International Journal of Research in Engineering, Science and Management
Volume-2, Issue-4, April-2019
www.ijresm.com | ISSN (Online): 2581-5792

Design and Fabrication of Automated Guided Vehicle with Automatic Storage and Retrieval System

S. Anish Kumar[1], V. S. Shachin[2], B. Sreemathy[3], U. Suresh Babu[4], S. Venkateswaran[5]
[1]*Assistant Professor, Dept. of Mechanical Engg., Sri Shakthi Institute of Engg. and Tech., Coimbatore, India*
[2,3,4,5]*B.E. Student, Dept. of Mechanical Engg., Sri Shakthi Institute of Engg. and Tech., Coimbatore, India*

***Abstract*: The long going approach that has been followed since then in the libraries, accounts for readers to manually wander and gather books tediously when needed. This way of searching for a prominent book from the lots is cumbersome and tame. Certain, high modernity libraries have adopted a well-defined approach in handling books, which increases flexibility in the working of machines and humans together. Although the modernized approach speeds up material handling tasks, there is a strict need of efficiency manually. Therefore, we use Automatic Storage and Retrieval System (ASRS) with Automated Guided Vehicle (AGV) for collecting and placing books. The project combining AGV with ASRS is a promising mechanical tool that is efficient and cost worthy. Normally the subsisting AGVs and AS/RS are discrete. For each rack, separate AS/RS system is needed whereas it cannot process to other racks. So the AGV system is adjoined with AS/RS, accordingly it can move on to any racks in the library. By this the system is facilitated for the readers and users. The design and analysis has been done intensely by using copious software and enumerations. It is designed for significantly low cost and exorbitant efficiency. The expenditure of the overall build is Rs.1,10,000/- which is cost worthy.**

***Keywords*: Automated Guided Vehicle, Automatic storage and retrieval system, Human machine interface, Switched mode power supply, Programmable logic controls, microcontrollers and arduinos.**

1. Introduction

A library is a collection of sources of information and that made accessible for reference. Book from the lots, will be arranged in a predefined place and it is recorded manually for ease of access. In this era, the existing method of arrangements and retrieval in library is complicated. The access to be efficient and sublimate, automation is indulged through this project.

A. Automation

Automation is the technology by which a process is performed with minimum human assistance. Its application is to control and monitor the delivery of various materials and services. It performs the tasks that were previously fed by humans. This helps to increase accuracy of the process and to speed up the process.

B. Library automation

The library such as cataloging and acquisition of books. Although these automotive activities library automation refers to the use of computer to automate the typical procedures of a are not associated with libraries, automation may thus be distinguished from information retrieval, automatic indexing, abstracting and automatic textual analysis It. implies the mechanization of traditional and manual housekeeping routine of a library.

C. Common problems identified in library

There are two major problems in traditional library system. They are

- Maintenance problem
- Accessing problem

D. Maintenance problem

The main problem in maintenance is that of cataloguing books. In small scale libraries there won't be much inconvenience in maintenance. Whereas in large scale libraries such as educational institutions, the number of books will exceed 10,000 and more. In that case, cataloguing will be a challenging part and also the chance of human error in this case are at peak

E. Accessing problem

Accessing problem in large scale libraries are another major challenge. Because of large quantity, reaching the required book for readers consumes more time. Though in some libraries, the database of the books are recorded for safety and locating purposes. But there is a chance of human errors and mismatch in cataloguing the books.

F. Conceptual design

Our conceptual design consists of AGV and ASRS setup as shown in the Fig.1. AGV setup is made by wooden hollow box with the area of 500X600X300mm. Four mecanum wheels are attached with the AGV body for the transportation of setup. The mecanum wheel is shown in Fig. 6. Three PLCs, arduino, relays, terminal blocks, SMPS, sensors are arranged in the

empty area of the AGV body. ASRS setup is made up of three axes such as x, y, z. Three axes are arranged in rectangular channel. Lead screws are used for transferring the drive from motor to all three axes. Rectangular channels are attached to support all the axes. Lead screw has diameter of 8mm. The x-axis has a length of 370mm, y-axis with 430mm and z- axis with 300mm. Gripper is attached with the mounting plate in y-axis for picking and placing of books. Pallet is placed on the AGV body for picking and placing two books in a single cycle and transferring the books to the receiver.

