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Design, Synthesis & Simulation Of Four Bar Mechanism For Guiding Wheel For Climbing

Rahul R.Gurpude
M.Tech Student

Dr.R.D.Ashkhedkar
Dean K.D.K.C.E,nagpur

ABSTRACT

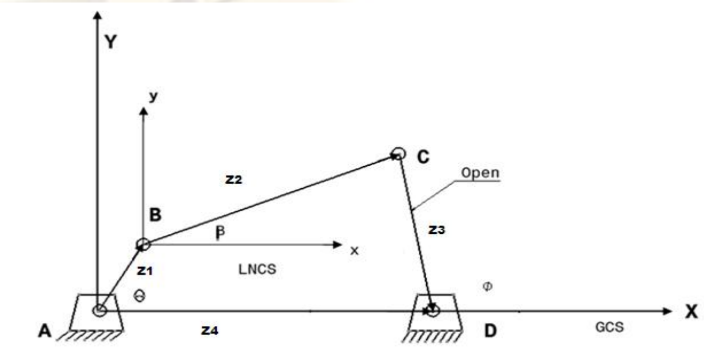
In the field of providing mobility for the elderly and disabled the aspect of dealing with stairs continues largely unresolved. This paper focuses on presenting the development of a stair-climbing wheelchair mechanism with high single step capability. The mechanism is based on all four wheel clusters connected to the base (chair) via powered linkages so as to permit the forward direction, and high single step functionality. Also the big task is to calculate the dimensions of four bar mechanism as per required task,hence with the help of chebechevs equation and fraudenstein's equation ,several bunch of solution being obtained depending on function on which simulation is carried out but only one can support to required task i.e. to climb the stair of 220 mm height with respect to reference skeleton frame with respect to which final simulation being carried out.

INTRODUCTION

As we enter the second millennium since the time of Christ there is an increasing mind fulness of the need to focus technology on helping people. One specific area of need is that of providing increased freedom in terms of mobility forthe elderly or disabled. The reasons being to provide an optimum quality of life for the disabled or elderly, and to reduce the load on care workers, the two aspects being closely linked by thec onscious sense of being a "burden". Autonomy in the area of mobility has always been highly valued, but is some time simpaired by some form of disability. In many cases this results in reliance on some form of external transport mechanism. In this regard traditional wheelchairs and powered wheelchairscontinue to play a vital role. However wheelchairs to date provide a high level of mobility only inartificial or "barrier free" environments. That is there remains a significant gap between theobstacle negotiating ability of a wheelchair and that of the average able bodied person. This aspect is perhaps most apparent when considering stair-climbing. While modern architecture and new policies continue to make newly built areas as "accessible" as possible to persons with awide variety of disabilities steps will always be a reality in the "real world".Hence in the field of providing mobility for the elderly and disabled the aspect of dealing with stairs continues largely unresolved.

This thesis focuses on presenting the development of a stair-climbing wheelchair mechanism with high single step capability.The mechanism is based on all four wheel clusters connected to the base (chair) via powered linkages so as to permit the forward direction, and high single step functionality for. Primary considerations were inherent stability, provision of a mechanism that is physically no larger than a standard powered wheelchair, aesthetics and being based on readily available low cost components. Also the big task is to all acuate the dimensions of four bar mechanism as per required task,hence with the help of chbechevs equation and fraudensteinsequationin which several bunch of solution being obtaind depending on function on ehich simulation is carried out but only one can support to required task i.e. to climb the stair of 220 mm height with respect to reference skeleton frame with respect to which final simulation being carried out.Alsocomparision carried out depending upon existing techniques used for task previously. It describes a design of a mechanism that aims a wheel to climb steps. The proposed four-bar linkage can be installed on each wheel of a vehicle, which therefore can be capable to climb stairs with suitable comfortable motion. A straight-line trajectory for the centre of a wheelis ensured through an easily controlled motion, and the compactness of the mechanismdesign makes it suitable for staircase climbing wheelchairs for aiding people with disability

