FABRICATION OF AUTOMATIC WEIGHT LIFT BY FORK SYSTEM

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ABSTRACT
A safer and more effective method of stocking warehouses is the Automatic Forklift System (AWFS). Employees risk their life in damage by using the manual forklifts that are currently in use. Additionally, employers spend a lot of money paying forklift operators' insurance and salaries at their warehouses. The AWFS will lessen the need for employees to physically operate forklifts, which will save long-term employer expenditures and lower the risk of employee damage. By using a handheld user interface, the user can select the actions they wish the forklift to take. The forklift system can receive wireless commands from the user. The system drives pick up the pallet and bring it to the desired location. The forklift operator describes the ideas behind using forklifts to lift weights and position them where they need to be. In this project, the major goal is to develop and construct a forklift that is novel and distinct from existing models. Because it lowers the cost of electricity, the forklift's design includes a solar panel that produces power from a rechargeable battery. Based on the forklift's construction, it may be inferred that this machine can lift a weight of up to 250 kg. SolidWorks software creates the design model, as well as the kinematic and load analysis of forklifts, racks, and pins. Currently, employ a Wi-Fi-based circuit system that controls the small forklift wirelessly from an Android smartphone. The results of this study demonstrate that the machine that was created can be utilized by small-scale companies.

Keywords: **Sensors, Battery, Automatic, WIFI module, Alarm.**

I. INTRODUCTION

A forklift is a machine that can lift hundreds of kilograms. On the front, it has two metal forks for lifting cargo. To lift the load many feet into the air, the operator moves the forklift ahead until the forks press under the cargo. Forks often referred to as "blades" or "lines," are typically composed of steel and have a lifting capacity of a few tons. Either gasoline or electricity powers forklifts. Batteries are required to power electric forklifts. Forklifts powered by gasoline or propane can occasionally be quicker or stronger than electric forklifts, but they typically require more maintenance, and their fuel can be expensive. Forklifts that run on electricity are ideal for warehouse use because they don't emit the same harmful emissions as gas-powered equipment does. Although some forklifts are made to be used outside, warehouses are where they are most frequently employed. While some tough-terrain forklifts run on diesel or natural gas, most of them are powered by gasoline. Rough terrain forklifts can be driven on the most difficult terrain because they have the most lifting capacity of any forklift with heavy-duty tires. While utilizing the forklift, the operator must take certain safety precautions. Drivers should use caution not to overload the forklift. Operators of forklifts must be competent to control the rear-wheel steering of the forklift. Driving a forklift requires regular steering to keep it moving straight ahead, much the same as driving a car in reverse. The forklift's center of gravity changes constantly; therefore, the driver needs to be aware of it to prevent making any sudden sharp turns or driving too quickly. Anyone who uses a forklift should be adequately trained and licensed. Work in warehouses has been transformed by forklifts. They let one person transport thousands of pounds all at once. Lifting and moving merchandise is infinitely easier when forklifts are well-maintained and safely operated. This is how a typical forklift truck is generally described. This prototype module was built using remote technology for future technology. The vertical moving mechanism with metal forks is assembled over the mechanical structure at the front side of the module, which is made of square metal pipes and has the appearance of a rectangular box. Meanwhile, it has a steering mechanism and uses a Wi-Fi module to work. This module models the actual working system and based on this technology, the system can be changed for actual applications by making minor adjustments to the structure and motor ratings. The mechanism uses a technique to convert rotary motion into linear motion. The forklift is made to be able to move in all directions, even backward.

II.

AUTOMATED GUIDED VEHICLE:

It represented one of the technological advances in material handling. AGVs operate autonomously and follow a path that is marked by induction tape, light beams, or frequency sensors. By removing the forklift operator, the organization can reduce costs and the risk level related to material requirements.

