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GENERATION OF CAM PROFILE USING COMPUTER AIDED TOOLS

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ABSTRACT
The paper deals with the generation of Cam profiles with the help of Computer Aided tools i.e. CAD/CAM Integration method. The program for drawing the Cam profile has been written in AutoLISP language. The drawing generated in AutoCAD can be transferred to CAMM software generating the NC part program automatically.

KEYWORDS: CNC, CAMM, CAD, CAM, AutoCAD

INTRODUCTION
CAD/CAM (Computer Aided Design/Computer Aided Manufacturing) can be defined most simply as the use of computers to translate a product's specific requirements into the final physical product. [1] With this system, a product is designed, produced, and inspected in one automatic process. It plays a key role in areas such as design, analysis, production planning, detailing, documentation, N/C part programming, tooling fabrication, assembly, jig and fixture design, quality control, and testing. Whenever any deviation is noted, a programmable controller takes automatic corrective action to compensate for the deviation. Thus a closed loop is formed which produces consistent quality products, reduces waste and improves productivity. Computer technology has become essential for improving performance and safety. In this paper the author has described a method of drawing Cam profile in AutoLISP as the programming language.

Cam
A cam is a mechanical component of a machine that is used to transmit motion to another component, called the follower, through a prescribed motion program by direct contact.[2] The driver is called a cam, and the driven member is called a follower. Cams are used to transform a rotary motion into a translating or oscillating motion. In certain cases they are also used to transform a translating or oscillating motion into a different translating or oscillating motion.[3] Cams are widely used in automatic machines, internal combustion engines, machine tools, printing control mechanisms, ejection molds, computers and so on. They are manufactured usually by die-casting, milling or by punch-presses.

Classification of Cams and Followers
Cams are classified according to:
Basic Shape: Wedge cams, Flat Cams, Radial or Disc Cams, Cylindrical Cams, Spiral Cams, Conjugate Cams, Globoidal Cams, Spherical Cams.
Follower Shape: Knife edge follower, Flat face follower, Roller follower, Spherical face or curved shoe follower.
Manner of Constraint of Follower: Pre-loaded Spring Cam, Positive-drive Cam, Gravity Cam.
Follower Movement: Rise-Return-Rise (R-R-R), Dwell-Rise-Return-Dwell (D-R-R-D), etc.
Manner of Constraint of Follower: Pre-loaded Spring Cam, Positive-drive Cam, Gravity Cam.
Follower Movement: Rise-Return-Rise (R-R-R), Dwell-Rise-Return-Dwell (D-R-R-D), etc.

DESIGN PROCEDURE
Various types of cams are required to serve the desired purpose. Desired purpose implies type of motion been given to follower like SHM, uniform acceleration and deceleration, uniform velocity etc.[4][5] Design procedure for each type of' motion along with for different types of cam are described below:

Uniform Velocity
This type of rnotion implies that the displacement of the follower is proportional to the displacement of cam. $s = h\theta/\varnothing$, Where s = Instantaneous follower displacement, h = Maximum follower displacement, θ = cam rotation angle (instantaneous), $\varnothing$ = cam rotation angle for the maximum follower

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displacement, But, $\theta = \omega t$, Where ω = angular velocity of the cam, t = time lapsed, therefore the above equation becomes $s = h\ \omega t/Ø$. Now velocity $v = ds/dt = h\ \omega t/Ø$ = constant and acceleration $f = d2s/dt2 = dv/dt = 0$.

Using the above relations, uniform velocity motion has been drafted. Initially user has to give the angle Ø lapsed during traversing the uniform velocity motion. To facilitate this, program asks the user to specify the angle in terms of a1 ("From angle") and a2 ("To angle"). Secondly the program asks type of stroke i.e. upstroke or down stroke. Upstroke means motion of follower starts from minimum radius of cam and continuous until maximum radius of cam. Difference between maximum radius and minimum radius is equal to h(sl). Reverse is case in down stroke. The follower may lie on only any of the two positions, minimum radius or maximum radius. To govern these two types of strokes two counters a and b, are assigned, a for initial displacement and b for final displacement.