Design of parts:

G. Isometric view of ASRS

The AS/RS assembled design is shown in the fig.3. It is constructed with a rectangular frame as base part of the ASRS. Then a pallet is placed on the ASRS. The X- axis frame is welded with the Y-axis frame. The axial movement of X and Y axes are arranged by the linear guides. The gripper is mounted on the vertical plate which has been fixed in the linear guides of Y-axis. All the movements are governed by 200 RPM geared DC motors. The opening and closing of the gripper is governed through 300 RPM geared DC motor. It is shown in Fig. 7.

2. Analysis using Ansys software

A. Analysis of AGV with AS/RS

The analysis of the setup is done through ansys software. Here the force applied part is analysed and results are discussed. The maximum weight that can withstand by the end effector of the gripper is analysed. Analysis which includes deformation test, maximum deformation test, meshing test, stress test and strain test.

B. Working of AGV with AS/RS

The whole setup of the AS/RS will be, mounted on the AGV with the help of bushes all around the four corners as shown in Fig.1. This will help the AS/RS setup to be move anywhere as per programmed. The AGV will be having sensors. They are 3 IR sensors, Ultrasonic sensor and 3 proximity sensors. These sensors helps to move the AGV in a predefined way. The IR sensor helps to detect the obstacles detection. Proximity sensor is indulged here for turning of the AGV. The AGV is moved through the black strip which will be issued for the route. Here 3 racks are used for prototype. Whereas in real time required racks can be provided and predefined program has to be done. When the AGV reaches the rack, it will be stopped by the stopper black strip which was provided for routing purpose. Then for the identification of book RFID is used. RFID is nothing but Radio Frequency Identification. It helps to detect the specified book for the ease access of readers.

The RFID detects the position of the book and gripper picks the book as the program works where the sizing of all the books will be predefined. Then the gripper picks up the book and keep it on the pallet which has been mounted on AGV. The design of the gripper and pallet is shown in Fig.4 and Fig. 5 Then it reaches the delivery table and places on the delivery pallet.

This AGV not only delivers the books. It also retrieves the books in its respected predefined places. The delivery table also consists of retrieve pallet where the readers place back the books which the read before. These signals are transmitted from push buttons in pallet. These programs will be loaded in PLCs and Arduino boards. The inputs will be given by HMI by the librarian.

3. Design calculation

A. Lead screw selection calculation

Table 1
Lead screw selection

Axis	F_a(N)	F_e(N)	F_f(N)	$F_T = F_a + F_e + F_f$(N)
X	1.1722	10	0.015	11.1872
Y	5.861	5	0.0075	10.868
Z	2.083	20	0.03	22.113

Table 2
Diameter of screw

Axis	Minor diameter(mm)	Unsupported length(mm)	Safety factor	End support type	RPM
X	6	370	1	Fixed-Fixed	11568
Y	6	150	1	Fixed-Fixed	7819
Z	6	400	1	Fixed-Fixed	9899

Table 3
Materials used

Material	Grade	Quantity
Aluminium	6082	5
Mild Steel	0.4%magn.	6
Acrylic Sheet	UV-b	3
Motor	200RPM	7
Mecanum wheel	-	4
Gripper	Mechanical	1
PLC	DVP-28SV	1
Extension PLC	16SP	1
Communication PLC	DVP-EN001	1
HMI	Touch	1
Ultrasonic sensor	-	1
Proximity sensor	-	3
IR sensors	-	3
SCADA	-	1

X axis =10 kg
Y axis =5 kg
Z axis = 20 kg

V = 0.083 m/s

Where,

V – velocity of the lead screw.

Step 1: Force acting on the lead screw

$F_T = F_a + F_e + F_f$

$F_a = \frac{a}{12} \times \frac{w}{g}$

F_e = Weight of the axis

$F_f = \mu W$

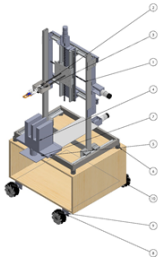
Where,

F_a – acceleration force,

F_e – external force,

F_f – frictional force

Fig.1. AGV with ASRS assembly



ITEM NO.	PART NUMBER	QTY.
1	Trapezoidal lead screw	3
2	Geared DC motor	8
3	Gripper assembly	1
4	AGV	1
5	Pallet	1
6	Rubber bush	1
7	Bush	4
8	Wheel coupler	4
9	Leg mount	4
10	100mm Aluminum Mecanum wheels	4

