International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 10 Issue 6 ǁ 2022 ǁ PP. 1730-1736

Automatic Navigating Bicycle

Nivedya T Nandan*[1], Harshed B[1],Vishnuprasad T V [1], Praveen M R[1]
*[*1]Mar Athanasius College of Engineering , Kothamangalam ,Kerala, India*
*CorrespondingAuthor:*nivedyatnandan@gmail.com*

Abstract
In the current scenario of heavy consumption of fossil fuels, which is expected to be depleted by the year 2060, there is a scope for inventing a new technology with nearly zero fuel consumption. Adapting environment-friendly transportation can help with the issue of carbon dioxide emissions and depleting fossil fuels. In this context, an idea of a campus or an institution that incorporates an eco-friendly mobility can bring a substantial difference. Bicycle sharing system is a common transport scheme that is used in these places. However, there are certain drawbacks that are associated with conventional bicycle sharing systems. Vehicle theft, space for parking a fleet of bicycles, availability on demand are matters of concern. We propose an Automatic Navigating Bicycle which not only makes transportation over small distances convenient but also enhances safety and provides on- demand mobility. When a user requests a ride, the autonomous bicycle recognizes the location of the user and arrives at the user's location automatically. The bicycle incorporates autonomous motion by positioning the rear wheels into a tricycle configuration, thus providing lateral stability and balancing itself. It configures to a bicycle model upon arrival and can be ridden as a regular bicycle. The Automatic Navigating Bicycle utilizes smart features like obstacle detection, RFID navigation for autonomous motion and proves to be an efficient and reliable mode of transportation.

Keywords: *Automatic Bicycle , Bicycle Sharing system, RFID Navigation*

Date of Submission: 14-06-2022 Date of acceptance: 28-06-2022

I. INTRODUCTION

In the era of rapid urban development, there are various technologies that are developed to make transportation easier. One such field is autonomous vehicles where not only the vehicle offers the advantage of reduced human effort and robustness. Any autonomous vehicle, even though it will have a lot of advantages like user friendliness, better operation etc. will also have certain disadvantages associated with it, making it a reason why this level of automation in vehicles is stillnot on roads, especially in a country like India. The development of an autonomous bicycle is hence here being concentrated on a smaller scale like a campus or an institution which later with the help of a more reliable technology can be developed for implementation in large platforms.

The implementation of autonomous driving technology address some of the current challenges of bicycle-sharing systems. We also propose a solution to provide bicycles of the necessary lateral stability to drive autonomously. Under this view, a fleet of autonomous shared bicycles would work as a mobility-on-demand system: when a user requested a ride, the nearest available bike would drive autonomously to wherever they are. Then, the userwould ride it like a regular bike, and upon arrival to the destination,the bike would leave autonomously again for the next user.Such a system would eliminate the need for rebalancingand dockingstations, and the needed fleet size would be smaller than in current station-based and dockless systems. In addition, it would solve the difficulty of finding available bicycles or docks and eliminate walking distance, improving the user experience and incentivizing its use.

According to the latest report from the United Nations on the world urbanization prospects by 2021 cities already represented 55% of the global population, and this number is expected grow to 68% by 2050. Combining the effects of this urbanization with the growth in the urban population, the number of people living in cities will increase by 2.5 billion. Even by 2030, 43 mega-cities will have more than 10 million inhabitants. As the world continues to urbanize, already stressed cities will have to face new challenges that will require innovative solutions regarding housing, infrastructure, services, and mobility. Concerning the last, there will be a need for efficient,ecologic, inexpensive, and reliable means of transport that ensure a convenient flow of people and goods around cities, minimizing mobilityrelated problems such as congestion, air pollution, or long daily commute times. In this paradigm of rapid urban growth, shared micro-mobility solutions have quickly proliferated; as can be seen in Fig.1, there are currently around 2147 station-based bicycle-sharing systems. Despite their popularity, micro-mobility solutions still must face several relevant challenges such as the rebalancing problem, the oversupply of vehicles or providing better user experience. We believe that new solutions generated from the combination of electrification, autonomous driving, and vehicle-sharing, which are predicted to shape the future of mobility, could solve many of the current challenges micro-mobility systems. This article proposes an autonomous bicycle-sharing system as an alternative approach to current bikes-sharing programs, allowing bike-sharing systems to work as an on-demand shared mobility platform.

II. METHODOLOGY

2.1.1 RFID based Navigation System

RFID technology is used for the navigation of autonomous bicycle. The technology is making use of RFID tag and reader, where the reader is placed in the bicycle and tag will be placed or fixed in the path for navigation. During the motion of the bicycle it will detect the tag placed on the path.

