

Dynamic Analysis Program Development for a Wiper Linkage

W. H. Kim, T. W. Park, S. P. Jung and J. H. Lee, W. S. Chung

Abstract—This paper presents the dynamic analysis program of the wiper system which is developed to estimate the trace of the blade. Using the developed program with convenient GUI, the wiper system model can be created simply. The program consists of three modules such as graphical wiper modeling preprocessor, dynamics solver and graphical postprocessor. In the preprocessor, hard points of the wiper system is converted into wiper multi body system. In the solver, the trace of blade is calculated. Finally, in the postprocessor, the result is displayed in the form of graphs and animation.

Index Terms—Wiper, Blade, Linkage, GUI

I. INTRODUCTION

The wiper system of a vehicle consists of four parts such as motor, linkage, arm and blade. Figure 1 shows the components of the wiper system. The wiper system should remove things such as rain, snow, dust and so on efficiently. Therefore the design of the wiper system has such a procedure. One is that the trace of the blade should be appropriate to certificate the sight of the driver. Another is that the appropriate contact pressure should occur between the blade and the windshield.

Usually, the arm pivoting point and size of the blade is different in every vehicle. And the size and curvature of the windshield is also different. That is, each vehicle model needs its own wiper system. But there are a lot of parameters in the design of the wiper arm and linkage. In the procedure of design, to define all the necessary data is very cumbersome and there can be many mistakes. Therefore, a program that simply creates and analyzes the wiper system model is needed.

In this study, a program that creates the wiper system model and calculates the locos of the blade is developed to decrease those minuses. The trace of the blade is decided by the wiper arm and linkage. So the design parameters are selected among many parameters. And the GUI is composed for convenience. Therefore, using the developed program, it is simple to create and analyze the wiper arm and linkage model.

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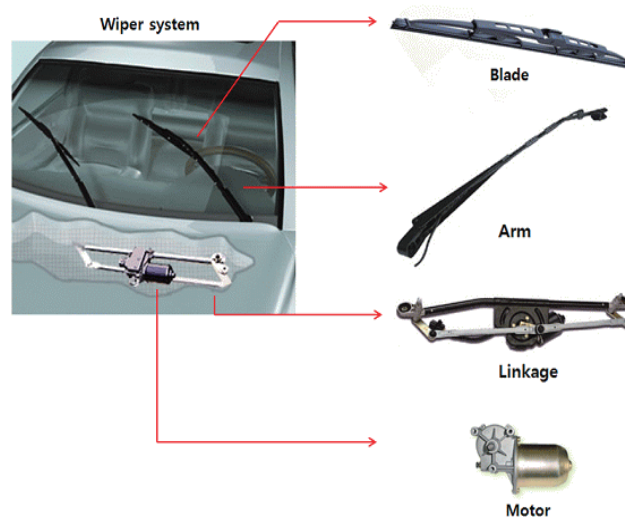


Fig. 1 Components of wiper system

II. DESIGN PARAMETERS

Figure 2 shows the constraint condition of the arm and linkage. The linkage moves by the rotation of the wiper motor. And the arm moves on the windshield by the motion of the linkage. The points needed to create the wiper model should be defined.

The ordinary wiper system that has two blades consists of 13 points. There are 7 points that consist the wiper linkage and 3 points that consist each blade. The developed program creates the wiper model using all the 13 points.

