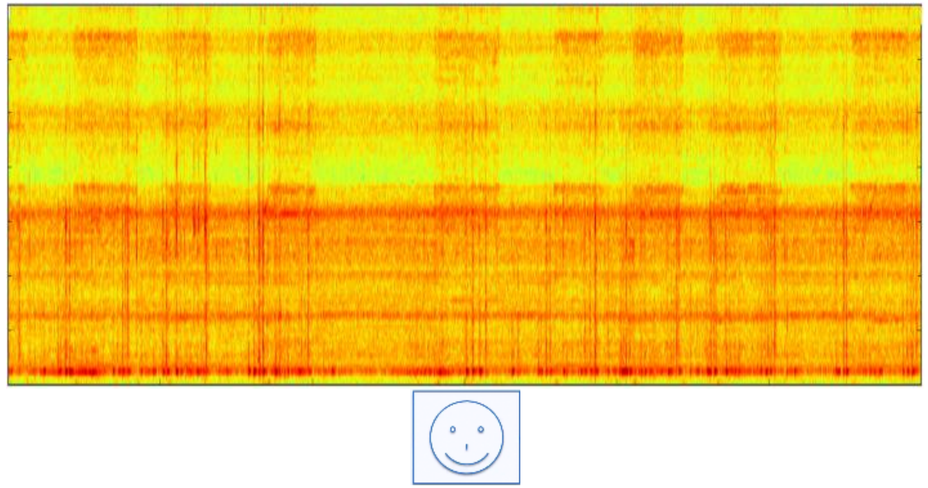
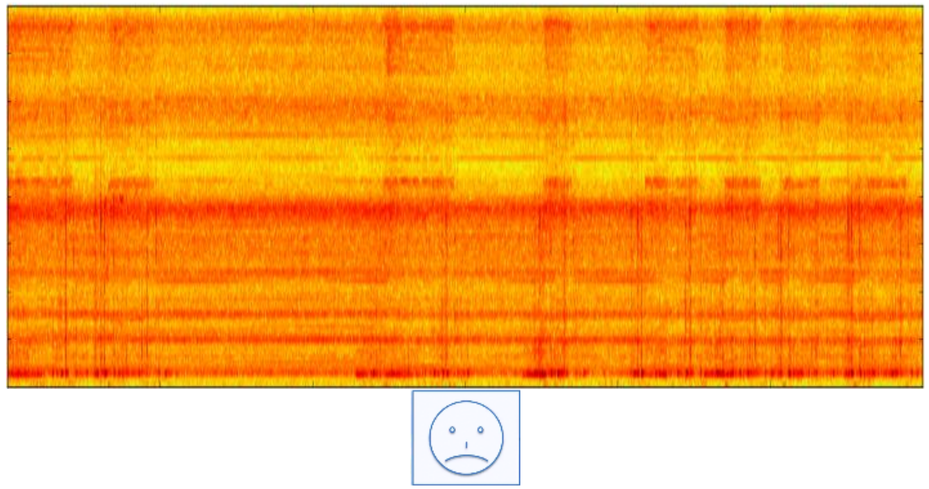
- Use Convolutional Neural Network.
- The model can label an unknown image as Cat or Dog.

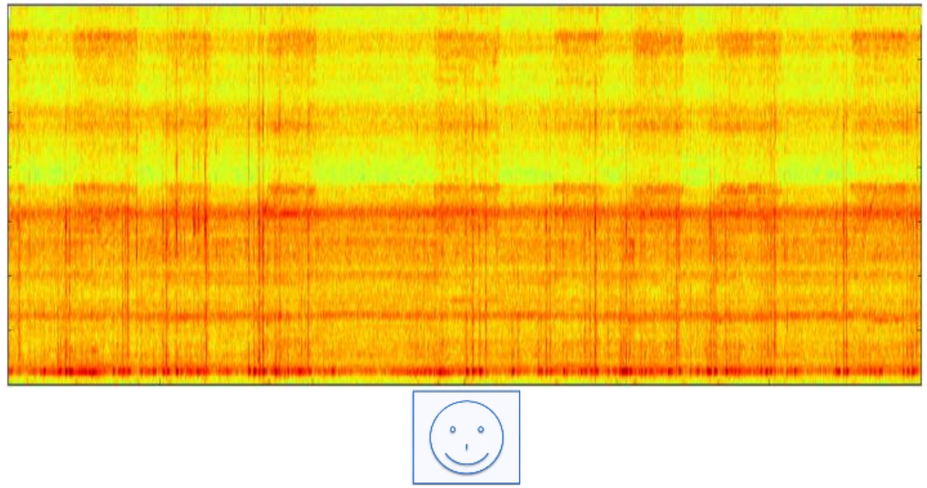
LET’S RETURN BACK TO THE PROBLEM OF LABELING FREQUENCY SPECTROGRAM FOR GEARS:

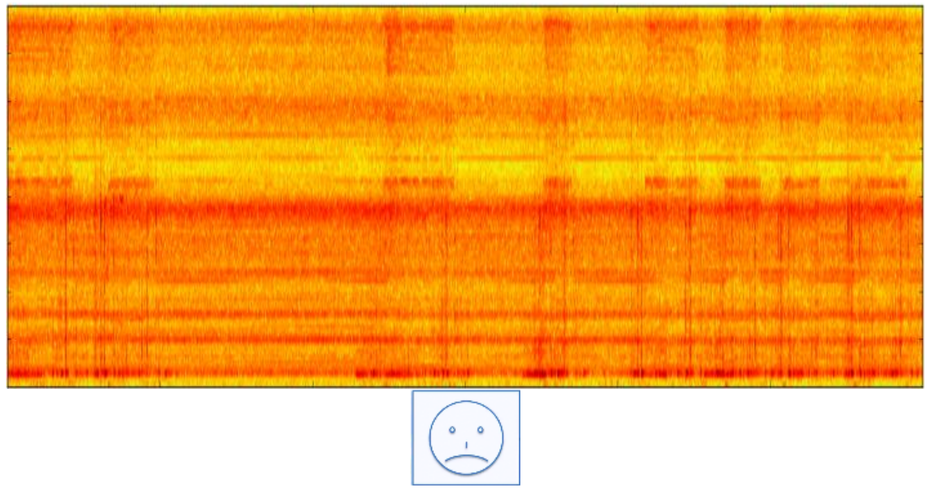




LET’S RETURN BACK TO THE PROBLEM OF LABELING FREQUENCY SPECTROGRAM FOR GEARS:

In the computer model, just replace the images of cats and dogs with the frequency spectrogram





RESULTS

- ✓ Several tests were conducted and sound was recorded during machining of each gear.
- ✓ The machining performance was recorded based on the finished gear quality (Happy/Sad).
- ✓ A Machine Learning technique were used for finding the patterns in Happy & Sad images (spectrograms).
- ✓ The results confirmed that sound can indicate poor machining conditions, and provide warning before it becomes critical.

What is the future of Manufacturing?

POSSIBILITIES ARE UNLIMITED!

Students View:

- ✓ Resources from other planets.
- ✓ Factories in other planets.
- ✓ Organic Materials.
- ✓ Zero Waste
- ✓ Everything will be automated.
- ✓ Machine Learning & Artificial Intelligent.
- ✓ Advanced AM (3D Printing).

My View:

- ✓ Products will be free (we pay fee for the services….)!
- ✓ We have to share stuff!
- ✓ We will buy codes not the actual products (you buy Gcode , and you have devices to make them yourself….)!
- ✓ Accessible and Easy Manufacturing Education to everyone!
- ✓ Shortage of Skilled Practical Hands-on Engineers!

COURSE CONCLUSION

My First Email to You:

Do you have the tools and confidence to enter a factory and be able to understand its operations and make suggestions for improvement? Do you know how your everyday items such as, water bottle, cloth hanger, electric power plug, toothbrush, gym dumbbell, coffee cup lid, Gillet razer handle, garbage bags, and so on to more sophisticated items such as your cellphone or laptop enclosure, parts in your bicycle or car, aircraft parts, and many other parts around you are made? Have you heard of additive manufacturing, such as 3D printing or metal laser sintering? What about Six-Sigma, and Lean Manufacturing? MECH 392 is an introduction to a wide range of manufacturing processes. In this course you will learn the fundamentals and applications of many manufacturing processes through lots of examples and video demonstrations. You will also gain a perspective on the future of manufacturing and how it will be shaped by advanced technologies.

Ahmad

Hope we could have achieved these objectives we set!

EXAM

Course Modules:

1. Machining
2. Sheet Metal Forming — mid-term
3. Injection Molding
4. Thermoforming
5. Casting
6. Forging
7. Powder Metallurgy — Final
8. Lumber Manufacturing
9. Additive Manufacturing
10. Quality and Monitoring

All the material to study (read or watch on Canvas)

The final exam (50%).
Exam: Module 4-10
There will be both conceptual and also calculation problems.
A formula sheet will be provided, similar to the midterm.(I will post the formula sheet on canvas.)
All the materials you need to study (read + watch) are on Canvas.
Study both the "Module Notes" and "The class lectures". (all posted under each modules).
Canvas/Modules/
Good luck on Friday the 13th !!!