Ratio of wind turbines

Brady Merten

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Abstract

The purpose of this project was to determine which gear ratio was most efficient depending on the wind speed. There were 3 different gear ratios, medium - medium, small - large, large to small. I would first 3d design each gear set and the rod and blades for the wind turbine. After that the parts were 3D printed and assembled. Each gear ratio was then tested at 3 different speeds ranging from slow-fast. Using a multimeter I could determine the amount of volts each gear ratio produced at a different wind speed, which would allow me to determine which gear ratio was most efficient depending on the wind speed. It would also allow me to do a t test to compare different data sets to determine if the results were significantly different.

Intro/Background

A wind turbine creates energy by the blades turning which "are connected to a drive shaft that turns an electric generator, which produces (generates) electricity". The drive shaft is a gearbox with a gear ratio which determines how fast the motor spins, which then decides how much energy is produced.ALso "A wind turbine will produce the most power when the turbine and generator are both operating at the optimal rpm" so if the wind is not at the most optimal speed it will not produce as much energy so I am trying to find out if increasing the great ratio or decreasing effects how much energy is produced. John Hall explains how there goal was to find the most efficient gear ratio and to have the highest gear life (how long it lasts), this author testeted 6 different gear ratios to see which one performed at the highest efficiency, unlike that article my goal is to not only to find which performs at the highest overall efficiency but to find which gear ratio performs best depending on the wind speed allowing for areas without the highest wind speeds to determine if they should use a different gear ratio. Also John hall and Mohamed shaltout explains VRG, this allows for the gear ratio to be changed which allows for the wind turbine to change its gears when its not at max speed allowing for it to produce the most amount of energy. but my research is important because if the wind turbine can only have one set gear or if they are changing the gear they are gonna want to understand which gear ratio is the correct one they should change it to produce the most amount of energy. After testing my wind turbine I believe to find that the best gear ratio no matter the wind speed is Large to small. So for example if I increase the gear ratio (ex: 40:10-80:5) it will increase the amount of energy produced, but if I decrease the gear ratio (ex:40:1-20:20) it will decrease the amount of energy produced no matter the wind speed.

Methodology

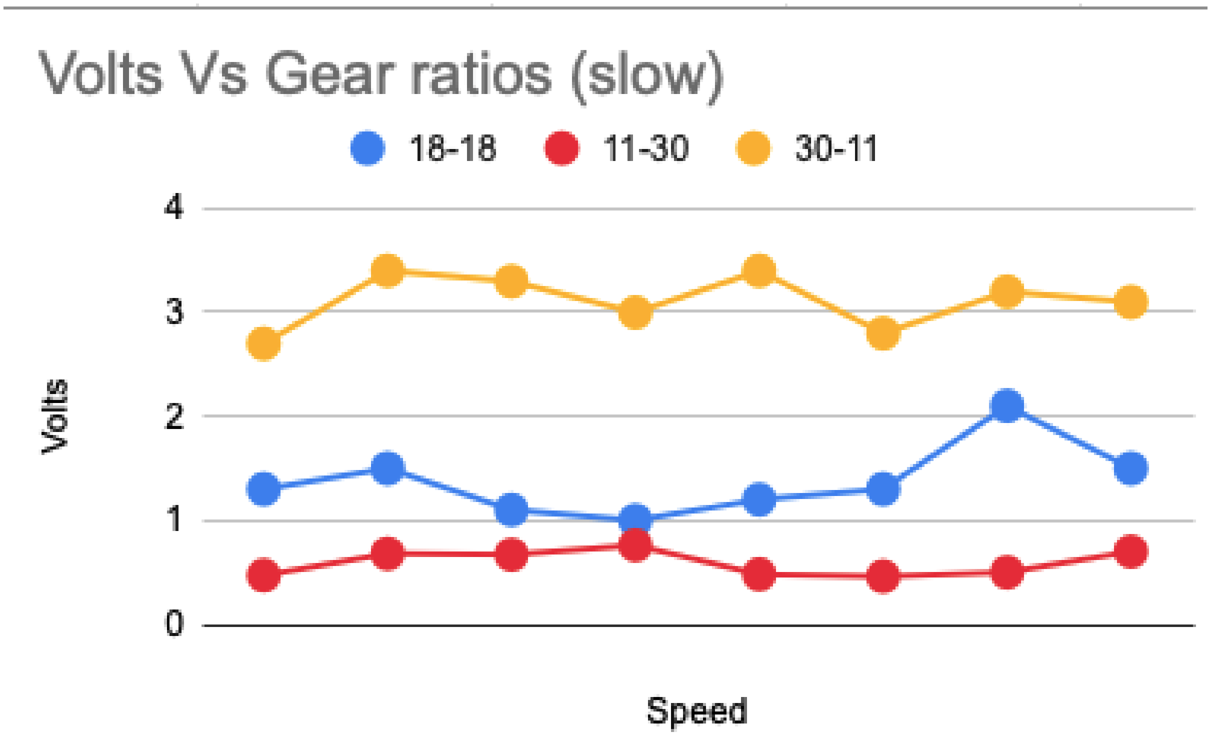
The Research sought to investigate different gear ratios and find which one produced the most energy depending on the speed of the wind.s. For the experiment to take place, a number of things had to be defined such as which gear ratios were gonna be used and what variables there were. The experiment consisted of two types of variables, the independent variables and the dependent variable. The independent variable was the wind speed.The independent variable was tested on several levels, for the wind speed it was 3 separate levels (slop, medium and fast).Along with each of these being tested by 3 different gear ratios. The dependent variable was the amount of energy produced. This information was gathered using a multimeter.