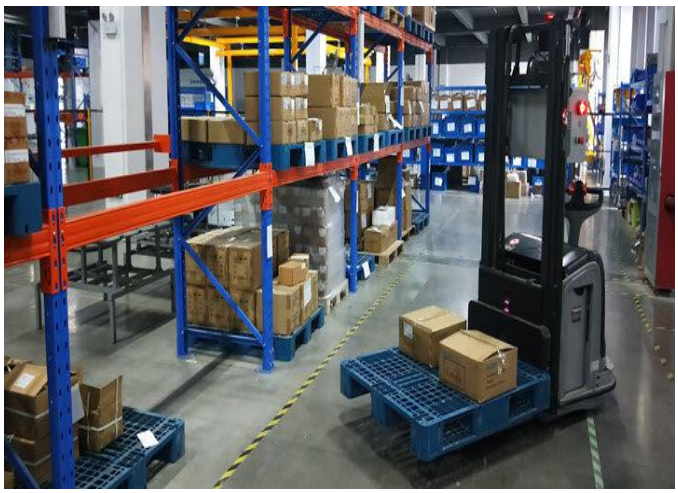

Fig.1: Automated Guided Vehicle

SCOPE OF WORK:

Helping small-scale industries is the primary goal of our activity. It has a lifting capacity of roughly 250 kg. With the help of an IoT module and an autonomous controller, you can effortlessly carry the items from one location to another while the fork is raised by turning a crank. Even though most forklifts in our solar-powered project are electric, this one will also save fuel and electricity by not utilizing them. It does not require a battery too so it could be green to start with. But it is not applicable for hilly or sloppy areas where a large amount of power and effort would be required which is not possible with manual operating. This forklift's distinctive design can be employed on flat surfaces in businesses or industries where repetitive loads need to be moved from one station to another, making the transfer of weight easier than it would be with merely manual effort.

III. WORKING PRINCIPLE AND MECHANISM:

Lifting Mechanism:

Using a gear component chain block mechanism, the load will be raised. It consists of a cranking pulley, chain, worm, and worm wheel. The worm, which rotates the worm wheel, is made possible by the pulley's rotation. The load deposited in the form of a forklift is raised with the aid of the chain, which is fixed toward the gear's output.

Steering Mechanism:

It comprises a steering rod with an eccentric pivot pin, ties rods, and a bell crank lever. Both tie rods have long arms that connect to the bell crank lever on each side, and one end of each tie rod is attached to the pivot pin. The front wheels are held by the short arm. The steering rod is attached to the pivot pin. A steering wheel that rotates controls the wheels.

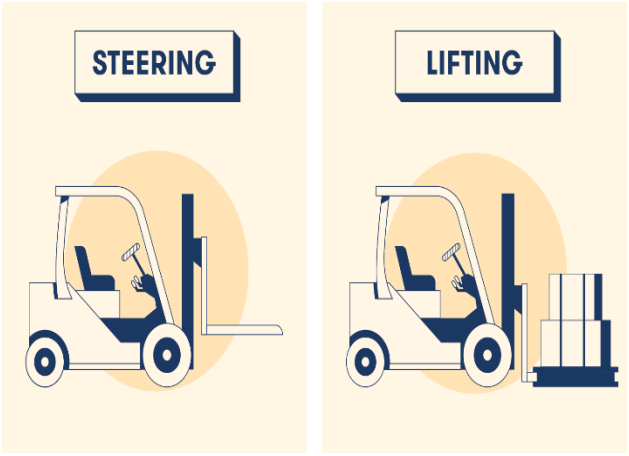

Fig.2: Steering and Lifting Mechanism

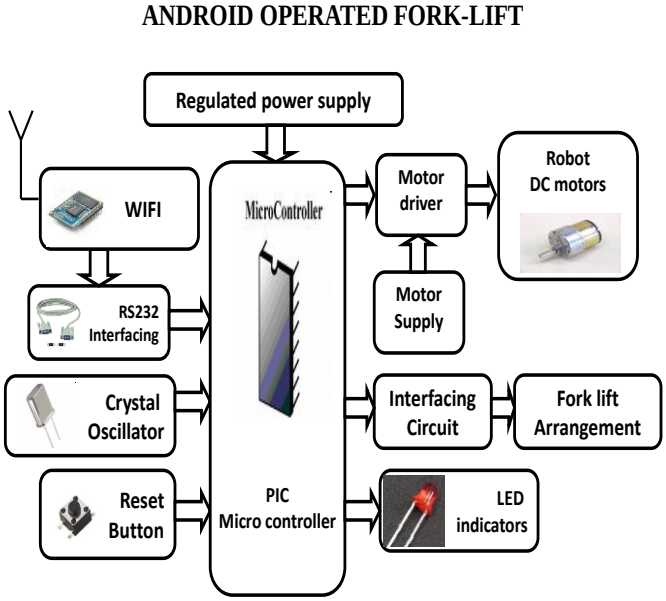

Fig.3: Block diagram of IOT-controlled Fork-Lifting Robot

An Android-powered forklift system uses a solar panel and is controlled by a cell phone. The solar panel, which houses the PV module, is connected to a rechargeable battery, which stores the energy, and the battery is linked to the microcontroller, which controls all the modules when the equipment is left outside on the ground (such as Wi-Fi or the reset button RS232). The microcontroller is also linked to the active motor driver. The forklift arrangement also receives access from the PLC

microcontroller for safety reasons, and an alarm indicator was installed in the aforementioned equipment. The motor driver supplies DC motors with power from the motor supply.

