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Kinematic Design of Automobile Seat Connection Mechanism to the Reactive Head Restraint

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1. Introduction

Automobile seats consist of two or three connected but distinct components that contact the occupant: the seat cushion, the seat back, and in many cases a separate head restraint.[1)]

Whiplash injuries resulting from car collisions cause human suffering and high social costs due to long term impairment of the human beings. It is assumed that the amount of whiplash associated disorders in rear-end collisions can be reduced significantly by design improvements of the vehicle seat and the headrest system.[2)]

An efficient inverse kinematic solving method is a key element in applications targeting the postural control of complex articulated kinematic figures.[3)]

The primary function of head restraints in case of the progressive paper is to give the proper support to the head and also take a very close look to the backset positions considering the movement of the head and neck. The secondary function of head restraints is to reduce the contact time in case of a rear collision.[4)]

In the previous paper written by the Y.S. Kim in that paper there is a proposed the seat back links and bracket connected with headrest which is able to improve the backset and also able to shorten the contact time in cases of the static and dynamic conditions.

In the present paper we progressively describe the strategic analysis of link mechanism of car seat through kinematic modeling considering the headrest. After that we will analyze the dummy motion to derive the ideal headrest trajectory. And we will find out the design parameters for the connection mechanism which is satisfied safety region in dynamic condition.

2. Kinematic modeling of the headrest connection

In this section of the paper we are about to describe the link connection mechanism and the design of the kinematic model of the proposed seat by the adaption of the inverse kinematics model followed by the Denavit-Hartenbarg notations. In the link connection mechanism we are using the virtual link connection and we are describing the inverse solution of the link.

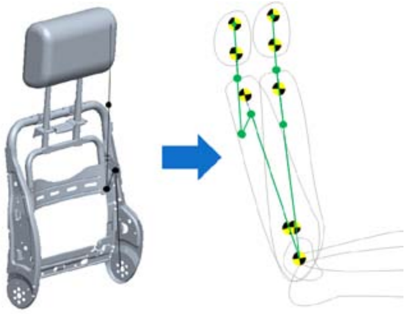
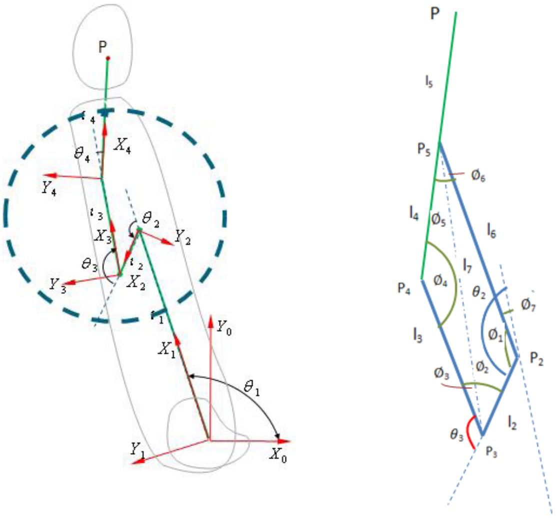


Fig. 1 Schematic showing of the seat back and the link connection modeling of reactive headrest

The inverse kinematics model was described as according to follow the kinematic diagram and using the equations obtain from it and also from the matrix formulation by the notations.



(a) Link connections (b) Kinematic diagram

Fig. 2 Description of link mechanism and the inverse kinematic design of the highlighted point

From the Fig. 2, we can write the as follows,

$$l_7 / \sin(\phi_1) = l_6 / \sin(\phi_2) \tag{1}$$

$$\phi_2 = \sin^{-1}(l_6 / l_7(\sin(\phi_1))) \tag{2}$$

$$\theta_2 = \phi_1 + \phi_7 \tag{3}$$

$$\phi_5 = \sin^{-1}(l_3 / l_7(\sin(\phi_4))) \tag{4}$$

$$\phi_3 = \pi - \phi_4 - \sin^{-1}(l_3 / l_6(\sin(\phi_4))) \tag{5}$$

$$l_7 = \sqrt{(l_6^2 + l_2^2 - 2 l_2 l_6 \cos(\theta_2 - \phi_7))} \tag{6}$$

$$\theta_3 = \pi - \sin^{-1}(l_6 / l_7(\sin(\phi_1)) + \pi - \phi_4 - \sin^{-1}(l_3 / l_6(\sin(\phi_4))) \tag{7}$$

$$\theta_3 = \pi - \sin^{-1}(l_6 / l_7(\sin(\theta_2 - \phi_7)) + \pi - \phi_4 - \sin^{-1}(l_3 / l_6(\sin(\phi_4))) \tag{8}$$

where;

l_2: length of the seat back arm and active links to panel

l_3: length of active panel

l_4: length between active panel and pivot P_5

l_5: length between pivot P_5 and point P

l_6: length between pivot P_5 and pivot P_2

l_7: length between pivot P_5 and pivot P_3

θ_2: angle between link 1 and link 2

θ_3: angle between link 2 and link 3

2.1 Static analysis

According to the standard of the headrest we can find out the go od acceptable and marginal condition for the backset and the height . In case of the progressive paper the optimal or standard condition is that back is 40mm and the height is 45mm.