To test how much energy was produced each gear ratio was attached to a rod on the same blades as each other and were tested 8 times per wind speed. Using this information it allowed for the most efficient gear ratio to be determined

Data and results:

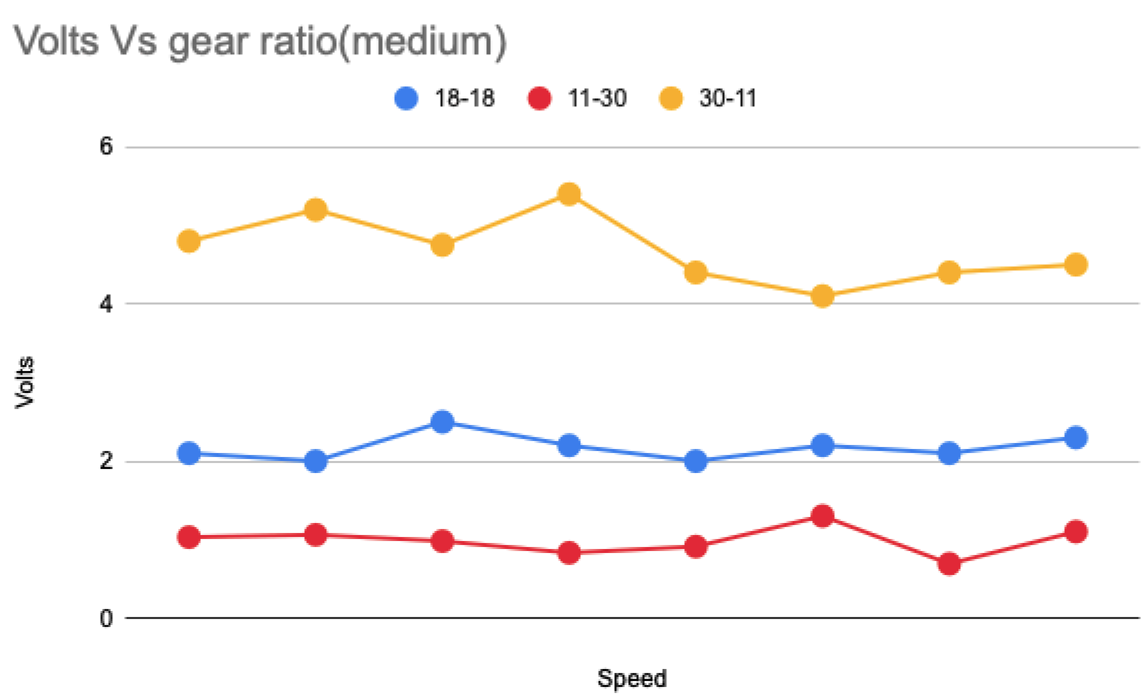
Slowest Speed

Gear ratio	18-18		11-30		30-11
Speed:low	1.3v		0.47v		2.7v
v=volts	1.5v		0.68v		3.4v
	1.1v		0.67v		3.3v
	1v		0.76v		3v
	1.2v		0.48v		3.4v
	1.3v		0.46v		2.8v
	2.1v		0.5v		3.2v
	1.5v		0.7v		3.1v
Mean	1.375		0.59		3.1125
Stand dev	0.341		0.12		0.264
Median	1.3		0.575		3.15



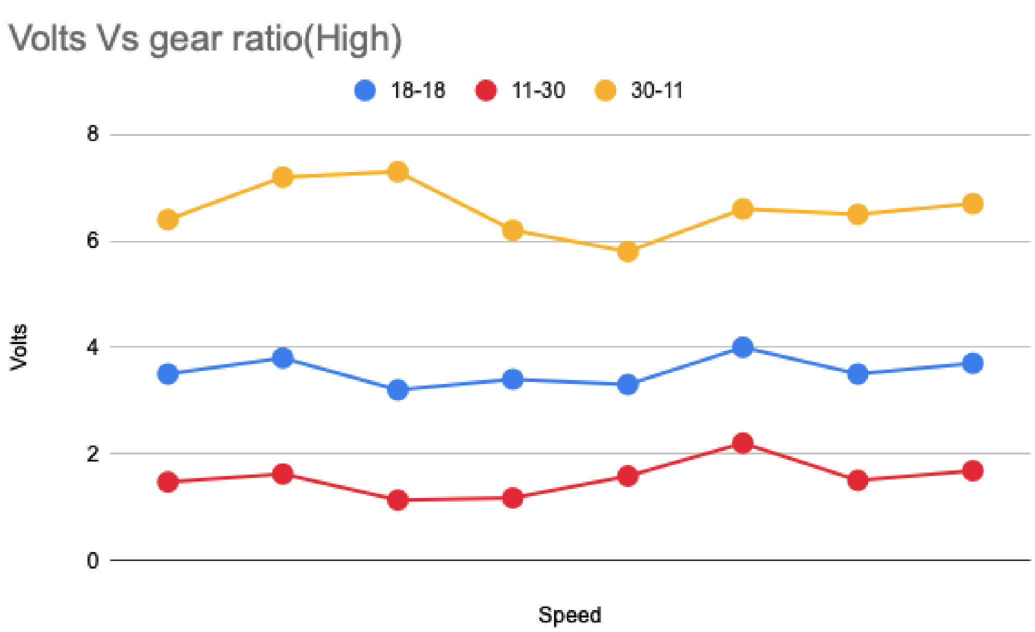
Medium speed:

Gear ratio	18-18		11-30		30-11
Speed:medium	2.1v		1.03v		4.8v
V=Volts	2v		1.06v		5.2v
	2.5v		0.98v		4.75v
	2.2v		0.83v		5.4v
	2v		0.91v		4.4v
	2.2v		1.3v		4.1v
	2.v1		0.69v		4.4v
	2.3v		1.1v		4.5v
Mean	2.175		0.9875		4.69375
Stand Dev	0.167		0.183		0.436
Median	2.15		1.005		4.625



Fastest speed:

Gear ratio	18-18		11-30		30-11
Speed:Fast	3.5		1.47v		6.4v
V=Volts	3.8v		1.62v		7.2v
	3.2v		1.13v		7.3v
	3.4v		1.17v		6.2v
	3.3v		1.58v		5.8v
	4v		2.2v		6.6v
	3.5v		1.5v		6.5v
	3.7v		1.68v		6.7v
Mean	3.55		1.54375		6.5875
Stand Dev	0.267		0.332		0.494
Median	3.45		1.525		6.5



On data table one in graph (low speed) we can see that 18-18 gear ratio maintained an average of 1.375 volts of energy produced. For the 11-30 gear ratio we can see that it had an average of 0.59 volts created and lastly for the 30-11 gear ratio there is an avg of 3.15 volts of energy. This contributes to the hypothesis that if the gear ratio increases from 10:10- 100:4 there will be an increase in the amount of energy produced no matter how fast the wind is. For the second table and graphs we can see the same trend with the 30:11 gear ratio produced on average 4.626 volts of energy while 11:30 produced 0.98 and 18:18 produced 2.175 volts of energy on average. Lastly the fastest speed of all also contributes to the hypothesis because while the gear ratio of 18:18 increased in the amount of energy it produced to 3.55 volts , but sid the 30:11 gear ratio it on average at the fastest speed produced around 6.5 volts of energy. Trends across all the data show that 30:11 gear ratio produced the most amount of energy no matter the speed. Along with that as the speed increased so did the amount of volts.

Conclusion

The purpose of the project was to find the most efficient gear ratio depending on the speed of the wind. For the slow speed data I found that the most efficient gear ratio was the 30:11 gear ratio based on the mean because it averaged around 3.1 volts produced while 18:18 averaged 1.4 volts of energy produced and 11:30 only averaged only 0.6 volts of energy produced. Along with on the graph and standard deviation we can see most of the time the amount of energy produced wasn't majorly skewed based because most of the points on the graphs were pretty close along with each data set's standard deviations being below 0.5. Although at medium speed the amount of energy produced did increase for every gear ratio the 30:11 gear ratio still produced the most energy it produced on average 4.6 volts of energy. The 18:18 gear ratio also maintained its second place with an average of 2.175 volts and 11:30 only averaged about 1 volts. Once again based on the graphs and standard deviation we can conclude that the data was not skewed because standard deviation was once again below 0.5 and on the graph all the points are pretty close to the average and maintain that for each of the 8 points. Lastly for the fastest speed the 30:11 gear ratio not only managed to come out on top with an average of 6.6 volts produced but also increased the most amount on average. Second for most volts produced is the 18:18 gear ratio produced on average 3.55 volts of energy while 11:30 gear ratio only produced on average 1.5 volts of energy. I also performed a T test comparing each gear ratio for each wind speed and every time the P value came back for each and everyone below 0.001 this means that all the data shows an extreme amount of difference from one another no matter the wind speed. One of the main reasons that the 30:11 gear ratio may have performed so well is because one full spin of the blades would spin the 30 gear one time which would spin the smaller gear almost 3 times while the other gears either only spun it once everytime or ⅓ times . I can also conclude that no matter the wind speed the small to large-small gear ratio will always produce the most amount of energy although overall no matter what gear ratio you are using the faster the wind speed the more energy the gear ratio will produce.

Expansion

A few ways I could expand this project is by changing the size of a wind turbine blade and seeing if that affected the amount of wind produced or find another renewable energy source and chance something small about that to see if it produced more or less energy depending on what I changed

References

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