Supplementary Materials Figure S1

Algorithm: Pseudo code for design lever contours for CVGC case study

Input: *Environment variables*
$x_{pivot}^{\#}$: *x coordinates for pivots,* $y_{pivot}^{\#}$: *y coordinates for pivots. (#:1 – 9)*
x_{spg}: *x coordinates for reference point of spring follower guide,* $\emptyset_{spg}$: *angle of spring follower guide*
Other variables including Cam profile, size of followers

Output: Coefficients defining each partial contour
$Coeffi_{PC1}$: *Coefficients defining partial contour 1 (Hermite spline)*
$Coeffi_{PC2}$: *Coefficients defining partial contour 2 (B spline)*
$Coeffi_{PC3}$: *Coefficients defining partial contour 3 (Circle and straight line)*
$Coeffi_{PC4}$: *Coefficients defining partial contour 1 (Hermite spline)*

Function rotationangleCal (*Envionmental variables, cam rotation angle*)
rotationangle ← *determined by geometric relations of pivot and lever_roation angle*
Return *lever_rotationangle*

Function designPC1 (*Envionmental variables, lever_rotationangle*)
for i =1:9
Spring follower positions in lever coordinates ← *determined by coordinate transformation*
end
Representative point of each spring follower trace ← *determined by common tangential line between adjacent spring follower circles*
$Coeffi_{PC1}$ ← *Coefficient of 2nd order polynomial based Hermite spline between two representative points*
Return $Coeffi_{PC1}$

Function designPC2 (*Envionmental variables, lever_rotationangle*)
Genetic algorithm
Design variables: coefficients of B spline
Objective function: max deformation at bot pivot/max deformation at top pivot
(Bot pivot condition)
B spline generation in lever coordinates
Transformation B spline from lever coordinates to global coordinates
Calculation the intersection point between lever and guideline of spring follower
Determination of deformation length at bot pivot condition

(Top pivot condition)
B spline generation in lever coordinates
Transformation B spline from lever coordinates to global coordinates
Calculation the intersection point between lever and guideline of spring follower
Determination of deformation length at top pivot condition

Calculation the score
Return *optimal coefficients of B spline*
Return $Coeffi_{PC2}$

Function designPC3 (*Envionmental variables, lever_rotationangle*)
Generation of straight line and arc which can avoid intervention between lever and the cam structure
Return $Coeffi_{PC3}$

Function designPC4 (*Envionmental variables, lever_rotationangle*)
Calculation of Hermite spline coefficients between the end point of PC1 and the start point of PC2
Return $Coeffi_{PC3}$