IV. METHODOLOGY:

In the design and construction of the forklift, a single motor's driving force was limited to 600 rpm and 40 watts, with a maximum lift capacity of 250 kg. This motor was chosen based on its efficiency, which was determined by dividing its mechanical output power by its electric input power. Based on the previous electric motor power, the mechanical power was determined considering the 600 rpm of the motor together with angular acceleration and was approximated to be about 0.363 watts to run the motor. This mechanical power was calculated taking into account input electrical energy as 0.28 A*12V is equivalent to 3.36 watts.

Fig.4: Fabrication Model

a. Component selection:

The electric forklift's main base frame is made using the same chassis as the other parts. As a result, the chassis, which is made of steel bars, is crucial to the forklift's construction and is regarded as the machine's structural skeleton. All of the extra parts are stored inside the chassis, which gives them the best protection and makes it easy to move them around.

b. Rechargeable battery:

When the solar panel isn't functioning due to weather conditions the forklift machine has a rechargeable battery as well as a manual charging device. Additionally, it is well known that the power source is 220 V ac. These batteries serve as the forklift's power source. The battery utilized has a 12V, 38 AH capacity and can run for 20 hours. The forklift has two batteries. This device has a circuit that uses electricity to recharge the batteries and convert AC to DC. The battery charging provision has been designed to allow it to be connected to an AC supply while being recharged.

c. Control System

The vehicle can be moved right and left as well as forward and backward using the control system. The mechanism aids in steering the car in various directions. It also offers the ability to turn the machine on or off. The motor supplies the drive wheel with energy, and the motor is coupled by gearing to the back wheel. This equipment also has an emergency switch that is situated in the control panel specifically made for a forklift.

. Microcontroller:

It is condensed in the microprocessor designed to manage embedded systems in office equipment, some household appliances, and remote controls. It accomplishes this by utilizing its core CPU to evaluate data that it gets from its I/O peripherals.

e. Wi-Fi Module:

WIFI modules, also known as WLAN, are electronic components used in a variety of products to enable wireless internet connection. Depending on the volume of data being delivered, radio waves at frequencies between 2.4 and 5 gigahertz are used to convey information among your devices as

well as a router.

V. SOLIDS WORKS MODEL:

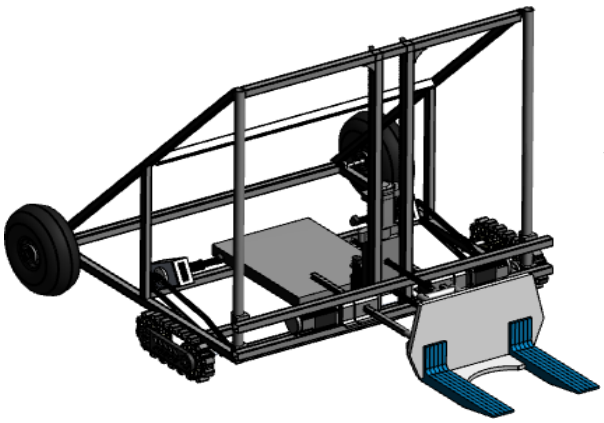

Fig.5: Forklift Solid Work Model

SolidWorks software was used to design the model or prototype. We will first produce all the parts with the accurate measurements required by our design, after which we will put some of them together as assemblies before putting them all together as an assembly. The truck structure, loading mechanism, counterweight, carriage, lifting cabin, and fork are all included in the model shown above. The forklift's wheels, power source, counterweight, and loading mechanism are all coupled to the truck frame, which serves as the forklift's basis. With a chain-lift transmission for the operator cabin, the design comprises 3600 rotating forks. It offers a complete loading range and promotes loading efficiency by holding the forks at a midway position when loading. However, due to the 3600 rotations of forks testing on top of the cabin, this design cannot be adapted to other loading devices or attachments. Additionally, the high center of mass during transportation would be hazardous, and there is a high risk of cargo breaking the operating cabin's roof. Our design consists of a total of 40 independently developed and produced elements. Among these parts, 10 are combined into a second lifting fork sub-assembly and 16 are assembled into the lift sub-assemblies. These two subassemblies are included in our final forklift assembly model together with the remaining 13 components.

