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Development of a screw driven mobile scissor lift table for radio antenna

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ABSTRACT – The design, analyze and fabrication of a screw-driven scissor lift with four levels elevated by one AC motor is being presented in the paper. The scissor was developed to lift a Jaybeam 300W Radio antenna. The device (scissor lift) was designed portable for easy of convinces by small buses or Van. A 3D cad model of the screw-driven scissor lift produced, before the design analysis of the Screw-driven scissor lift. A control unit was also developed to automatically control the movement of the lift via a proximity sensor. The machine is tested by mounting the Jaybeam antenna on the platform and lifting it to the maximum designed height successfully.

1. INTRODUCTION

Scissor lifts, as depicted in figure 1, are a type of mechanism that allows for vertical displacement of some load such as an antenna, through the use of linked, folding supports, in a crisscross "X" pattern, referred to as a pantograph (or, simply, a scissor mechanism) [1]. Scissor lifts are widely used in industrial applications, for lifting a load to the desired height because its one of the most economical lift devices compared with height assessed. Each arm of the crosses is called a 'scissor arm' or 'scissor member'. The upward motion is produced by the application of force, by some actuator (usually hydraulic, pneumatic, or mechanical actuator), to the outside of the one set of supports, elongating the crossing pattern, and propelling the load vertically. However, the positioning of the actuator, in terms of the point of application of the force on the pantograph, can affect the force required of the actuator for a given load. Prudent placement of the actuator can greatly reduce the force required and the stress levels in the adjacent scissor arms [2]. This mobile scissor lift is portable enough to be conveyed by a small bus to the broadcast location.

2. MATERIALS AND METHOD

The materials used in the fabrication of the screw-driven scissor lift are list in Table 1 with their specifications.

Figure 1, shows the 3D concept of the screw-driven scissor lift design and produced for a lifting of a 4Kg radio antenna. The major components of the lifts are the screw driving mechanism, the base, the scissor arm, and the platform. The drive mechanism is power by an AC motor and controlled using ATMEGA 80S51 and speed of rpm) which is connected to the lower scissor arm via a 2m long power screw. As the motor turns the screw the links are lowered or risen to a maximum height of 8m. Also, the 5 scissor arms that are cinematically connected are lifted at the same time, which in turn raises the platform carrying the 4Kg antenna.

Table 1: Materials Used.

S/No	Components	Specifications
1	AC Motor	1hp
2.	Power Screw	ϕ2mm
3.	Ultrasonic Proximity sensor	
4.	Links	2" x 1" Mild steel pipe
5.	Antenna	Jaybeam 300W
6.	The Base	2" Equal Angle – Mild steel
7.	The Platform	1" Square Pipe – Mild steel
8	Rollers	ϕ100mm x 4 pieces
9.	Bearings	2 Nos.

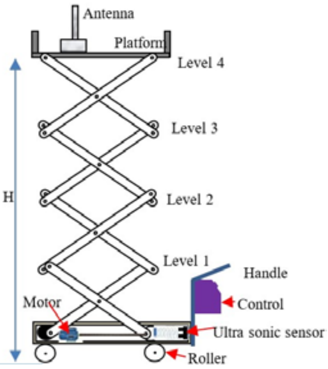

Figure 1 Concept of the screw-driven scissors lift.

The design analysis of the scissor lift was conducted to establish the forces acting in the links and joints. The reaction forces were used to determine the dimensions and stress level of the links. a 3D CAD model of the lift was developed using Solid works software and also, motion analysis of the movement of the links was studied.

The fabricated screw-driven scissor lift in Figure 2, was tested in other to ascertain the maximum height the antenna can rich. The control unit was connected to the main power supply. And the desired height was inputted (5m) and the scissors lift was allowed to raise to the 5m height with the antenna.

Figure 2 Produced screw-driven scissor lift.

3. RESULTS AND DISCUSSION

3.1 Design analysis results

Figures 3 and 4 show the design analysis results. Figures 3 and 4 show the reaction forces acting and the stress developed on the lower link of the lift platform which is carrying the overall load. Figure 3 shows that the load reduces from 4550N to less than 500N as the angle increases. This shows that joint reactions decrease sharply up to angle 0.6 rad and remain steady at 1 rad. The maximum stress develops the lower link is about 0.8 Mpa, which is far lower than the material yield stress.