FOUR BAR MECHANISM



Out of which we will go for Fraudenstein's equation because of advantage that all values are being arranged in analytical manner and also

calculation are being arranged simple formulation hence will leads towards accuracy as compared to other methods as that of graphical which will leads to an huge error in case of small mistakes .
To solve resolving all forcces in x-direction & y-direction on adding both we have
$\cos\theta_1.\cos\theta_1 + \sin\theta_1.\sin\theta_2 = k_1\cos\theta_1 - k_2\cos\theta_2 + k_3$
$\cos(\theta_2 - \theta_1) = k_1\cos\theta_1 - k_2\cos\theta_1 + k_3$
Where, $k_1 = r_1/r_2$, $k_2 = r_1/r_4$, $k_3 = r_2^2 - r_3^2 + r_4^2 + r_1^2 / r_2.r_4$

FORMULATION OF PROBLEM:

Here we have to finalize dimensions of four bar mechanism,taking into consideration 3 precision point method and fraudeinsteins equation following procedure for different functions such as $y=1/x, y=x^2, y=x^3$, y=In X, Y=log x, $y=e^x$, y=sin x, y=cos x, y=tan x are different types of functions being used and calculation are as follows
1)0<x<360
2)$\Delta\theta=360^0$, $\Delta\Phi=120^0$
3)$\Phi s=0^0, \theta s=0^0$
4)Bychebchev spacing $\Delta Xj=\Delta X/2(1-\cos(\prod(2j-1)/2n))$
5) $\theta j=\Delta\theta/\Delta X\ (Xj-X1)$
6) $\Phi j=\Delta\Phi/\Delta Y\ (Yj-Y1)$
7)ByFraudensteins equation $K_1\cos\theta + K_2\cos\Phi + k_3 = -\cos(\theta-\Phi)$
8) Calculate K_1, K_2, K_3
9)Assume any one linklength Z_1=220mm
10)$K_1=Z_1/Z_4$, $K_2=-Z_1/Z_4$, $K3=Z_3^2-Z_2^2-Z_1^2-Z_4^2/2*Z_2*Z_4$

CALCULATIONS FOR DIFFERENT FUNCTIONS:

We have,
3 precision point and fraudensteins equation
$0^0<x<360^0$
$\Delta\theta=360^0$, $\Delta\Phi=120^0$
$\Theta s=0^0$,$\Phi s=0^0$

1)For Function $Y=X^5$

By chebyshev spacing formula
$\Delta Xj=\Delta X/2*(1-\cos(\prod(2j-1)/2n))$
$\Delta X=(Xn+1)-(X0)=360-0=360$
For j=3.5,4.5,5.5
$\Delta X1=360/2*(1-\cos(\prod(2*3.5-1)/2*3))=35$
$\Delta X2=360/2*(1-\cos(\prod(2*4.5-1)/2*3))=45$
$\Delta X1=360/2*(1-\cos(\prod(2*5.5-1)/2*3))=55$
Now,
$X_0=0$ $Y_0=\infty$
$X_1=226$ $Y_1=5.89*10^{11}$
$X_2=261$ $Y_2=1.21*10^{12}$
$X_3=306$ $Y_3=2.68*10^{12}$
$X_4=360$ $Y_4=6.04*10^{12}$
We have,
$\theta j=\Delta\theta/\Delta X(Xj-X1)$ $\Phi j=\Delta\Phi/\Delta Y(Yj-Y1)$
Therefor,
$\theta 1=360/360*(0-0)=0$ $\Phi 1=120/6.04*10^{12}(\infty-\infty)=0$
$\theta 2=360/360*(261-226)=35$
$\Phi 2=120/6.04*10^{12}*(1.21*10^{12}-5.89*10^{11})= 50$
$\theta 3=360/360*(261-206)=45$
$\Phi 3=120/6.04*10^{12}*(2.68*10^{12}-1.21*10^{12})= 55$
$\theta 4=360/360*(360-306)=55$
$\Phi 4=120/6.04*10^{12}*(6.04*10^{12}-2.68*10^{12})= 65$
Now by Fraudeinsteins equations
$K_1\cos\theta_1+K_2\cos\Phi_1+K_3=-\cos(\theta_1-\Phi_1)$
We have,
$0.81K_1-0.5K_2+K_3=-0.81$
$0.707K_1+0.034K_2+K_3=-0.37$
$0.57K_1+0.98K_2+K_3=-0.96$
Therefore
K1=0.33,K2=-0.37,K3=1.08
We have
$K_1=Z_1/Z_4$
$K_2=-Z_1/Z_2$
$K_3=Z_3^2-Z_2^2-Z_1^2-Z_4^2/2*Z_2*Z_4$
Assume
Z_1=220mm
Then Z_4=**72.29mm**,Z2=**29mm**,Z3=**195mm**