2.2 Dummy motion analysis

From the dummy motion analysis we will find out the ideal headrest trajectory and after that by using the upper solution we will find out the design parameters for the connection mechanism which is satisfied safety region in dynamic condition.

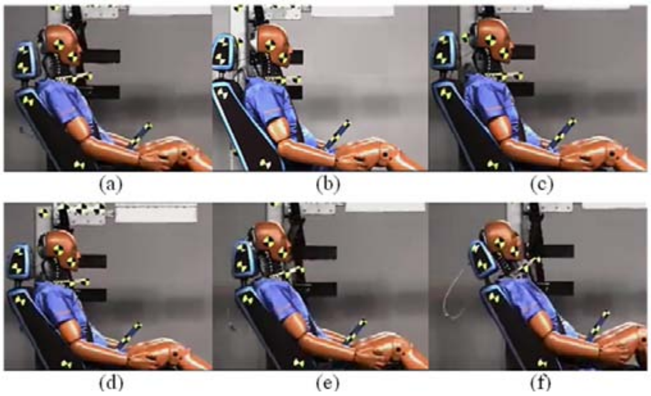


Fig.3 Dummy motion analysis

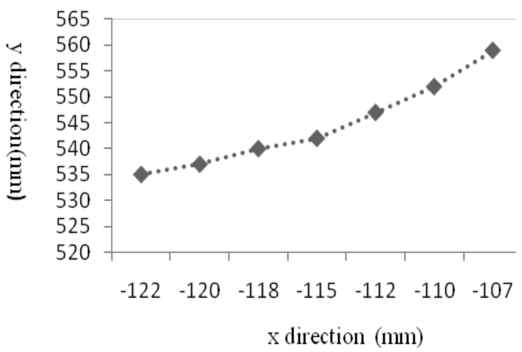


Fig. 4 Ideal trajectories form the sled test

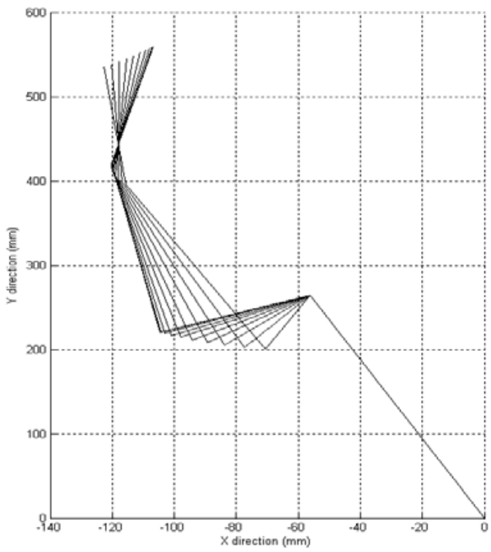


Fig.5 Headrest kinematic solution according to the equations

By analyzing all the things as like dummy motion, head restraint trajectory draw the ellipsoid trajectory and also the inverse kinematic solution as shown in Fig. 5. In this case we will find out that one bracket is needed to draw the ellipsoid motion.

3. Conclusions

A properly adjusted head restraint will prevent excessive extension of the neck of a properly positioned occupant in a rear impact collision.

1. By the exact formulation of the kinematic modeling we can reduce the backset and also can make a very good support for the head in case of the collisions. By varying the ranges of the dimensions like the angles or the length of the kinematic model it will produce the design very effective one.
2. From the dummy motion analysis we will find out the ideal headrest trajectory and we will find out the design parameters for the connection mechanism which is satisfied safety region in dynamic condition.
3. When there is no dynamic process in that case it will be provide the minimize contact time solution in a rear impact.

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Reference

1. Haland, Y., Lindh, F., Fredriksson, R., Syensson, M., “The influence of the car body and the seat on the loading of the front seat occupant’s neck in low speed rear impacts (96SAF020),”Proceedings of the 29th ISATA Conference, June 1996.
2. H. Cappon, M. Philippens, M. van Ratingen, J. Wismans TNO Automotive, Delft, The Netherlands, “Development and Evaluation of a new Rear-Impact Crash Dummy: the RID2,” Stapp Car Crash Journal, Vol. 45 (November 2001).
3. Paolo Baerlocher, Ronan Boulic, “An inverse Kinematics architecture enforcing an arbitrary of strict priority levels,” Visula computer, Springer-Verlag 22 june 2004.
4. Y.S. kim, E.S. Jeon, "An Analysis of Head Restraint on Connection Mechanism for Reducing the Whiplash Injury in Rear end Collision", pp.119 - 200, KSPE 2009.