CHAPTER 2 - LITERATURE REVIEW

In this chapter, the theoretical method that covers behind the model application and previous studies are explained briefly in here.

2.1 Theoretical Perspectives

2.1.1 Lead Screw vs Ball screw

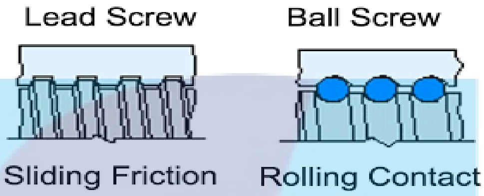

Figure 1. Lead Screw vs Ball Screw

Lead screws and ball screws are two similar components used to convert rotary motion into linear motion. The key difference between them lies in the respective nuts. Lead screw nuts have deeper helical threads and directly contact the screw, typically made of bronze or a polymer composite to minimize friction and enable smooth sliding. On the other hand, ball screw nuts have a matching helical space that accommodates ball bearings, which roll in contact between the screw and the nut. The rolling motion reduces sliding friction associated with lead screw and helps maintain cooler operating temperatures. In this particular project model, a ball screw nut is chosen for its practicality and ability to generate low friction between the nut and the screw, thus increasing its running efficiency.

2.1.2 Linear Guide

Figure 2. Linear Guideways

Linear guides or linear rail slides are mechanical components specifically to provide precise guidance for light and heavy loads along a straight vertical, horizontal, or level linear path. Also known as linear slides or linear guideways, these components effectively transfer loads within the linear guide rails in a single axis. They are found in extensive use in various applications, particularly in robotic systems and machining processes. There exists multiple types of linear guides, where each of them are suited for different applications and requirements.

2.1.3 Application of Linear guide and ball screw methods in Adjustable height sink

The application of combination between linear guide and ball screw in machine usage is very useful and efficient to generate a precise linear actuation motion. Depending on the movement of the actuators, the components can be constructed in different positions whether it's going up and down, left to right, or forward and backward. There are 3 different styles of linear actuators that are commonly used, which are external linear actuator, non-captive linear actuator, and captive linear actuator. For this model, external linear actuator style is used due its simplicity on the combination, where usually coupling is used to affix the shaft screw onto the shaft of the motor.

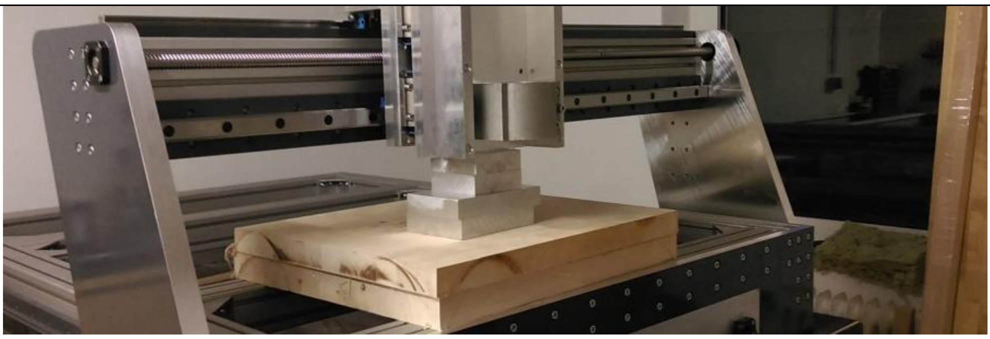

Figure 3. Linear guides and ball screws usage for wood CNC

To generate a linear movement, the ball screw nut that rides on the shaft’s ball screw needs to be attached tightly into the desired component with the help of its housing to prevent it from rotating so that linear motion can be achieved. With this combination of linear drive system and precise guide linear movement, the adjustable height sink can be applied into this method to achieve precise movement and accuracy on determining the required height of the sink.

2.1.4 Anthropometric Analysis

Anthropometry analysis is a scientific field that focuses on the measurement of a person’s size, shape, and physical capabilities. This study plays a critical role in determining human measurements within the general population and is utilized in designs that involve a human body. Following proper anthropometric measurements is essential to prevent any unintended accidents or issues. In the case of this model, the data specifically for Indonesian individuals between the ages of 7 to 12 years old has been collected and utilized into the software program.