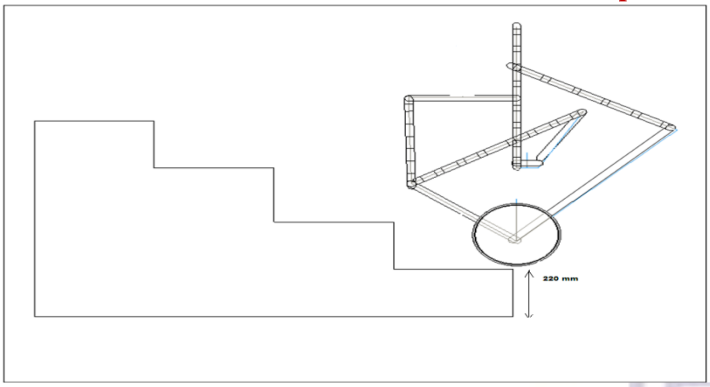
Basic link dimensions on comparision for different function as $Y=X^5$, $Y=X^3$ $Y=X^2$, Y=1/X

Function	Z1	Z2	Z3	Z4	Result
$Y=X^5$	220mm	**29mm**	**195mm**	**72.29mm**	simulaed
$Y=X^3$	220mm	129mm	340mm	536mm	Can be simulated
$Y=X^2$	220mm	**35mm**	**205mm**	**80.29mm**	Can be simulated
Y=1/X	220mm	73.82mm	319mm	151.72mm	Can be simulated

SIMULATION

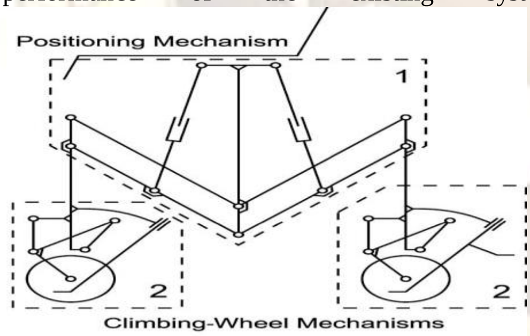
1)Identify the problem:

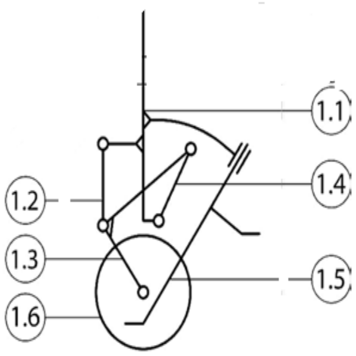
First of all to calculate dimensions required as per need i.e. to formulate and calculate dimension of mechanism to climb the stair of height about 220mm and calulation as shown in the syntesis formulation and table with formulation as follow



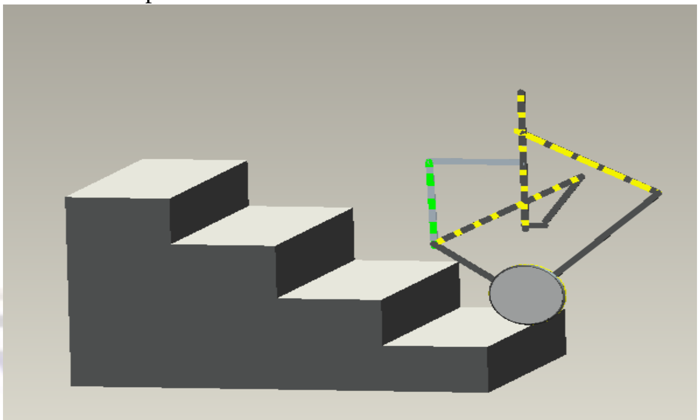
2) Formulate the problem:
With following steps we can formulate the problem
1)$0<x<360$
2)$\Delta\theta=360^0$, $\Delta\Phi=120^0$
3)$\Phi s=0^0$,$\theta s=0^0$
4)Bychebchev spacing $\Delta Xj=\Delta X/2(1-\cos(\prod(2j-1)/2n))$
5) $\theta j=\Delta\theta/\Delta X\ (Xj-X1)$
6) $\Phi j=\Delta\Phi/\Delta Y\ (Yj-Y1)$
7)ByFraudensteins equation $K_1\cos\theta+K_2\cos\Phi+k_3=-\cos(\theta-\Phi)$
8) Calculate K_1,K_2,K_3
9)Assume any one linklength Z_1=220mm
10)$K_1=Z_1/Z_4$, $K_2=-Z_1/Z_4$, $K3=Z_3^2-Z_2^2-Z_1^2-Z_4^2/2*Z_2*Z_4$

3) Collect and process real system data: Collect data on system specifications (e.g., bandwidth fora communication network), input variables, as well as performance of the existing system.