Drawing of cam profile during the concerned degree of motion is initiated by specifying points P1, P2, P3, using the format specified in AutoLISP in polar coordinate system and after marking these three points the points are joined using "Arc", an AutoCAD command.

SHM

Here displacement of the follower is simple harmonic in nature governed by equation, $s = h/2\ (1 - \cos\beta)$ Where $\beta = \pi\theta/Ø$. Therefore $s = h/2(1 - \cos(\pi\theta/Ø))$, Now Velocity $u = ds/dt = (h/2)\ (\pi\omega/Ø)\ (\sin(\pi\theta/Ø))$ and the acceleration $f = h/2(\pi\omega/Ø)2(\cos(\pi\theta/Ø))$

Using above relation of displacements for SHM the profile for cam has been drafted. To facilitate this, program asks the user type of stroke, up or down.

For upstroke the relation used is θ (th) = $(\pi/10)$i and for down stroke th = (10 - i) $\pi/10$ where i, the counter, varying from 0-10. Here the follower displacement curve is divided into 10 equal parts meaning that the angle of lapse i.e. a12 = (a2 - a1)/10= each part. Various points P1, P2, P3,……..are specified using standard AutoLISP format for specification of point giving an increment of a12 in each point. These points are joined using "Arc" command.

Uniform Acceleration and Deceleration

In such a follower programme, there is acceleration in the first half of the follower motion whereas it is deceleration during the later. The magnitude of the acceleration and deceleration is the same and constant in the two halves. To facilitate the drawing of cam profile for uniform acceleration and deceleration follower displacement diagram has been divided into eight equal parts. First four parts represent the displacement of follower during which acceleration is supposed to take place while the remaining four parts represent the deceleration period. To draw the cam profile we have set counter i for accelerating motion of follower and points P1, P2, P3,……..are marked until counter $i < 4$. After $i = 4$, counter j has been set that takes into account decelerating rnotion of follower and subsequently mark points on the cam profile. These points are joined by "Arc" command. Above description holds good for upstroke while in down stroke counters i and j perform reverse functions i.e. i for deceleration and" j for acceleration.

Cycloidal

To draw the cam profile having cycloidal motion of follower the formula used is $s = h/\pi\ ((\pi\theta/Ø)- 1/2 \sin (2\ \pi\theta/Ø))$ where θ is taken as input from the user as th $(\theta) = a2 - a1$.

Tangent Cam

Following relations were used while generating tangent cam profile. Program asks the user to give the angle between two flanks. From this angle nose angle is evaluated which in turn will also be equal to angle of lift. At the same time minimum radius, maximum radius and lift are also known and hence all the required point to generate the cam profile are marked and tangent cam is drawn. Relations used are, Nose Angle = $\pi/2$ - 1/2 (Angle between flanks), Distance between can centre & nose centre = Lift/(1 - Cos (Nose angle)) = r(say).

The figure1 below shows the Tangent cam drawn through the use of the steps explained in the procedure of drawing the Tangent cam.

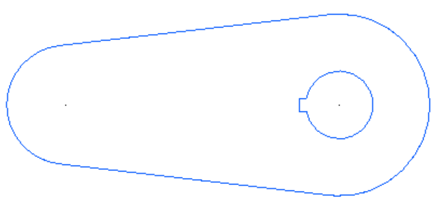

Figure 1:Tangent Cam

Convex Cam

Here a part of the profile is convex in nature. Following notations are used, r= Distance between centre of nose and cam, rn= Nose radius, rc= Base

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circle radius, h= Lift, a1 = acute angle of lift. Now, r = rc + h.rn = b = OQ. Distance between two centres, d = (b2 - (rc - rn)2) / 2 ((rc - rn) - b Cos al) = OP distance from Cam centre and centre of convex flank, e = d + rc - rn = PQ distance between nose centre and centre of convex flank.

First centre of cam a is located and then with the help of distance b nose centre Q is located. Then using the cam geometry and above equations point p, centre of convex flank is located. In this cam profile P comes out to be in IV quadrant. Now using the centres O, Q and P, points P1, P2, P3 and so on are obtained and using "Arc" command these are joined one half of cam and by taking its mirror image the whole Cam profile is generated. Using the steps as explained above for the drawing of convex cam profile figure2 below shows the profile of the convex cam.