Dimensi	Keterangan	5th	50th	95th	SD
D1	Tinggi tubuh	104.57	125.04	145.51	12.44
D2	Tinggi mata	92.52	113.52	134.53	12.77
D3	Tinggi bahu	82.98	101.35	119.72	11.17
D4	Tinggi siku	62.44	77.5	92.57	9.16
D5	Tinggi pinggul	21.56	70.17	118.78	29.55
D6	Tinggi tulang ruas	40.15	52.21	64.27	7.33
D7	Tinggi ujung jari	34.72	44.67	54.62	6.05
D8	Tinggi dalam posisi duduk	55.03	65.22	75.41	6.19
D9	Tinggi mata dalam posisi duduk	45.52	55.18	64.85	5.88
D10	Tinggi bahu dalam posisi duduk	34.42	41.49	48.56	4.3
D11	Tinggi siku dalam posisi duduk	11.89	15.59	19.29	2.25
D12	Tebal paha	2.81	9.27	15.73	3.93
D13	Panjang lutut	33.16	41.67	50.17	5.17
D14	Panjang popliteal	28.29	35.48	42.68	4.37
D15	Tinggi lutut	31.68	39.28	46.88	4.62
D16	Tinggi popliteal	27.42	33.85	40.28	3.91
D17	Lebar sisi bahu	23.59	30.26	36.93	4.06
D18	Lebar bahu bagian atas	6.65	18.79	30.93	7.38
D19	Lebar pinggul	19.39	25.29	31.19	3.59
D20	Tebal dada	11.27	15.08	18.9	2.32
D21	Tebal perut	11.45	16.28	21.11	2.94
D22	Panjang lengan atas	19.63	24.6	29.56	3.02
D23	Panjang lengan bawah	27.54	33.59	39.63	3.68
D24	Panjang rentang tangan ke depan	46.27	56.02	65.77	5.93
D25	Panjang bahu-genggaman tangan ke depan	40.13	49.33	58.52	5.59
D26	Panjang kepala	14.65	17.34	20.03	1.64
D27	Lebar kepala	12.7	14.83	16.97	1.3
D28	Panjang tangan	7.5	14.47	21.44	4.24
D29	Lebar tangan	1.6	6.86	12.12	3.2
D30	Panjang kaki	7.44	19.56	31.69	7.37
D31	Lebar kaki	6.64	8.74	10.83	1.27
D32	Panjang rentangan tangan ke samping	103.82	124.86	145.91	12.79
D33	Panjang rentangan siku	51.89	63.97	76.05	7.34
D34	Tinggi genggaman tangan ke atas dalam posisi berdiri	127.16	150.63	174.1	14.27
D35	Tinggi genggaman ke atas dalam posisi duduk	74.83	89.06	103.3	8.65
D36	Panjang genggaman tangan ke depan	46.1	55.27	64.45	5.58

Tahun: Semua Tahun
s/d: Semua Tahun
Usia: 7
s/d: 12
PROSES

Figure 4. Indonesian Anthropometric Data

2.2 Previous Studies

2.2.1 Optimization of Automatic Hand Washer for Elementary School Children with Adjustable Sink

The objectives of this thesis paper include achieving accurate user height detection, a fast response time for the height adjustment system within 30 seconds, and an ergonomic placement of the sink. The design model has approximate dimensions of 180 cm in height, 45 cm in width, and 180 cm in length. To enhance stability, speed, and rigidity, the model incorporates HGR20R linear rails and HGH20CA linear guides on the left and right sides of the aluminum frame. An ultrasonic sensor is utilized to detect the sink height and the user's desired height, positioned at the sink and the top right of the frame. The mechanical movement for height adjustment utilizes an SFU2005 ball lead screw.

For controlling the electronic components, which are sensors and motor, an Arduino UNO microcontroller is employed due to its compatibility. The dunkermotoren GR63X25 motor with a nominal torque of 0.14 Nm at 24 V is used to rotate the lead screw for upward and downward movement. The HC-SR04 ultrasonic sensor is selected for its resilience and minimal interference with color sensing. Two sensors are applied on the model to measure the height of the sink and the user's hand height.

Compared to the previous thesis, the final system's performance has improved. The addition of linear rails and guides has significantly reduced the system vibrations, enhancing the stability during movement of the sink. The response time of the self-adjusting system has also been reduced by over 70%, resulting in an average time of 10 seconds. Testing data demonstrates that the height accuracy is above 90%. (Perdana, 2022)

2.2.2 Improvement of Automatic Hand Washer for Elementary School Children with Adjustable Sink

In this thesis paper, the objectives are to develop an integrated water container and an automated soap dispenser as a continuation of the optimization process for an automatic hand washer, as mentioned in the literature review section 2.2.1. Changes were made to the design, specifically on the backside of the model. The water container is now positioned on top of the electrical parts to prevent water splashes. The hand detecting sensors that were initially located on the roof have been relocated due to safety concerns, as the roof posed a risk of user injury and was prone to leaning forward, causing the sink to fall when moved.

Most of the electrical components remain the same as the previous version, but they were replaced as many of them had become damaged due to short circuits or the presence of metal dust in the workshop. The electronic parts used include a 24V/30A power supply, BTS7960 motor drivers, HC-SR04 ultrasonic sensors, and TIO32C PNP transistors. The microcontroller utilized in the system is still using an Arduino UNO, but a newer component. The water container has a volume of 92.7 liters but cannot be filled to its full capacity. The soap dispenser releases soap upon detecting a hand using a proximity sensor powered by a power bank.

Overall, the results show an improved design achieved by removing unnecessary parts, utilizing unused space, and maintaining the functionality of the system. The system demonstrates an accuracy rate of 90% percent. The objectives of creating the water container and soap dispenser have been successfully accomplished, although there is a concern about the exposure of the electrical components. (Wijaya, 2022)