



# Automatisation Of Manual Gearbox

**Brendan G. Carr**

## Automatisation Of Manual Gearbox:

*Model-based calibration of automated transmissions* Huang, Hua, 2016-11-18 With continuous restrictions on emission standards and demands for higher driving comfort the calibration of shift quality is linked deeply and widely to automated transmission control algorithms This calibration process is typically implemented with real vehicles on the road under poorly reproducible conditions where the calibration engineer has no other choice but to try different control parameters till the subjective assessment on the shift quality meets certain requirements such as shifting comfort or sportiness Compared with today's multiplying number of variants in vehicle engine transmission combinations and exponential growth of control parameters this traditional method is backward and costly An efficient way to rise to the challenge is the model based automatic calibration In contrast to the conventional shift quality calibration this novel method uses a closed loop approach based on a dynamic model instead of human know how A shift quality correlated position trajectory is proposed Compared to the traditional control parameter adjustment method the guided trajectory has a higher tolerance to the system's hardware components and a better compatibility with TCUs from diverse suppliers Since shift quality is not restricted to a general summarized grade e.g. comfort and sportiness are always two conflicting in uence factors in the terms of shift quality calibrations a multi objective evolutionary algorithm is applied to search the set of Pareto optimal front which includes all the optimal compromised control parameters of the gear shifting trajectory for possible choice In this work a hydro mechanical AMT synchronization system is used as an example to explain the proposed optimization process A Modelica based non linear hydro mechanical AMT system is modeled which describes the transient behavior during gear shifting in detail An effective fuzzy sliding mode position controller is designed for the referenced position tracking during synchronization in contrast to the conventional trial and error tuning method a genetic algorithm is applied to automatically identify and optimize the sliding mode controller parameters A novel multi objective evolutionary algorithm MLIA is developed to find out the optimal control set for the synchronization trajectories Verification at a transmission test bench shows that this model based multi objective optimization method has a guiding capability in automated transmission calibration Mit deutlich strengerem gesetzlichen Anforderungen hinsichtlich der Abgasemissionen und einer zunehmend anspruchsvollerem Nachfrage bezüglich des Fahrkomforts rückt die Frage nach der Schaltqualität stärker in den Fokus der Getriebeentwicklung Die Kalibrierung umgangssprachlich die Applikation ist deshalb ein Schwerpunkt bei der Entwicklung von Algorithmen für die Schaltqualität von automatisierten Getriebesteuerungen Der Kalibrierungsprozess wird in der Regel im Fahrzeugversuch auf der Straße durchgeführt Der Applikationsingenieur versucht unter diesen nicht reproduzierbaren Bedingungen verschiedene Steuerparameter zu adaptieren Dies wird für eine Schaltung solange durchgeführt bis die subjektive Beurteilung der Schaltqualität und die zugehörigen Eigenschaften wie zum Beispiel Schaltkomfort und Sportlichkeit erfüllt ist Dieser beschriebene Prozess ist zeit und personalaufwendig was mit dem aktuellen Angebot an Motor Getriebe Fahrzeugvarianten

kaum bewältigt werden kann. Als weitere Herausforderung steigt die Anzahl der kalibrierbaren Parameter der Regler und Steuerungsmethoden stetig um die Kundenbedürfnisse zu befriedigen, weshalb auch aus Kostensicht ein besserer Prozess gefunden werden muss. Eine effiziente Möglichkeit zur Lösung der skizzierten Problemstellungen ist die modellbasierte automatische Kalibrierung. Im Gegensatz zu der herkömmlichen auf Fahrversuche basierende Kalibrierung der Schaltqualität verwendet dieses neue Verfahren ein dynamisches Modell in einer geschlossenen Schleife. Anstelle des Applikationsingenieurs für die Fahrvorgaben wird in der Schleife ein Fahrerregler und ein Optimierungsalgorithmus verwendet, um so eine hohe Reproduzierbarkeit des Schaltereignisses sicherzustellen. Es wird vorgeschlagen, die Bewegung der Schaltstellung zu optimieren, da diese mit der Schaltqualität korreliert. Diametral steht dem die allgemein bliche Regleranpassung verschiedener Parameter für die Synchronisation gegenüber. Die vorgeschlagene Methode der gefundenen Schaltbewegung weist eine deutlich höhere Toleranz gegenüber der Varianz an Hardwarekomponenten und damit eine bessere Kompatibilität zu den Getriebesteuergeräten TCUs verschiedener Lieferanten auf. Die Schaltqualität lässt sich nicht auf ein subjektives Kriterium zusammenfassen, es werden immer unterschiedliche Faktoren wie z.B. Komfort und Sportlichkeit den Schaltvorgang bestimmen. Deshalb wird für die Optimierung des Schaltvorgangs eine mehrkriterielle evolutionäre Algorithmus angewandt, um die Paretofront zu identifizieren, was alle Kompromisse der Schaltbewegungsregelung einschließt. Es wird ein Modell eines hydromechanischen Synchronisationssystems für ein automatisiertes Getriebe als Beispieldemonstration benutzt, um den vorgeschlagenen Optimierungsprozess zu demonstrieren. Das nichtlineare hydromechanische Synchronisationssystem wird mit der objektorientierten Sprache Modelica modelliert. Mit dem Modell werden Schaltvorgänge detailliert beschrieben. Ein Fuzzy Sliding Mode Regler wird für die jeweilige Bewegung der Schaltung während der Synchronisation benutzt. Im Gegensatz zur herkömmlichen empirischen Anpassung der Reglerparameter wird ein genetischer Algorithmus angewendet, um die automatische Erkennung und Bewertung der Parameter vom Fuzzy Sliding Mode Regler zu optimieren. Ein neuartiger evolutionärer mehrkriterieller Algorithmus MLIA wurde angewandt, um eine optimale Bewegung der Schaltstellung während der Synchronisierung zu finden. Die Validierung am Getriebeprüfstand zeigt, dass diese modellbasierte Methode der mehrkriteriellen Optimierung in der automatisierten Getriebekalibrierung eine deutliche Verbesserung darstellt.

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