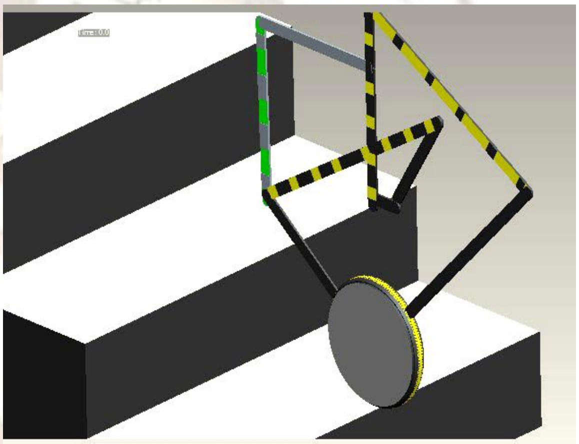


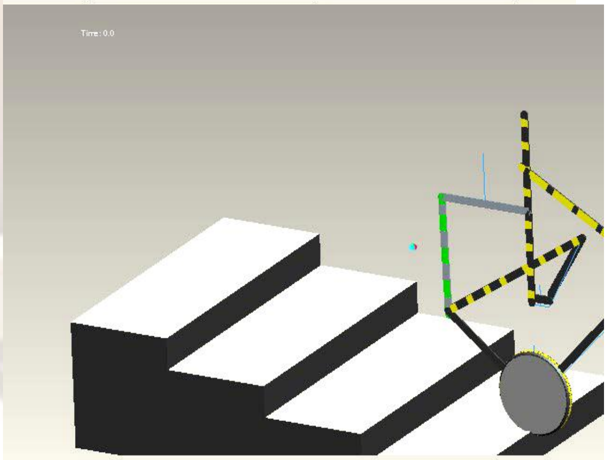


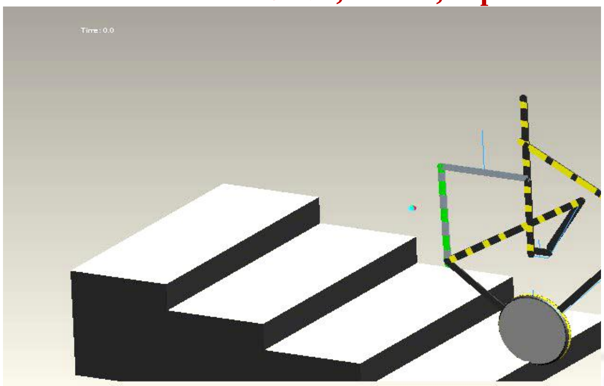
4) Formulate and develop a model: Develop schematics and network diagrams of the system (How do entities flow through the system?). Translate these conceptual models to simulation software acceptable form.



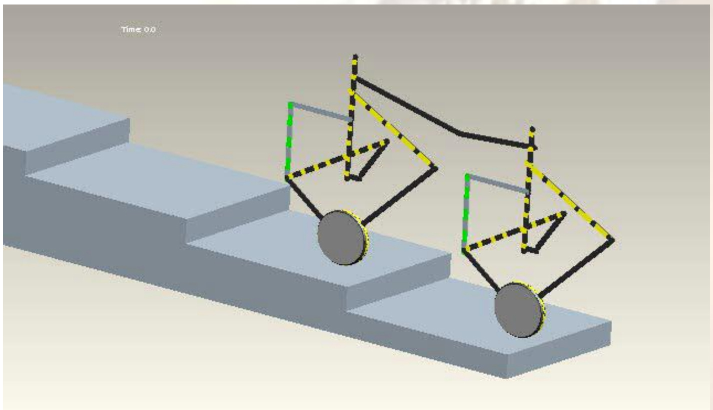
5) Validate the model: Compare the model's performance under known conditions with the performance of the real system.