VI. RESULTS AND DISCUSSIONS

a) Load Analysis

b) Kinematic Analysis

a) LOAD ANALYSIS

A forklift operator can maintain several safety precautions while the machine moves objects of various sizes and weights. As the load that the forklift picks up elevates up into the air, the forklift can become unsteady leading to a tip-over. The pressure sensor is one tool we use to keep an eye on the load. As a heavy load is lifted by the forklift, the pressure sensor notices the change and notifies the controller or operator to sound an alarm if the load weight increases. To return to a safe condition, the forklift automatically slows down and signals the operator to start charging. The cargo is picked up and transported by the forklift using its load analysis components. There are two types of failure in this process: an abrupt fracture brought on by a heavy load and a fatigue fracture brought on by vibration during transit as a result of uneven ground.

Table 1. Maximum and Minimum Load of Forklift

Name	Type	Min	Max
Stress	Von misses stress	5.836e-02 N/m^2 Node:16468	1.821e+06 N/m^2
Displacement	Resultant displacement	6.791e+00 am Node:10903	1.389e+05a m Node:8187
Strain	Equivalent strain	6.923e-13 Element:5968	5.028e-06 Element:4567
Factor of safety	Automatic	2.910e-02 Node:11447	6.209e+09 Node:15914

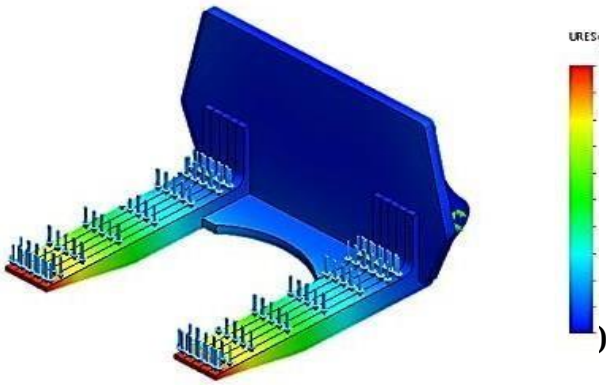

Fig.7: Stress Analysis of Forklift

For the static analysis of stress, the result is at the maximum load capacity of this forklift is 250 kg with a weight of 1.821 e + 06 N/m2. The corner of the fork is colored red, which means this part of the fork is taking the biggest stress. As a result, the corner is the most likely location for fracture.

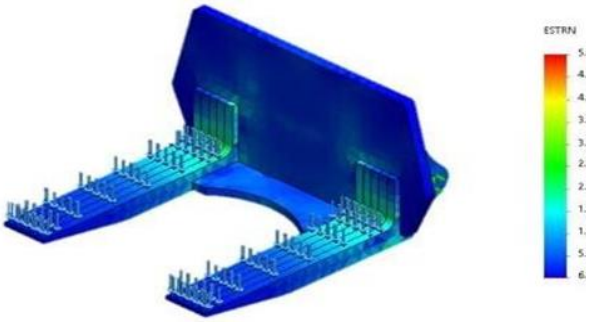

Fig.8: Strain of Forklift

For the static analysis of strain, the result is this forklift has a maximum load capacity of 250 kg at a weight of 5.028 e-06 at element 4567 and a minimum load capacity of 6.923 e-13 at element 5968.