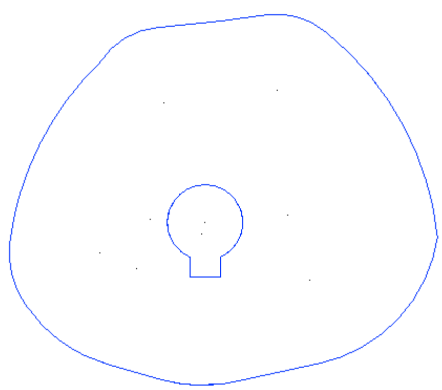


Figure 2: Convex Cam

Concave Cam

Here a part of the profile is concave in nature. The notations used are same as in convex cam & the equations used are

r = rc + h - rn = b = OQ,

d = ((rc - rn)2 - b2) / 2 ((rc-rn) - b Cos al) = OP,

e = d - rc + rn = PQ

In this Cam profile P comes out to be in II quadrant. Now using the centres O, Q and P, points P1, P2, P3 and so on are obtained and using "Arc" command these are joined one half of cam and by taking its mirror image the whole Cam profile is generated. The figure3 shows the concave cam drawn using the steps above.

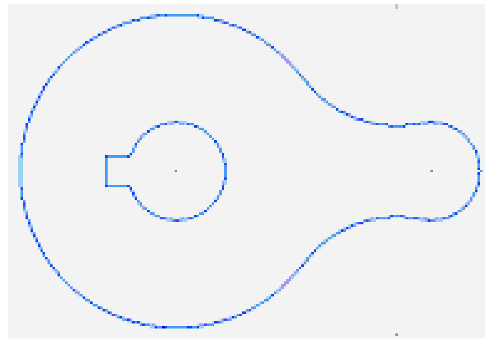
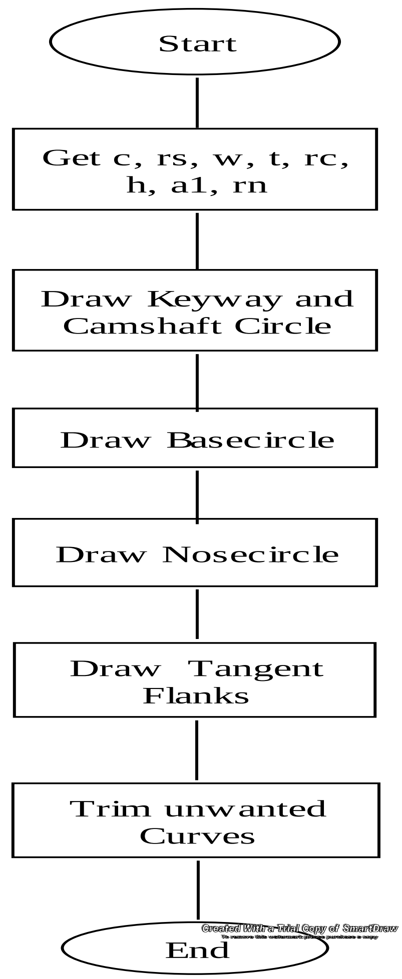


Figure 3:Concave Cam



Flowchart 1: Design procedure of Tangent Cam profile

CONCLUSION

The survival of the industry in the current content of globalisation, intense customer focus and rapid changes depends upon its adaptation to demands put by the environment. Companies in search of excellence have initiated use of artificial intelligence, fuzzy logic, Expert systems and use of softwares like IDEAS, ProENGINEER, UNIGRAPHICS, CATIA, CAMM, ANSYS, ACAD etc. with overall thrust on total productivity and better performance, This Paper presented generation of Cam profile with the help of Computer Aided Tools. This is a step towards automation. This greatly reduces the idle time, increase the productivity and accuracy. Profiles of various types of Cams like general or specified contour can easily be generated using CAD / CAM tools. Any changes in design can be introduced by just changing or modifying the parameters. This gives more flexibility

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