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Analysis of Auto-Gear Shifting Mechanism on different Load Conditions

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Abstracts

As conventional gear-boxes are capable to vary the gear arrangement according to fluctuating load. In this paper fabrication of an automated gearbox is done and comparison of torque, rpm is carried out with standard elementary equations. Finally we conclude the efficiency of this fabricated model in terms of gear shifting and power transmission. The performance of this gearbox can be increased to the standard values by varying the design parameters of gears and pre-requisites.

Keyword: Deferent types Gears arrangement, Micro-controller, Hall effect sensor (magnetic rpm sensor), L298 Motor Driver, screw gauge.

Introduction

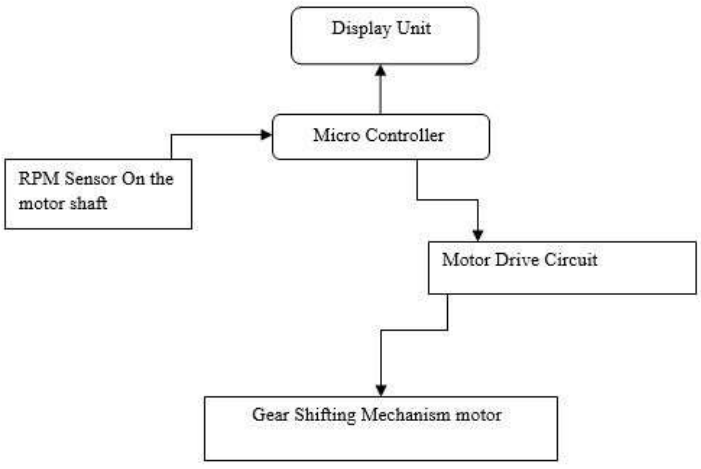
In automatic gear transmission system, decision of gear shifting is made by the car's on computer board, without direct interference of driver. This system shifts gears based on speed of vehicle according to accelerator, brake or other vehicle running or load conditions. Direct shift gearboxes are unique in that either operated manually or automatically. The automatic transmission in car is computer controlled and programmed to keep the engine running at optimum rpm. Whenever rpm level increases above the top limit, the transmission automatically shifts into higher gears so that engine will turn slower under sa

me power. When rpm level decreases beyond the low limit (engine is running too slow) the transmission automatically shifts into a lower gear so that the engine will turn faster under the same power.

Literature review

In automatic gearboxes various techniques are used for gear shifting whose are mechanically controlled. The present paper discussed the gear shifting using an embedded system has small dimensions, economical and low maintenance cost. In this the "microcontroller" selects the transmission gear as per speed of the vehicle without any human interference [1].As per comparison between manual and automated transmission, manual transmission don't want much maintenance cost and support to save fuel. In automated transmission there is more comfort during driving situation and minimize daily normal driving difficulties which arrive in hills, traffic or situation where we required rapid gear shifting[2].The gearbox which is operating under different load condition and diagnose the common mechanical faults. In this paper an experimental setup is designed and calculate the characteristic performance on different load condition [3] Different methods are discussed for power loss reduction in gearbox. No load losses can be reduced especially of low temperature and part load conditions. Low loss gears can contribute substantially to load dependent power loss reduction in the gear mesh. [4] Automatic transmission shift process has joint elements such as clutch and bands engage, linking sets of gears to create a fixed gear ratio. Since these ratios differ between gears in a fixed gear ratio transmission, the motion of the vehicle could change suddenly during shift process. [5]

Block diagram of the project



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Fabrication of model setup and methodology

In our research we fabricate a proto-type model of gearbox. On this we calculate the torque and rpm on different load condition and check the performance of gearbox model for gear shifting according to load and ratio of power transmission to the rear drive which is given by an electric motor to the gearbox.