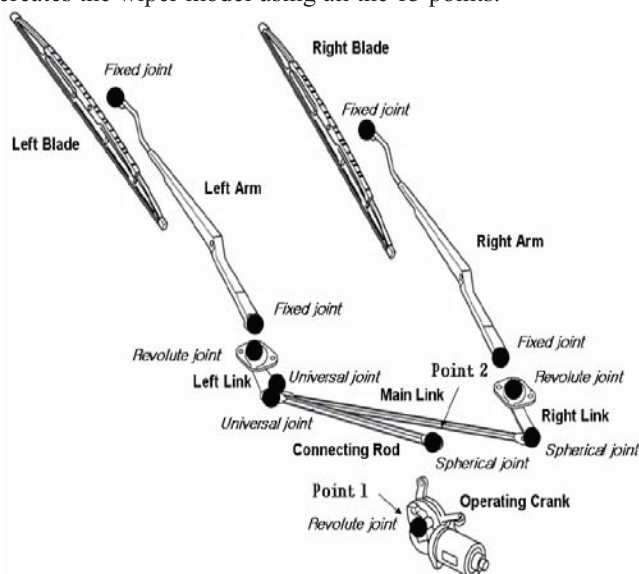


Fig. 2 Constraints of wiper arm and linkage

III. DYNAMIC ANALYSIS PROGRAM

A. Software Structure

The objective of the developed program is that it should be simple to define the design parameters and to obtain the desired result. Figure 3 shows the data flow of the developed program. The solver of the program is developed using MATLAB considering the convenience of the development. The GUI of the program is developed using MATLAB Graphic User Interface module considering the interface with the solver. And the GUI is composed so that the wiper system model can be simply created. Figure 4 shows the main windows of the developed program. Figure 5 shows the main menus and their sub menus. Each sub menu has its own function.

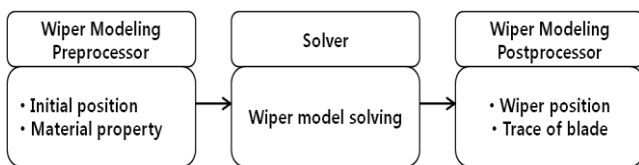


Fig. 3 Data flow of the program

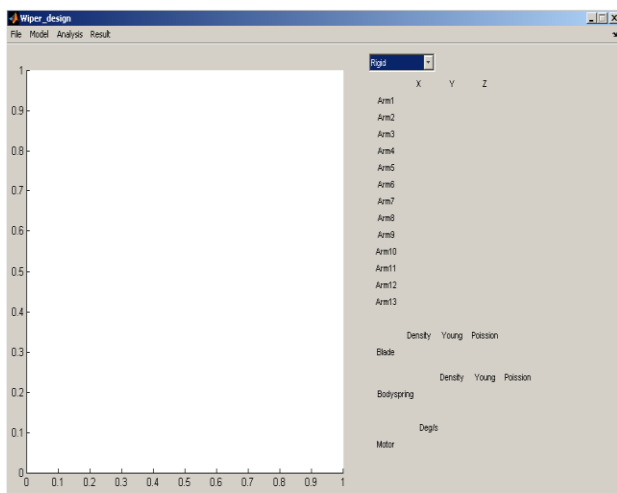


Fig. 4 Main menus of the developed program

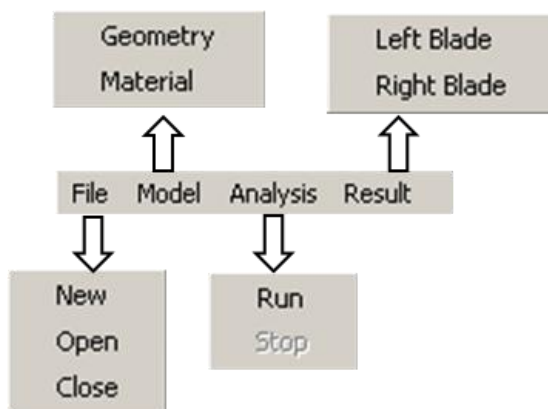


Fig. 5 Sub menus of the developed program

B. Pre-processor

In the pre-processor, geometry coordinates and material property is entered. Using the function 'New' shown in the Figure 5, modeling is started. Figure 6 shows the window where the coordinates of the linkage and blade are defined.