Fig. 2. Parts of AGV with ASRS assembly

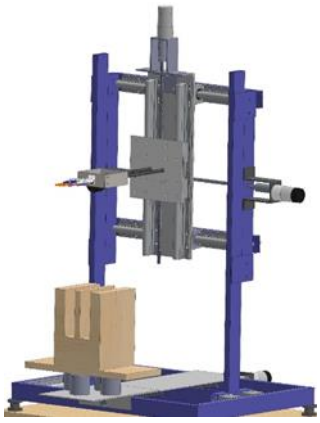


Fig. 3. ASRS assembly

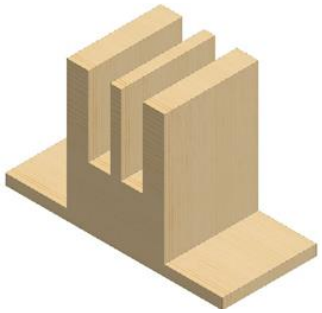


Fig. 4. Pallet

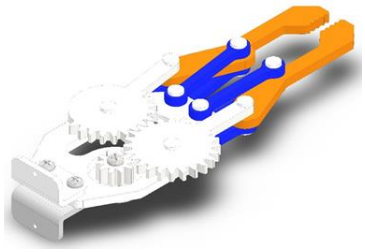


Fig. 5. Gripper

Fig. 6. Mecanum wheel

Fig. 7. Geared shielded DC motor

4. Literature

The references for the project has been obtained from various authors.

[1] Automated guided vehicle (AGV) Egbelu P.J (1986) explained the characterized AGV dispatching rules by focusing on selecting best unit load size in a flexible manufacturing system using a procedure that is based on the application of mathematical programming, computer simulation and statistics to minimize the total cost of manufacturing.

Robert J. Gaskins et al., (1987) discovered the first model for the AGV flow path design. The objective is to find the flow path which will minimize total travel of loaded vehicles. In their zero-one integer programming model, they assumed that the facility layout is given and the pickup/delivery stations are fixed.

Robert J. Gaskins A et al., (1989) conducted a model for determining the optimal flow path designs for an AGVs with virtual flow path. This model is a linear integer program and can be used with loaded vehicle travel data as well as empty vehicle travel data. Such as vehicle blocking and traffic congestion.

[2] Automatic Storage and Retrieval System (AS/RS).

Golgen Bengu (1995) described an optimal storage assignment for automated rotating carousels by automated rotating carousels are increasingly used as building blocks for material

storage and control systems in factories to provide easy and quick access to materials.

Thomas Landers et al., (1996) explained his assignment algorithm for dynamic picking systems. His paper describes an approach, conceptual framework and heuristic dynamic stock location assignment algorithm for dynamic reconfiguration of the order picking system. Previous relevant research is reviewed.

Khalid M. Altassan (1997) explained about conducting the approximating work cycle times in warehousing systems, analytical models yielding approximate work cycle times are proposed for warehousing systems using opportunistic and forced interleaving. With opportunistic interleaving, the models are also used to approximate the distribution of single and dual command work cycles as a function of the transactions demand and storage layout of a facility.

[3] Programmable Logic Controllers (PLC)

Michael R. Foster (2010) studied review of programmable logic controllers in control systems education his paper reviews the literature devoted to control systems education. It shows how academia is using PLCs in education and how it can complement the traditional focus on continuous-based control.

[4] Sensors Zhenhai Chen et al., (1998) determined the design and implementation of capacitive proximity sensor using microelectromechanical systems technology. His paper presents an innovative proximity sensor using Micro Electro Mechanical Systems (MEMS) technology. The proximity sensor works on the principle of fringe capacitance. The target object does not need to be part of the measuring system and could be either a conductor or nonconductor.

Carullo. A (2001) introduced ultrasonic sensor for distance measurement in automotive applications. This paper describes an ultrasonic sensor that is able to measure the distance from the ground of selected points of a motor vehicle. The sensor is based on the measurement of the time of flight of an ultrasonic pulse, which is reflected by the ground. A constrained optimization technique is employed to obtain reflected pulses that are easily detectable by means of a threshold comparator.

Yanbo Li et al., (2008) explained the high-performance UV detector made of ultra-long ZnO bridging nanowires. A nanowatt UV photoconductive detector made up of ultra-long (~100 μm) ZnO bridging nanowires has been fabricated by a single-step chemical vapor deposition (CVD) process.

