1. DR. JONATHAN VALVANO: Today, we're going to demonstrate aliasing,
2. which is what happens if we violate the Nyquist theorem.
3. I've invited our videographer, Justin, to participate
4. in this next demonstration.
5. Hey Justin, does your video camera capture data in digital form?
6. JUSTIN: Yes, it does.
7. DR. JONATHAN VALVANO: Oooh, so it must have a sampling rate.
8. So, do you know what that sampling rate is?
9. JUSTIN: 24 frames per second.
10. DR. JONATHAN VALVANO: Oooh, so I wonder what
11. happens if I rotate the motor at 12 rotations per second.
12. I wonder what would happen?
13. DR. RAMESH YERRABALLI: Oh, I guess it has to violate the Nyquist theorem,
14. so we should see the aliasing effect.
15. JUSTIN: Stop talking, let's see it.
16. DR. JONATHAN VALVANO: So we're now at 1.3 volts,
17. and we're spinning at that rate.
18. So I'm going to increase the voltage so it should spin faster.
19. And it slowly spins up faster and faster.
20. DR. RAMESH YERRABALLI: OK, ramping up.
21. Ramping up to two frames per second, so two rotations per second.
22. Three-- And steady at three.
23. DR. JONATHAN VALVANO: So, we're still under the 12 rotations per second,
24. so you should still see the blue dot.
25. So let's go faster and see what happens.
26. Increasing voltage from two to three volts.
27. So it should be speeding even faster.
28. DR. RAMESH YERRABALLI: So we're at six and rising.
29. DR. JONATHAN VALVANO: Let's go even faster.
30. At four volts.
31. We cranked up the voltage so the motor will spin very fast.
32. As it spins faster and faster, watch the white spokes
33. as they appear to first spin clockwise and then counterclockwise.
34. Next we cut the power and the motor will start slowing down.
35. As it spins slower and slower again, the spokes
36. will appear to spin clockwise and then counter clockwise.
37. What we have witnessed is aliasing.
38. Aliasing occurs when the input signal oscillates
39. at a rate greater than or equal to one half the sampling rate.
40. In this case, the camera samples at 24 frames per second.
41. So any image moving at a rate greater than 12 times per second
42. will get all messed up.
43. Aliasing causes the apparent rotations per second
44. to be different than the actual rotations per second.