Automated Guided Vehicle For Physically Handicapped People – A Cost Effective Approach

To cite this article: Dr. G. Arun Kumar and Mr. A. Sivasubramaniam 2017 IOP Conf. Ser.: Mater. Sci. Eng. 282 012017

View the article online for updates and enhancements.

You may also like
- An application of the Kalman filter in automated guided vehicles
  M Dobrzanska and P Dobrzanski
- Multi Automated Guided Vehicle (AGV) cardboard carrier using wireless communication
  B E Putra, A Z Arfianto, L Subiyanto et al.
- Research on Quasi - Stop Control of AGV
  Sun Xuan, Wang Guangqi, Li Yingjun et al.
Automated Guided Vehicle For Physically Handicapped People – A Cost Effective Approach

Dr. G. Arun Kumar¹ and Mr. A. Sivasubramaniam²

¹Professor and Head, Department of Mechanical Engineering, Sathyabama University, Chennai, Tamilnadu, India.
²Assistant Professor, Department of Mechanical Engineering, VSB Engineering College, Karur, Tamilnadu, India.

*E-mail: garun55@gmail.com

Abstract. Automated Guided vehicle (AGV) is like a robot that can deliver the materials from the supply area to the technician automatically. This is faster and more efficient. The robot can be accessed wirelessly. A technician can directly control the robot to deliver the components rather than control it via a human operator (over phone, computer etc. who has to program the robot or ask a delivery person to make the delivery). The vehicle is automatically guided through its ways. To avoid collisions a proximity sensor is attached to the system. The sensor senses the signals of the obstacles and can stop the vehicle in the presence of obstacles. Thus vehicle can avoid accidents that can be very useful to the present industrial trend and material handling and equipment handling will be automated and easy time saving methodology.

1. Introduction

An automated guided vehicle or automatic guided vehicle (AGV) is a mobile robot that follows markers or wires in the floor, or uses vision or lasers [1]. The AGV can tow objects behind them in trailers to which they can autonomously attach. Automated guided vehicles increase efficiency and reduce costs by helping to automate a manufacturing facility or warehouse [2]. AGVs are employed in nearly every industry, including, pulp, paper, metals, newspaper, and general manufacturing. Transporting materials such as food, linen or medicine in hospitals is also done. Automated Guided Vehicle or AGV is one of material handling equipment that has been widely used in most manufacturing industry today as it provides more flexibility to the systems, the design of this AGV has to be done properly in order the maximize the usability of this AGV [3-4].

The mechanical part or system of this AGV will be incorporated with the guidance system done. The basic concept of the AGV incorporates battery-powered and driverless vehicles with programming capabilities for path selection and positioning [5].

The software used for analysis in this project is FEMPRO V22. It is used to find the displacement for this AGV when the load is applied to the base structure and other components [6]. The choice of the material for the structure is also important as it will compromise the weight to power ratio of this vehicle.

The steering system also will be one of the important of AGV as it will contribute to the radius of turn angle and also the design of the AGV focusing on the mechanical design concept of the AGV which combines knowledge on mechanical parts such as the electric motor, gears, wheels, structure of the AGV and others mechanical parts that are essential [7].

The AGV operated in a model warehouse, built to scale. Its primary task was to relocate pallets within the warehouse. An external input generated by an infrared remote Control notified the AGV...
whether a pallet was entering or exiting the warehouse [8]. When the four pair line follower module detected an intersection, the AGV determined whether to turn or go straight by using an algorithm that incorporated the vehicle's current location and direction. A radio frequency remote was used to control the AGV signaling another autonomous vehicle, the ASRS, the new location of the pallet. The second operation allowed for a pallet to be shipped out of the warehouse [9-10].

The AGV waited for the ASRS to confirm that it dropped off a pallet at one of the transition docks before it picked it up and moved the pallet to the outgoing shipping dock [11]. While travelling, the AGV polled two forward-facing infrared range finding sensors to determine if an object was in its forward collision path. If any object was detected, the vehicle would stop and wait for the obstruction to be cleared. While reversing, bump sensors detected the occurrence of a rear collision [12].