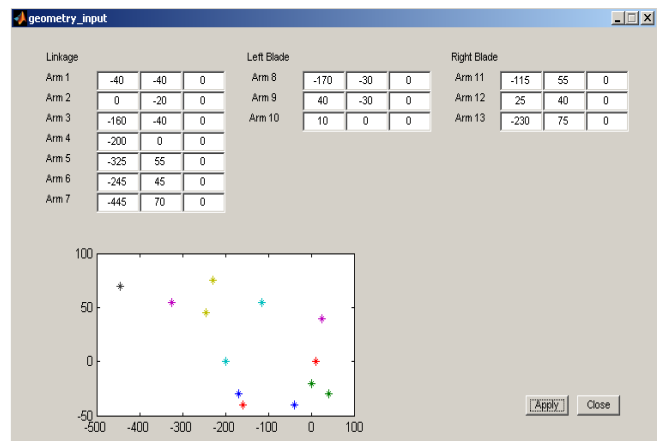


Fig. 6 Geometry parameters menu

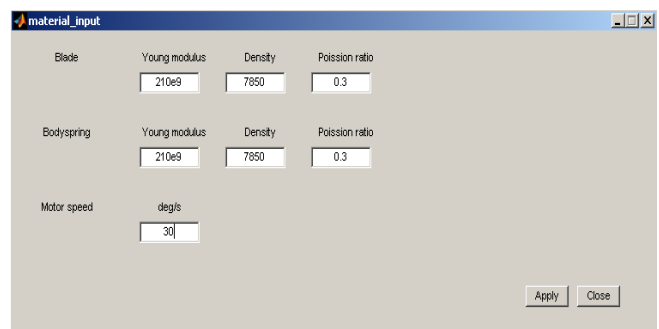


Fig. 7 Material property of parts

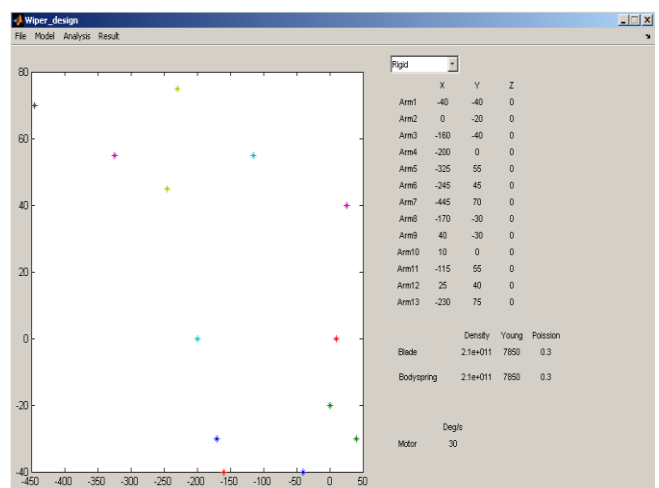


Fig. 8 Display of parameters

When the coordinates of the linkage and blade are entered, the defined coordinates are displayed in the bottom window. Figure 7 shows the window where the material property of the bodies is defined. Figure 8 shows the entered data displayed in the main windows. So the information of the current model is easily certificated.

C. Solver

After entering all necessary data, the analysis is started. The solver of the program is developed referring [1]-[3]. The solver is composed of 21 m-file. Using the entered data in the pre-processor, rigid multi-body model is created. The motion of the linkage and blade by the rotation of the wiper motor is calculated. Figure 9 shows the algorithm of the solver.

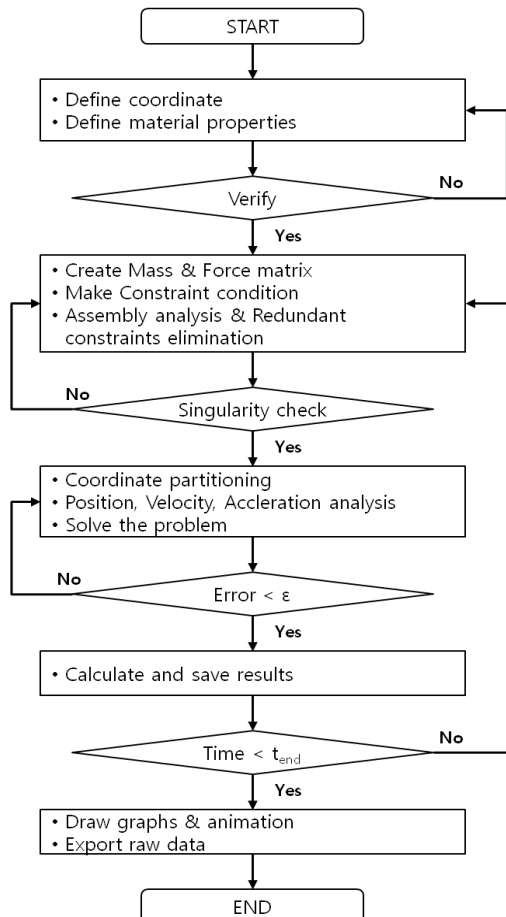


Fig. 9 Algorithm of solver

D. Post-processor

If solving is finished successfully, the result is accessed in the post-processor. The motion of the blade calculated in the solver is displayed by two forms. One is to draw a graph of the trace of the tip of two blades. Figure 10, 11 shows the trace of the tip of the blade. Another is to draw a graph of the whole wiper system by the time. Figure 11 shows the graphs that the wiper moves as time goes.