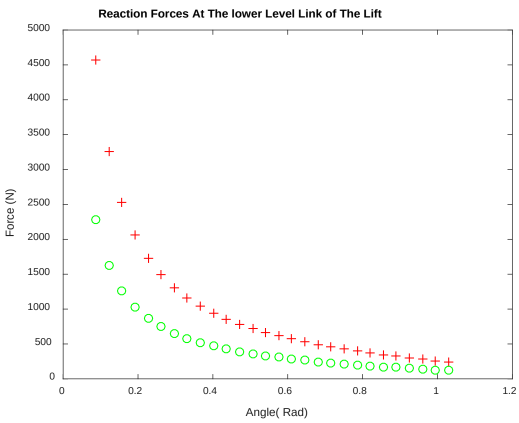

Figure 3 Forces acting in the lower link.

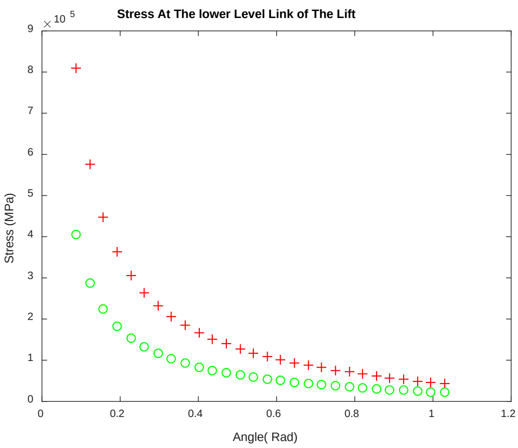

Figure 4 Stresses in the lower link.

3.2 Motion analysis results

The result of the motion analysis is shown in figures 5-6, which is the velocity and acceleration of the level 1 link along the horizontal axis. The motion profile of the lower link is identical to the links on the remaining levels of the scissor lift. The initial velocity of the link is high and became stable around 161 m/s as shown in figure 5. Figure 6 also, has the same profile as that of the velocity in figure 5, on that the unstable nature of this type of scissor lift is clearly shown in the acceleration profile.

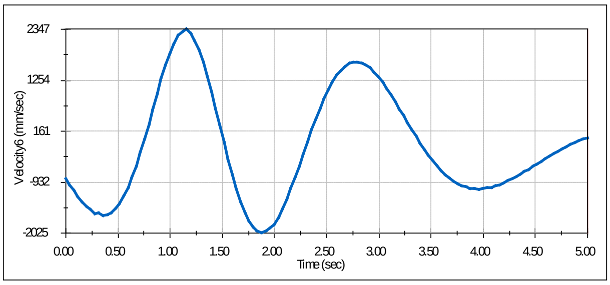

Figure 5 Velocity profile of links at level 1.

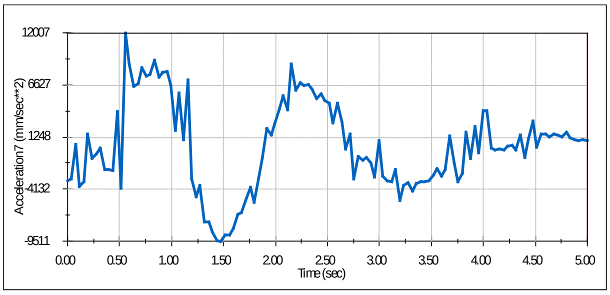

Figure 6 Acceleration profile of links at level 1.

4. CONCLUSIONS

The development of a screw-driven scissor lift was successfully conducted to lift a Jaybeam 300W antenna for a maximum height of 8m. The height control was automatic via the use of an ultrasonic proximity sensor. The design analysis and synthesis of the four (4) level screw-driven scissor lift and shows that the lift structure stress level is within the yield stress of the mild steel material used. During testing, it took less than five (5) minutes to reach the height of 8m.

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