2. Description of Automatic Guided Vehicle
The Automatic Guided Vehicle used for material handling in an industry is shown in Figure 1. The components include chassis and the steering system [1]. Functions of chassis is to act as a frame for attaching other components, carry the load of other components and the payload, act as sacrificial component to prevent damage of expensive payload in case of accidents. Electrical components include the motor and the power supply for the motor itself [2]. Battery is being used. Electronic components provide sensing, logical decision and control of the vehicle. It includes a programmed microcontroller for the decision logic, the motor driver as both sensing and control of motor [3]. The predetermined path of the AGV is shown in Figure 2.

3. Electrical and Electronic Components
The transmitter receiver pair is shown in Figure 3 that transmits and receives electronic signal. It is used for transmitting the path data to the AGV microcontroller. The transmitter Module has 2 pins, the receiver has 2 pins. Two sets of transmitter receiver is being used to track the path of the AGV. Infrared sensors are being used as receivers [4].
A microcontroller (µC, uC or MCU) is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications [5]. The Microcontroller used in the AGV is ATMEG 8051 -89S52. The reasons for using ATMEG8051 -89S52 are cheap cost, Easy to program, Availability of UART Communication, High stress values. The Microcontroller is programmed with the required program to accept the data from the transmitter, interpret it, and calculate the path in terms of spatial orientation and five logical values to the Motor driver [6].

The LM158 series consists of two independent, high gains, internally frequency compensated operational amplifiers which were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage. Application areas include transducer amplifiers, dc gain blocks and all the conventional op amp circuits which now can be more easily implemented in single power supply systems [7]. For example, the LM158 series can be directly operated Off of the standard a5V power supply voltage which is used in digital systems and will easily provide the required interface electronics without requiring the additional g15V power supplies. The UTC ULN2003 is high-voltage, high-current Darlington drivers comprised of seven NPN Darlington pairs. 30RPM Centre Shaft Economy Series DC Motor is high quality low cost DC geared motor is shown in Figure 4. It has steel gears and pinions to ensure longer life and better wear and tear properties[8]. The gears are fixed on hardened steel spindles polished to a mirror finish. The output shaft rotates in a plastic bushing. The whole assembly is covered with a plastic ring. Gearbox is sealed and lubricated with lithium grease and require no maintenance. The motor is screwed to the gear box from inside[9].

Although motor gives 30 RPM at 12V but motor runs smoothly from 4V to 12V and gives wide range of RPM, and torque. Tables below gives fairly good idea of the motor’s performance in terms of RPM and no load current as a function of voltage and stall torque, stall current as a function of voltage[10].

### 3.1. Atmel 8-Bit Microcontroller

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory is shown in Figure 5. The device is manufactured using Atmel’s high-density nonvolatile memory technology and is compatible with the industry-standard 80C51 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer [11]. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications. The AT89S52 provides the following standard features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, three 16-bit timer/counters,a six-
vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. In addition, the AT89S52 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes[12].

Figure 5. Atmel 8-Bit Microcontroller.

The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port, and interrupt system to continue functioning. The Power-down mode saves the RAM contents but freezes the oscillator, disabling all other chip functions until the next interrupt or hardware reset. The specifications of the AGV’s ATMEL Microcontroller is shown in Figure 6.

| Parameter                  | Value      |
|----------------------------|------------|
| Flash (Kbytes):            | 8 Kbytes   |
| Max. Operating Frequency   | 24 MHz     |
| CPU:                       | 8051-12C   |
| Max I/O Pins               | 32         |
| UART:                      | 1          |
| SRAM (Kbytes):             | 0.25       |
| Operating Voltage (Vcc):   | 4.0 to 5.5 |
| Timers:                    | 3          |
| ISP:                       | SPI        |

Figure 6. Specifications of ATMEL8051 -89S52 Microcontroller.

3.2. Memory Organization
MCS-51 devices have a separate address space for Program and Data Memory. Up to 64K bytes each of external Program and Data Memory can be addressed [13-14].

3.3. Program Memory
If the EA pin is connected to GND, all program fetches are directed to external memory. On the AT89S52, if EA is connected to VCC, program fetches to addresses 0000H through 1FFFH are directed to internal memory and fetches to addresses 2000H through FFFFH are to external memory.