In our model mainly we have fabricated a gear box with the four speed level and hence we have four different output torques. There is an RPM measuring sensor mounted on the engine shaft which measures the rpm of engine shaft and this data is given to the micro controller. There is a gear shifting mechanism comprised of a screw jack system which shifts the gear in to and fro manner. As we know vehicle running on some speed if encounter a load or breaks are applied the rpm of engines goes down, the micro controller watches this down fall and shift the gears to next upper level with the help of gear changing mechanism so that vehicle can bear the load encounter, if the encountered load is greater the rpm remains down and hence the micro controller continuously looking for rpm shift the gear to another next upper level and vehicle automatically manages the load. This way we achieve the auto transmission.

(a) List of Mechanical Components -

S.No.	Component Name	Specification	Quantity
1.	Gears (Double)	48-24 teeth	9
2.	Gears (Single)	18 teeth	7
3.	Aluminium L-Angle	1”x 1.5”x7.5”	2
4.	Acrylic Sheet	4.5” x 2.5”	2
5.	Robo wheel	8cm (diameter)	4
6.	Iron Rod	6 mm and 8 mm	2

(b) List of Electronic Components -

S.No.	Component Name	Specification	Quantity
1.	Micro-Controller	AT89552	1
2.	Hall Effect Sensor	--	1
3.	Motor Drive	L-298	2
4.	Voltage Regulator	7805 (12 V- 5V)	1
5.	Optical Sensor	--	4

Experiment and results

(1) Gear shifting according to load - In this experiment by the velocity ratio and various gear calculation we found out the range of rpm and range of torque transmitted to different gears. These are calculated as per gearbox model (theoretical results obtained)

S.No.	Range of rpm (N)	Range of Torque (T)	Gear Position
1.	3 – 15	14.8 – 3.68 N-m	I
2.	15 – 60	3.68 – 0.91 N-m	II
3.	60 – 249	0.91 – 0.23 N-m	III
4.	249 – 430	0.23 – less N-m	IV

Now we check the performance results of the gear box practically by run the set up on various load condition and compare the data that gears are automatically changing or not according to this range. In this the experimental setup weight is considered that setup will run on this initial load i.e. 1.745 kg. We achieved that on five different load conditions the gear shifting results are (Practically results obtained)

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S.No.	External Load (kg)	rpm	Torque (N-m)	Gear Position
1.	No Load	120	0.47	III
2.	0.60	90	0.63	III
3.	0.86	75	0.76	III
4.	1.46	62	0.89	III
5.	1.66	55	1.04	II

Finally the result obtained that gears are shifting automatically same as that theoretically calculated. Hence the practical gear shifting satisfy the theoretical results in given range of torque and rpm on various load conditions

(2) Power transmitted by gearbox- In any automobile system power produces by I.C. engine in terms of rpm/torque. There will be power (energy) losses when using gear system to transmit the torque which is due to many factors like friction between gears teeth, lubrication motion in gearbox.

According to gear design factors gearbox ratio achieved and compare with the practical setup and also calculate the efficiency on particular gear to find out the performance on various load conditions. The table shows the gear transmission ratio and efficiency of particular gear

S.No.	Gear Position	Max. rpm on particular gear	Transmission Ratio (practical)	Transmission Ratio (theoretical)	Efficiency on particular gear
1.	I	15	4	3.81	95%
2.	II	60	3.15	2.71	77%
3.	III	249	1.72	1.37	79%
4.	IV	430	1.16	1	86%

By the further results the overall efficiency of power transmission calculated as 84.25%. This efficiency is calculated on by the results of fabricated proto-type gearbox experimental setup.

Conclusion

As per study of load and rpm analysis, we observe that in gearbox setup, auto-gear shifting is almost satisfy the theoretical and practically results. The analysis of power transmission also shows the transmission of engine rpm/torque to rear wheel. On comparing the transmission ratio on different gears which give results that top and first gears are in approximately good condition, but on second and third gears there is more difference. According to the engine load and wheel rpm we find out overall efficiency of power transmission that is 84.25%. This gearbox can make more efficient by increasing the transmission ratio. Friction can be considering into the account for more results and analysis. The gear teeth and diameters can be further modified to achieve results more closure to the standard parameters. Proper material selection and reducing weight of the vehicle can also be helpful to perform the setup in better condition and can improve the load bearing capacity on higher gears.

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