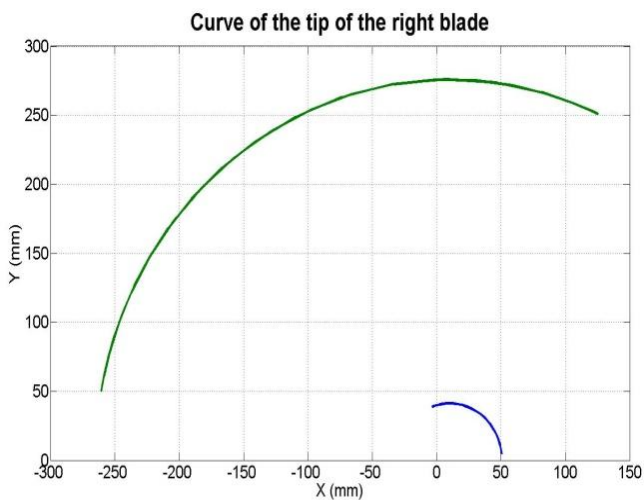


Fig. 10 Trace of tip of the right blade

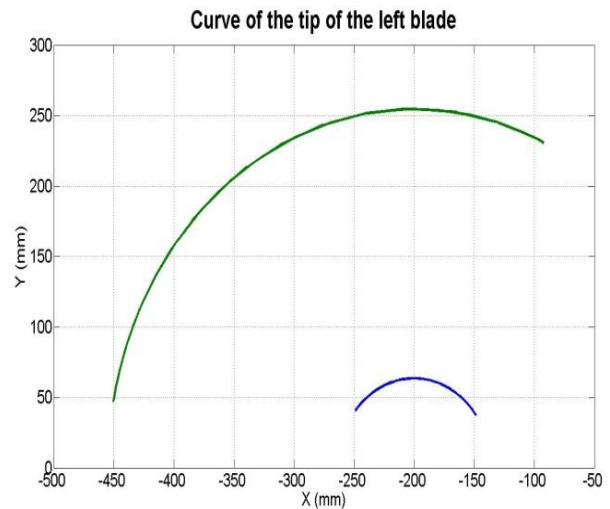


Fig. 11 Trace of tip of the left blade

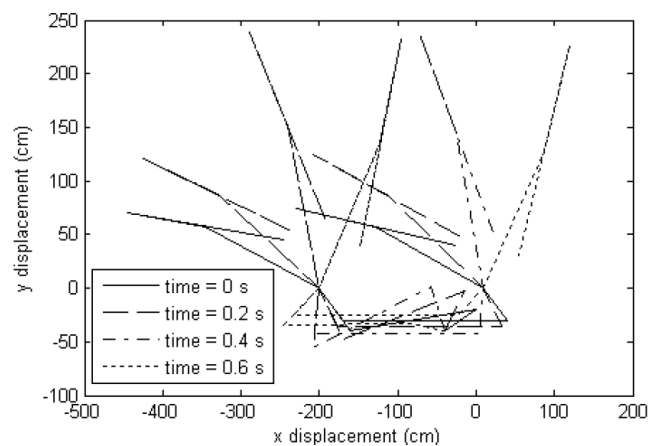


Fig. 12 Simulation result of wiper motion

IV. CONCLUSION

In this study, the program that analyzes the motion of the wiper system is developed. Using the developed program, the wiper system model is simply created. And the trace of the blade is certificated by the motion of the wiper. In the future, the next things can be added.

- 1) The optimization of the coordinate of the system
- 2) The calculation of the contact pressure of the blade considering the characteristic of rubber
- 3) The improvement of the contact pressure through the section design of the blade

REFERENCES

- [1] E.J. Haug, 1989, *Computer Aided Kinematics and Dynamics of Mechanical System, Vol. 1 : Basic Method*, Prentice-Hall, Inc., 1989.
- [2] P.E. Nikravesh, *Computer Aided Analysis of Mechanical systems*, Prentice-Hall, Inc., 1988
- [3] A.A. Shabana, *Dynamics of Multibody systems, 2nd edition*, Cambridge university press, 1998.
- [4] S.P. Jung and T.W. Pak, *Analysis and Control of the Flexible Multibody System Using MATLAB*, Korean Society of Mechanical Engineers, A, 32, 5, 437-443, 2008
- [5] Kyoung nam Ha, Wan hee Jeong, Sung-Soo Kim, Do hyun Jung, Tae oh Tak, *Development of Real-time Multibody Vehicle Dynamics Software Part II: Preprocessor and Postprocessor Using MATLAB GUI and VR Toolbox*, Transactions of KSAE, Vol. 17, No. 1, pp.169~175, 2009
- [6] *MATLAB User's Guide*, The Math Woks. Inc