3.4. Data Memory
The AT89S52 implements 256 bytes of on-chip RAM. The upper 128 bytes occupy a parallel address space to the Special Function Registers. The Data memory is shown in Figure 7. This means that the upper 128 bytes have the same addresses as the SFR space but are physically separate from SFR space. When an instruction accesses an internal location above address 7FH, the address mode used in the instruction specifies whether the CPU accesses the upper 128 bytes of RAM or the SFR space. Instructions which use direct addressing access of the SFR space. For example, the following direct
addressing instruction accesses the SFR at location 0A0H (which is P2). MOV 0A0H, #data
Instructions that use indirect addressing access the upper 128 bytes of RAM [15]. For example, the
following indirect addressing instruction, where R0 contains 0A0H, accesses the data byte at address
0A0H, rather than P2 (whose address is 0A0H). MOV @R0, #data Note that stack operations are
examples of indirect addressing, so the upper 128 bytes of data RAM are available as stack space.

Figure 7. Data Memory.

3.5. Circuit Connection:
The AGV’s circuit connection is shown in Figure 8.

Figure 8. Circuit Connection.
The Infrared based obstacle detector circuit diagram is shown in Figure 9. It will sense and detect the obstacle. Then the AGV will deviate from its original path and then it will regain its original path after crossing the obstacle.

4. Path Planning
The AGV’s movement is based on path planning. The path planning is based on spatial graph theory. It is represented in Figure 10.

4.1 Spatial Graph Theory
The path is not currently in use by other AGV and the path does not cross the lines being used by other AGV, the path is under maintenance.

5. Cost Analysis of AGV
Estimated cost of the AGV model is Rs 8000/-
The Fabricated model is shown in the Figure 11.

5.1 The AGV is a productivity increasing feature in a factory that has the following advantages
- Speed of delivery
- Flexibility of path
- Adaptive to changes in factory layouts
- Reduction in labor cost and Running cost
- Ability to add sensors to detect the payload conditions

5.2 Disadvantages
- Should be recharged periodically
- Will stop delivery when the AGV is forced off the path.
- High Initial cost

![Figure 11. Fabricated Model of the Automated Guided Vehicle.](image)

### 6. Conclusion
The Advantages of the AGV far shadow over the disadvantages and hence it is concluded that in a mass production factory with large area, a AGV will definitely increase productivity, decrease expenditure.

### References
[1] Jervis B "Guidance options for AGVs". Webb Company, 2007.
[2] Mahendra, “Structural and Embedded design”, Chrysler Automotive India, 2010
[3] Murty. D.V.S, “Transducers and Instrumentation” Prentice Hall of India Publishing Company Limited, 2001.
[4] Olmi, Roberto (2011). Traffic Management of Automated Guided Vehicles in Flexible Manufacturing Systems. Ferrara (Italy): University of Ferrara.
[5] Paul.B,AGV Drive and Steering Options Transbotics Corp., 2009
[6] Rajneesh Kumar Singh"Automated Trailer Loading AGVs" JBT Corporation. 2009.
[7] R.N.Mall"Pallet Handling AGVs" JBT Corporation. 2009.
[8] Savant “The Basics of Automated Guided Vehicles”. AGV Systems. 2006
[9] Shyam Sundar, “The 8051 Microcontroller Architecture, Programming & Applications”, Penram International Publishing (India) Private Limited.
[10] Shyam kumar chowdry,Kuldip kumar sahu,“Common AGV Applications: Raw Material Handling” JBT Corporation. 2009.
[11] Vivek Kumar,R.N. Mall “Sonar sensor and mounting”. University of Birmingham. 2006.
[12] Vivek Kumar,R.N. Mall,Rajneesh Kumar Singh"Towing AGVs ". Hi-Tech Robotic Systemz Ltd. India, 2009.
[13] Vivek Kumar "Common AGV Applications: Roll Handling” JBT Corporation. 2009.
[14] Vivek kumar,R.N.Mall"Battery Charging Systems for Automated Guided Vehicles”.AGV Battery Charging Systems. Egemin Automation Inc. 2006.
[15] Vivek kumar"Work in Process Movement with AGVs” JBT Corporation. 2009.