[5] Microcontrollers Vaglica J.J et al., (1990) explained how to select a microcontroller. A set of guidelines for the designer to use as a checklist for evaluating candidate devices is given. The first decision examined is the level of performance required, that is, on the word size of the controller. The second step is to identify the quantity, frequency and type of all input/output (I/O) signals, as well as any other special requirements, including those imposed by mechanical aspects of the system.

Pounraj. P et al., (2010) explained the continuous health monitoring system for photovoltaic array using arduino microcontroller. In this paper new technique is developed to monitor the health status of the PV panels in the array. For finding the health status short circuit current is measured continuously over a fixed time period. This technique can classify the health status into four categories such as healthy, low fault, medium fault and high fault.

[6] Embedded C Tingting Yu et al., (2011) demonstrated using “Property-based oracles when testing embedded system applications”. Embedded systems are becoming increasingly ubiquitous, controlling a wide variety of popular and safety critical devices. Effective testing techniques could improve the dependability of these systems. In prior work we presented an approach for testing embedded systems, focusing on embedded system applications and the tasks that comprise them.

Govindaraju K et al., (2014) explained that “Embedded based vehicle speed control system using wireless technology” .The research focus on unifying the Global Positioning system with embedded wireless system is the new approaches in intelligent vehicle control for critical remote location application using arm. In conventional system they are designed to control the speed of vehicles in all days. The main objective of the proposed system is to operate the vehicle in safe speed at critical zones.

[7] Switched Mode Power Supply (SMPS) Horand I. Gassmann et al., (2008) explained the SMPS format recent extensions to the SMPS format have vastly increased the range of stochastic linear programs that can be expressed within the format. This paper illustrates some of the features of SMPS using sample problems from the literature. For each problem, we give the general mathematical formulation, a small illustrative instance and the SMPS core, time and stock files.

Yoon Sang Kim (2014) explained about development of a Sensor Network-Based (SNB) SMPS System a smart LED monitoring application based on wireless sensor network. As the specifications of personal, industrial and medical devices become increasingly sophisticated, the demand for high power devices is also growing rapidly. Because high power supply devices are needed in order to operate high power devices with high specifications, stability and reliability are important factors to consider when it comes to high power supply devices.

[8] Mechanical Gripper Kurt E. Clothier (2010) explained a geometric approach for robotic arm kinematics with hardware design, electrical design his paper presents a geometric approach to solve the unknown joint angles required for the autonomous positioning of a robotic arm. A plethora of complex mathematical processes is reduced using basic trigonometric in the modeling of the robotic arm.

Krishna Raju (2015) demonstrated the design of three fingered robot-gripper mechanism the aim of this paper is to study the challenges and to design a three fingered robot mechanism which has the potential to fulfill various demand in industry and factories. So far there are so many mechanisms available for robot gripper in three fingered robot gripper mechanism is a type of mechanism which is used in industrial

robots for moving object, which has higher gripper ratio.

[9] Lead screw Vahid Araghi (2009) explained friction-induced vibration in lead screw systems lead screw drives are used in various motion delivery systems ranging from manufacturing to high precision medical devices. Lead screws come in many different shapes and sizes they may be big enough to move a 140 tons theatre stage or small enough to be used in a 10ml liquid dispensing micro-pump.

Mehul V. Gohil (2014) concluded the design of lead screw mechanism for vertical door wrapping machine. His design is concerned with the wrapping of maximum 10-foot height of door. Lead screw mechanism consist of lead screw, lead screw nut assembly. Lead screw supporting structure, lead screw driving motor, limit switches.

Jean K. Miller (1972) described the computer assisted circulation control at health sciences library a description of the circulation system which the health sciences library at the state university of New York at buffalo has been using since 1970. Features of the system include automatic production of overdue, fine, and billing notices; notices for call-in of requested books; and book availability notices.

Maurice J. Freedman (1981) conducted the circulation systems past and present on library automation. Traces the development of circulation systems through the librarian's perception of circulation control and the technology of modern online systems. The librarian have switched from a broad service approach to a narrow record keeping approach and back again as technological innovation has expanded their view points.

[11] Integrated library system

Laura Kinner et al., (2009) explained about the integrated library system from daring to dinosaur? The Automated Library System (ALS) has undergone significant changes since its inception in the 1970s. It is no longer simply a database to house and retrieve a library's holdings. It has become an Integrated Library System (ILS) comprised of robust clusters of systems involving every process and module related to libraries.

