Development of Planar linkage analysis program for working device of wheel loader

Jin-Seok Jang[1], Hyun-Gyu Park[1], Min-Seok Kim[2], Hee-Jong Lee[2], Kun-Woo Kim[3], Wan-Suk Yoo[4]

[1] School of Mechanical Engineering
Pusan National University
Geumjung-gu, Busan 609-735, Korea
jsjang6321, gusrb1895@naver.com

[2] Construction Equipment Research Institute
Hyundai Heavy Industries Co. Ltd.
Dong-gu, 682-792 Ulsan, Korea
mskim77, runnerlhj @hhi.co.kr

[3] Construction Equipment R&D Group, Korea Institute of Industrial Technology, Daegu 711-883, Korea
kwkim@kitech.re.kr

[4] Faculty of Mechanical Engineering
Pusan National University
Geumjung-gu, Busan 609-735, Korea
wsyoo@pusan.ac.kr

Abstract

Under construction equipment research area, many researcher has been carried out dynamic analysis of working device and wheel loader for improving performance and efficiency. Reno Filla[1] presented simulation of complete machines for analysis and optimization. Yangmin Li[2] used Huston method and software MBDA to establish EOM of working device and solve the acceleration of the bucket for predicting security of the mechanism. Allan Ericsson[3] reported that a method of simulation the forces acting on a wheel loader or excavator shovel when excavating granulated material by using user-subroutine . Kihan Shin[4] presented the parameter optimization of a coupled linkage system for optimal power consumption.

In case of redundancy mechanism such as working device of wheel loader, planar MBD program is more efficient than 3D program, because of evading redundant constraint condition. There have been few studies on planar dynamic analysis program including assembly algorithm and characteristic analysis of break-out and lifting force.

In this research, planar linkage analysis program is developed including automatic assembly algorithm for working device of wheel loader. Basic planar multibody dynamics theory[5,6] is used to develop the program. Automatic assembly program(Figure 1) is developed to design working mechanism for part designer in component level, easily. The designer make the component of working device and then, they make the assembly condition in CAD software. Therefore, automatic assembly program can help predict assembly configuration and working performance judging from the designer perspective.

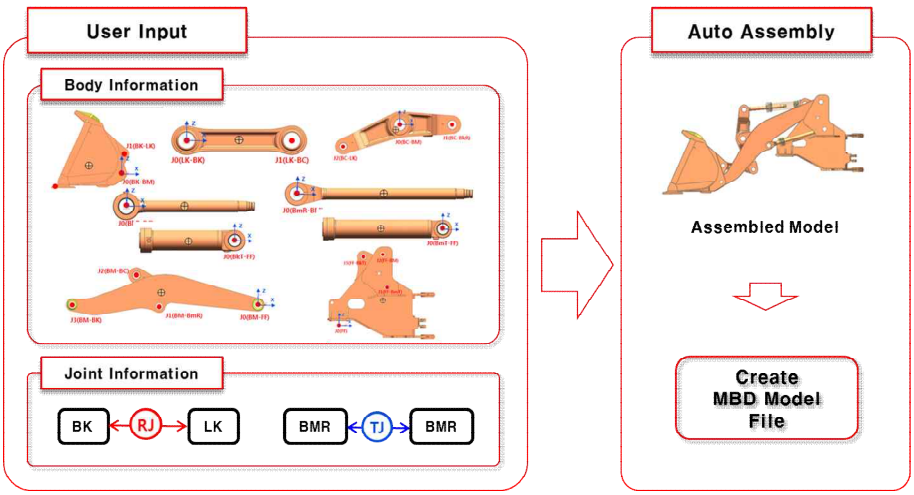

Figure 1: Working device assembly of wheel loader

Characteristic analysis contains several steps for analyzing break-out and lifting force(Figure 2). Equation(1) means break-out force on the bucket in case of applying maximum cylinder force. Maximum cylinder force is calculated by actuator condition, relief pressure and pressure area.‘a’ means ratio of cylinder reaction force according to external force on bucket tip in normal direction shown in figure 2. 'b' is cylinder reaction force according to gravity force.

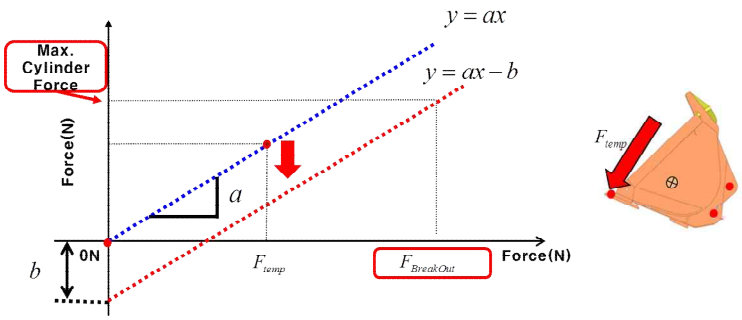

Figure 2: Calculation of break-out force

$$F_{BreakOut} = \left(\text{Max. Cylinder Force} + b\right) / a \tag{1}$$

Characteristic analysis algorithms are embedded in each module, it is possible to evaluate the performance according to working positions, efficiently.
This program(Figure. 3) receives joint position and connection information of each link as ASCII form and evaluates performance factor. It is expected that this program will be applied to find optimum wheel loader working device by optimizing link joint position.

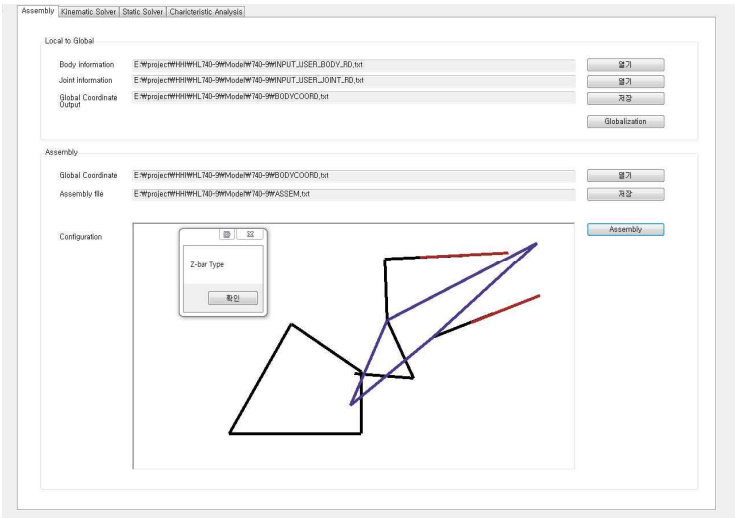

Figure 3: User interface of Planar linkage analysis program for working device

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