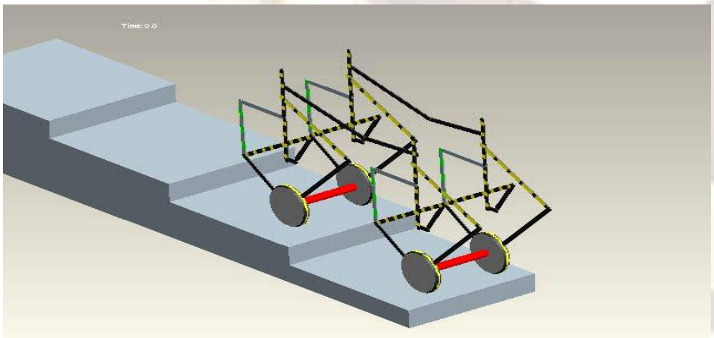




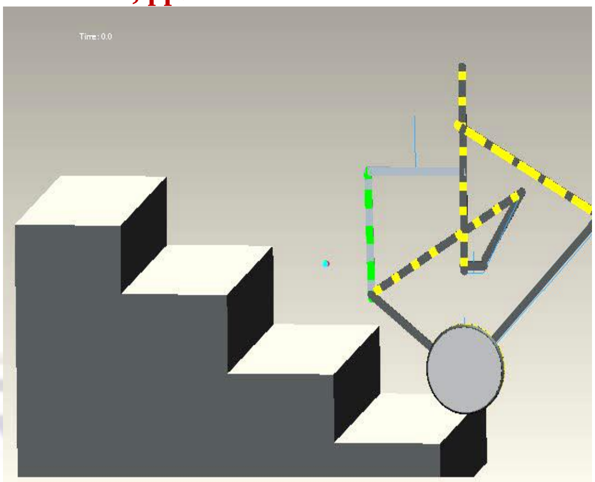
6) Establish experimental conditions for runs: Address the question of obtaining accurate information and the most information from each run. Determine if the system is stationary (performance measure does not change over time) or non-stationary (performance measure changes over time).

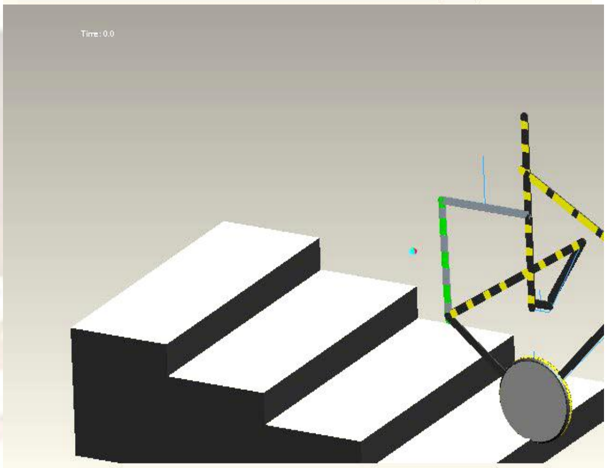


7) Perform simulation runs:

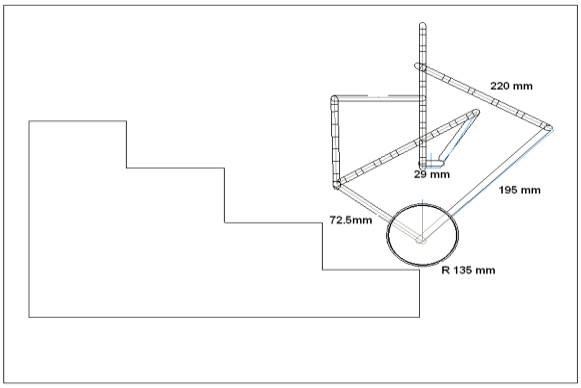


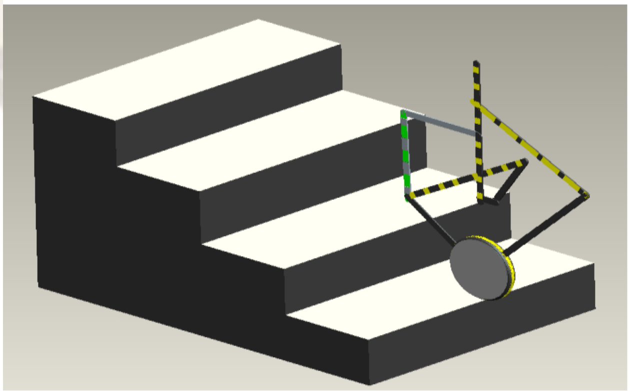
8) Interpret and present results:

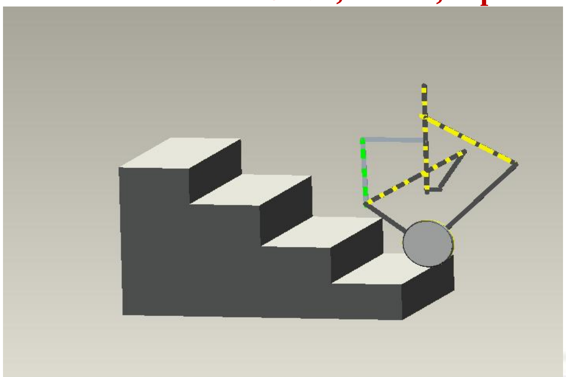


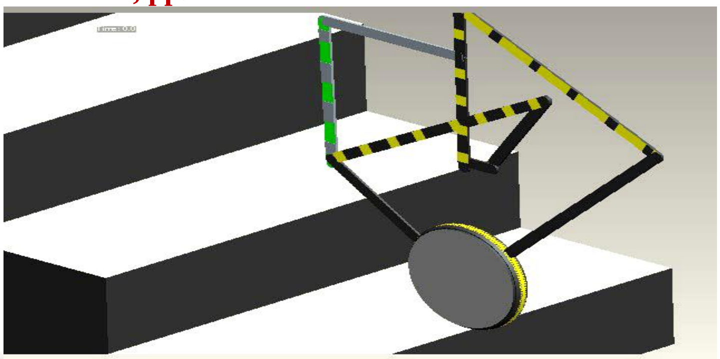


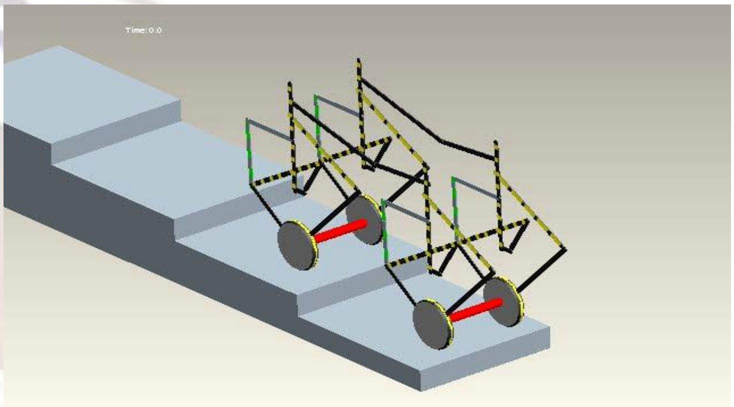
9) Recommend course of action











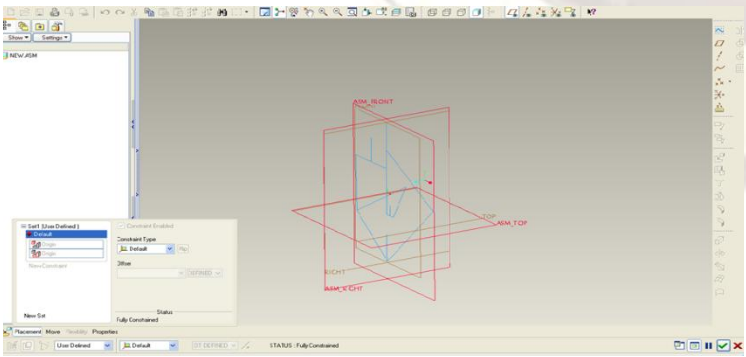
RESULT AND CONCLUSION:

By synthesis of four bar mechanism by fraudensteins equation and chebchevs equation, four bunches of dimension being obtained by concidering different function as follows

Basic link dimensions on comparision

Function	Z1	Z2	Z3	Z4	Result
$Y=X^5$	220mm	29mm	195mm	72.29mm	simulaed
$Y=X^3$	220mm	129mm	340mm	536mm	Can be simulated
$Y=X^2$	220mm	35mm	205mm	80.29mm	Can be simulated
Y=1/X	220mm	73.82mm	319mm	151.72mm	Can be simulated

On which the simulation is being calculated out of which all dimension can be simulated bue the calculation gor function $Y=X^5$ being selected because it is only dimension which would folloe the skeleton digram required for simulation remaning will give the deviation as shown below and final assembly been produced.



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