Sukumar Manda (2013) explained about the standards requirement for integrated library system this paper attempts to design a framework for comparison of standards available in public domain and implementation of standards facilities in open source ILSs. The frame work is mainly based on recommendations given by ILS - DI and IFLA working group on the area under consideration.

5. Conclusion

This paper presented design and fabrication of automated guided vehicle with automatic storage and retrieval system.

References

[1] A. Carullo and M. Parvis, "An ultrasonic sensor for distance measurement in automotive applications," in *IEEE Sensors Journal*, vol. 1, no. 2, pp. 143-, Aug 2001.

[2] Egbelu P.J "Characterization of automated guided vehicle dispatching rules", journal from international journal of production research, 1984.

[3] Golgen Bengu "An assignment algorithm for dynamic picking systems", Institute of industrial engineers, 1995.

[4] Govindaraju K, Boopathi S, Parvez Ahmed F, Thulasi Ram S and Jagadeeshraja M "Embedded based vehicle speed control system using wireless technology", International journal of innovative research in electrical, electronics, instrumentation and control engineering, volume 2, issue 8, 2014.

[5] Horand I. Gassmann and Bjarni Kristjansson "The SMPS format explained", IMA journal of management mathematics, volume 19, issue 4, 2008.

[6] Jean K. Miller "Computer assisted circulation control at health sciences library a description of circulation system", State university of New York, 1972.

[7] Khalid M. Altasa "Cycle time models for dual address storage and retrieval systems", IEEE international conference on systems, man and cybernetics, 1997.

[8] Krishna Raju, Ramkumar R and Lenin V.R "Design of three fingered robot gripper mechanism", "International Journal on Mechanical Engineering and Robotics", volume 3, page 18-24.

[9] Kurt E. Clothier "A geometric approach for robotic arm kinematics with hardware design, electrical design, and implementation", Journal of robotics, 2010.

[10] Maurice J. Freedman "Circulation system past and present on library automation", school of library service, Columbia, New York City, page no.279, vol.14/4, 1981.

[11] Mehul V. Gohil, Jignesh Patel "Design of lead screw mechanism for vertical door wrapping machine", International journal for scientific research and development", issue 02, volume. 2, page no 185, 2014.

[12] Michael R. Foster "Review of programmable logic controllers in control systems education", a review of programmable logic controllers in control systems education, 2010.

[13] Pounraj P. Periyasamy, Winston D. Prince, Cynthia Christabel S. "A Continuous health monitoring system for photovoltaic array using arduino microcontroller", circuits and systems, volume 7, page 3494-3503, 2010.

[14] Robert J. Gaskins and Jose M. A. Tanchoco "Flow path design for automated guided vehicle systems", International journal of production research, volume 25, page 667-676, 1987.

[15] Robert J. Gaskins, Jose M. A. Tanchoco, Taghaboni and Fataneh "Virtual flow paths for free ranging automated guided vehicle systems", International journal of production research, volume 27, page 91-100, 1989.

[16] Sukumar Manda, "Standard requirements for integrated library system", Asian journal of multidisciplinary studies, vol.1, issue 5, 2013.

[17] Thomas landers, Malik Sadiq and Don Taylor G "An assignment algorithm for dynamic picking systems", Institute of industrial engineers, volume 28, issue 8, 1996.

[18] Tingting Yu, Ahyoung Sung, Witwas Srista-an and Gregg Rothermel "Using property based oracles when testing embedded system applications", IEEE international conference on software testing, verification and validation", page 100-109, 2011.

[19] Vaglica J.J and Paul Gilmour "How to select a microcontroller", IEEE Spectrum, IEEE Journals & Magazines", volume 6, issue 3, 1990.

[20] Vahid Araghi, Nima Eslaminasab and Golnaraghi M "Friction induced vibration in lead screw systems", Journal of Vibration and Acoustics", volume 131, issue 10, 2009.

[21] Yanbo Li, Florent Della Valle, Mathieu Simonnet, Ichiro Yamada and Jean-Jacques Delaunay "High performance UV detector made of ultra-long ZnO bridging nanowires", Book of nanotechnology, volume 20, issue 4, 2008.

[22] Yoon Sang Kim "Development of a sensor network based SMPS system, a smart LED monitoring application based on wireless sensor network," international of distributed sensor networks, 2014.

[23] Zenhai Chen and Luo R. C. "Design and implementation of capacitive proximity sensor using microelectromechanical systems technology", IEEE transactions on industrial electronics, volume 45, page 886-894, 1999.