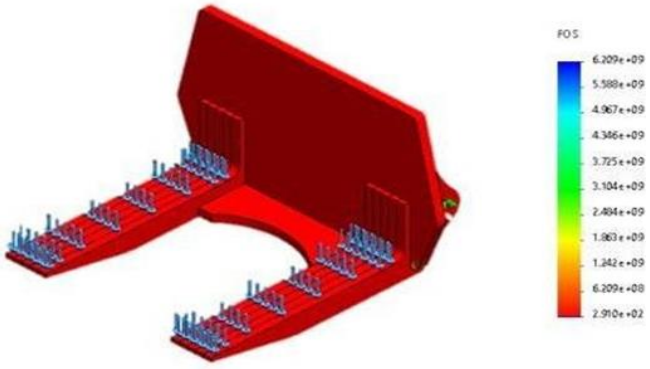

Fig.9: Factor of Safety of Forklift at 250kg

For the analysis, the factor of safety result at the maximum load capacity of the forklift is 250 kg (6.209 e + 09) at Node: 15914, and the minimum load capacity of the forklift is 6.209 e + 09 at Node: 15914. The factor of safety of the fork at the color is blue, which means the fork is safe when the applied force is the safe load of 250 kg.

KINEMATIC ANALYSIS:

The method of evaluating the kinematic quantities used to characterize motion is called analysis. For instance, in engineering, the range of motion for a given machine may be determined using kinematic analysis. Working backward, the kinematic analysis of a mechanism entails computing the position, velocity, and acceleration of any points or connections.

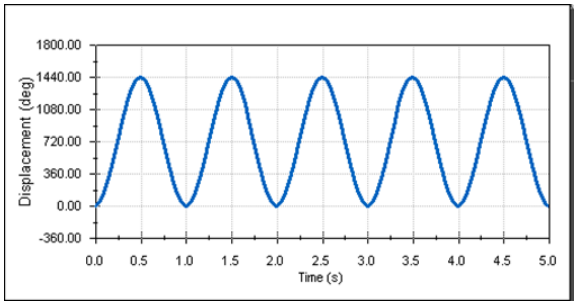

Fig.10: Time vs Displacement of Rack and Pinon

The above figure shows the time vs. displacement of the rack and pinion gear. When the steering wheel is rotated by providing an input signal, the DC motor tends to follow the desired signal.

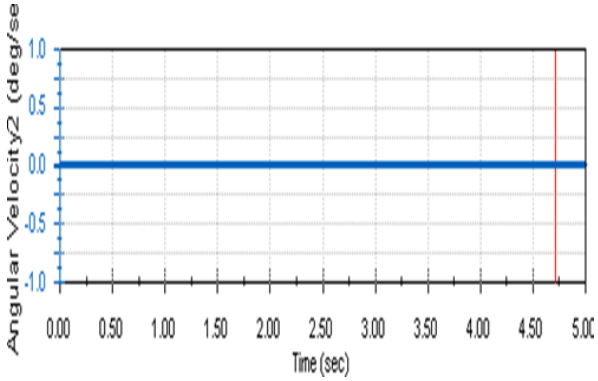

Fig.11: Time vs Angular Acceleration of DC motor

The above figure shows the time vs angular acceleration of the motor and shaft in the forklift mechanism, where the maximum angular acceleration is at 19 deg/sec2 at 0.5 sec and the sine steer input parameter is at 900◦C clockwise and anti-clockwise at high frequency to represent the steering wheel rotation angle.

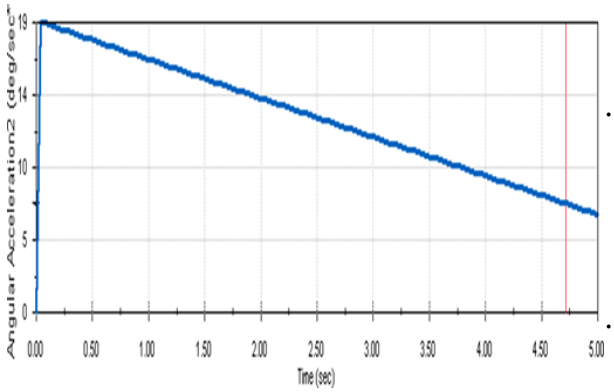

Fig.12: Time vs Angular Velocity of Forklift

The Time vs. Angular velocity of the forklift Mechanism at a maximum load of 250 kg is 5 seconds, as shown in the graph above. Blackwash is the clearance between the gear teeth matching in gear pairs such as rack and pinion. When the pinion is rotated, slack occurs at a point where there is a clearance between the rack and the pinion.

CONCLUSION:

In this project work, the design and fabrication of the forklift were analyzed. The maximum weight that the forklift can handle is 250 kg. The forklift's rechargeable battery allows it to operate consistently for 8 to 10 hours after a full charge. A forklift has already been successfully built and constructed using a prototype based on specifications and standards, as well as the intended load and acceleration. From the load and kinematic analysis, results noticed that the maximum stress and strain value is 1.821 e+06 N/m2, 5.028 e-06. The maximum rotation of the gear is 1440 degrees in 0.5 seconds. Research into forklift weight shift and stability while turning and speeding are possible in the future.

REFERENCES:

1. In addition to Ganesh, A.B., Prathama's, B.G., Omkar, K.S., and Abhijeet, N.N., AllwynL.M. (2018). Construction of a mechanized forklift. Engineering and Technology International Research Journal, 5(3): 1125–1136.
. U.S. Sachin, S.S. Tushar, L.S. Sachin, and K.R. (2014). The forklift's development, design, and modeling. 3(4): 1234–1238 International Journal of Engineering Research and Technology.
. R.R. Wade and R.K. Wag chore (2018). 3-wheel drive forklift with battery power for industrial warehousing. 5(12), 670–673,

International Journal for Scientific Research and Development.

4. Zhao, D.X., Wang, Y., L., Zhang, Z.X., L.L., and Hu, Y.J. (2016). Based on a power bond graph, dynamic simulation, and analysis of a forklift's elevating mechanism. 30: 4043– 4048. Journal of Mechanical Science and Technology. https://doi.org/10.1007/s12206-016-0817-y.
5. Desai, A.A., Koli, P.S., Khujat, S.M., Jagtap, K.S., and Londhe, S.D. (2018). Design and construction of a remote-controlled, battery-operated articulated forklift. 7(1): 809–813, International Journal of Advance Research in Science and Technology.
6. Reddy, A.S., G.S.K., G.S.S., and Kumar, K.S. (2018). construction of a little forklift with a WiFi module. 5(9): 613-617 in Journal of Emerging Technologies and Innovative Research.
7. Design of an autonomous forklift utilizing Kinect by M. Abdullatif, M. Shoeir, O. Talaat, M. Qabalah, M. Elabably, and S. Saleh. 153: 1–5, MATEC Web of Conferences. https://doi.org/10.1051/matecconf/20181530 4005
8. Raj purohit, R., Patel, N., Rotliwala, K., A. Vaidya, M. Prajapati, and N. (2016). Design of a forklift with a pedal-operated wheel drive. 9(1), 17-22, International Journal of Design and Manufacturing Technology.
9. Vaishnav, S., Chore, S., Ghatol, C., Salunke, G. (2018). using a manufacturer's catalog to design a hydraulic forklift circuit in an automation studio. 8(5), 1210–1219, International Journal of CurrentEngineeringandTechnologyhttps://doi.org/10.14741/ijcet/v.8.5.3.
10. Chu, B., Liu, D.C., and Zhu, C.A. Shen, Y. (2015). the forklift vehicle's steering mechanism has been improved for idle performance. Engineering Mathematical Problems, Hindawi, 2015: 1–9. http://dx.doi.org/10.1155/2015/313182.
11. Voruganti, H. K., Kumar, K. K., Krishna, P. V., & Jin, X. Prasanthi, G (2019). Advances in Applied Mechanical Engineering.
12. Prasanthi, G. (2014). 12th GLOBAL CONGRESS ON MANUFACTURING AND MANAGEMENT, G. Prasanthi MM 2014 FEA Simulation analysis of tube hydroforming process using. Procedia Engineering, 97, 1187–1197. https://doi.org/10.1016/j.proeng.2014.12.397.
13. Prasanthi, G. (2015). Design and Development of New Passenger Seat for Electrical Multiple Unit Trains. 2(8), 2136–2139.
14. Surya, M. S., & Prasanthi, G. (2020). Physical and Mechanical Characterisation of Al7075 / SiC Functionally Graded Materials Fabricated by Powder Metallurgy Route. Advances in Materials and Processing Technologies, 00(00), 1–16. https://doi.org/10.1080/2374068X.2020.1835022.
15. Kadapa, A. P. (2019). MECHANICAL PROPERTIES AND MORPHOLOGY OF POLY (LACTIC ACID) (PLA) WITH DIFFERENT FLEXIBLE. 10(01), 745–754.
16. Sreenivasulu, A., Venkatachalapathi, N., & Prasanthi, G. (2015). Modeling and Analysis for Minimization of Mean Flow Time in FMS Simulation. 14(4), 235–245. https://doi.org/10.1142/S0219686715500158.