A new navigation method is described for autonomous driving.Using radio frequency identification (RFID) tags is a new way of giving location information to users. Due to its passive communication circuit, RFID tags can be embedded almost anywhere without an energy source. The autonomous bicycle system is composed of a Radio Frequency Identification (RFID) tag sensor, and a commercial four-wheel autonomous bicycle. The RFID tags are used as landmarks for global path planning and the topological relation map which shows the connection of scattered tags through the environment is used as course instructions to a goal. The robot automatically moves along path using the scanned range data until a tag is found and then refers to the topological map for the next movement. Our proposed technique would be useful for real-world robotic applications such as intelligent navigation for motorized wheelchairs. Radio Frequency Identification (RFID) is a technology that uses radio waves to passively identify a tagged object. It is used in several commercial and industrial applications, from tracking items along a supply chain to keeping track of items checked out of a library. The system has two basic parts: tags and readers. The reader gives off radio waves and gets signals back from the RFID tag, while the tag uses radio waves to communicate its identity and other information.The technology has been approved since before the 1970s but has become muchmore prevalent in recent years due to its usages in things like global supply chain management and pet microchipping. Every RFID system consists of three components: a scanning antenna, a transceiver and a transponder. When the scanning antenna and transceiver are combined, they are referred to as an RFID reader or interrogator. There are two types of RFID readers – fixed readers and mobile readers. The RFID reader is a network-connected device that can be portable or permanently attached. It uses radio waves to transmit signals that activate the tag. Once activated, the tag sends a wave back to the antenna, where it is translated into data. The transponder is in the RFID tag itself. The read range for RFID tags varies based on factors including the type of tag, type of reader, RFID frequency and interference in the surrounding environment or from other RFID tags and readers. Tags that have a stronger power source also have a longer read range. RFID tags are made up of an integrated circuit (IC), an antenna and a substrate. The part ofan RFID tag that encodes identifying information is called the RFID inlay.Low-power, embedded non-volatile memory plays an important role in every RFID system. RFID tags typically hold less than 2,000 KB of data, including a unique identifier/serial number. Tags can be read-only or read-write, where data can be added by the reader or existing data overwritten.The read range for RFID tags varies based on factors including type of tag, type of reader, RFID frequency, and interference in the surrounding environment or from other RFID tags and readers. RFID security and privacy: A common RFID security or privacy concern is that RFID tag data can be read by anyone with a compatible reader. Tags can often be read after an item leaves a store or supply chain. They can also be read without a user's knowledge using unauthorized readers, and if a tag has a unique serial number, it can be associated to a consumer. While a privacy concern for individuals, in military or medical settings this can be a national security concern or life-or-death matter. Because RFID tags do not have a lot of compute power, they are unable to accommodate encryption, such as might be used in a challenge-response authentication system. One exception to this, however, is specific to RFID tags used in passports – basic access control (BAC). Here, the chip has sufficient compute power to decode an encrypted token from the reader, thus proving the validity of the reader.

2.1.2 Block Diagram

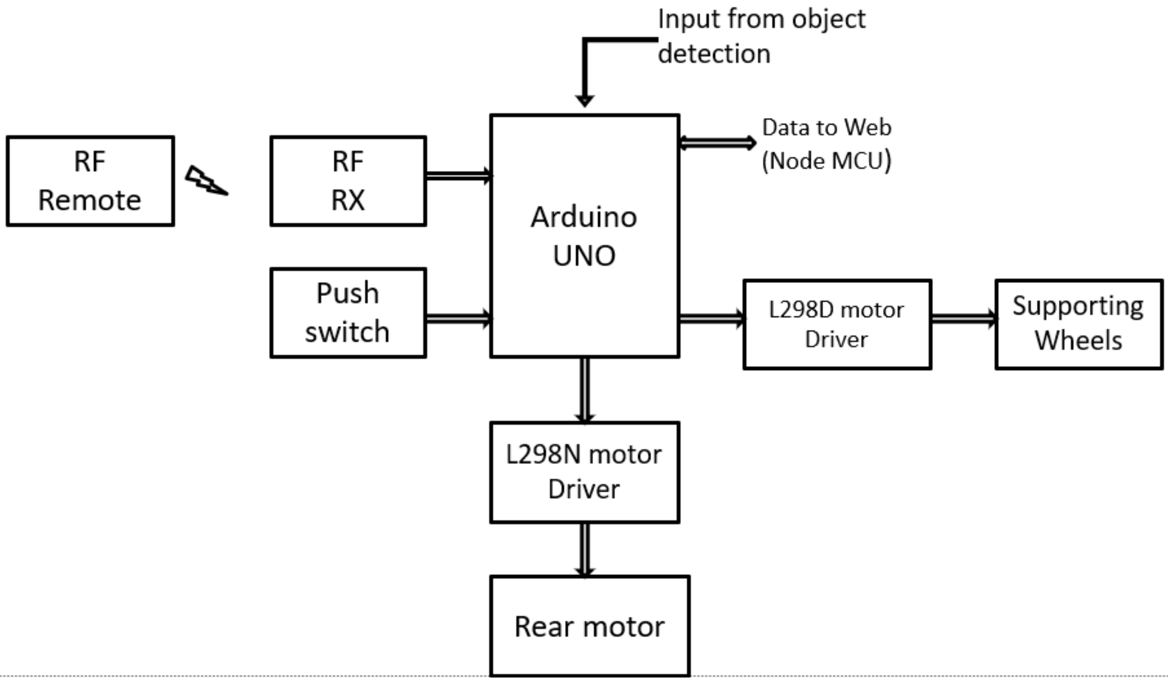

Figure1: Basic Working of Automatic Navigating Bicycle

The autonomous mode operation of bicycle begin with the call from the RF remote. RF remote has particular number of press button as per the required number of hubs. The operation begin with the call from any of the hub, let us assume it as hub number 1.. The information of the hub number is received by RF receiver which placed on the bicycle. Corresponding hub number will be displayed in the LCD display. The controller Arduino UNO is programmed in a way to start and stop the motor control, where the start operation begins with the input and stops only when it reaches the hub destination. DC geared motor is used for driving the bicycle in autonomous mode.This motor is interfaced with rear wheel using chain drive mechanism.

Lateral stability for autonomous mode is provided using balancing wheels which make use of DC motor with L298 motor driver. A limiter switch is placed beneath the seat of the bicycle, when the user takes seat on the bicycle there will be a pressure change. If the pressure value exceeds the threshold pressure value which is programmed in the controller the balancing wheel action takes place. Node MCU is also a controller where hub position and related data is pushed to web page which shows the current status of the bicycle.

2.1.3Circuit Diagram

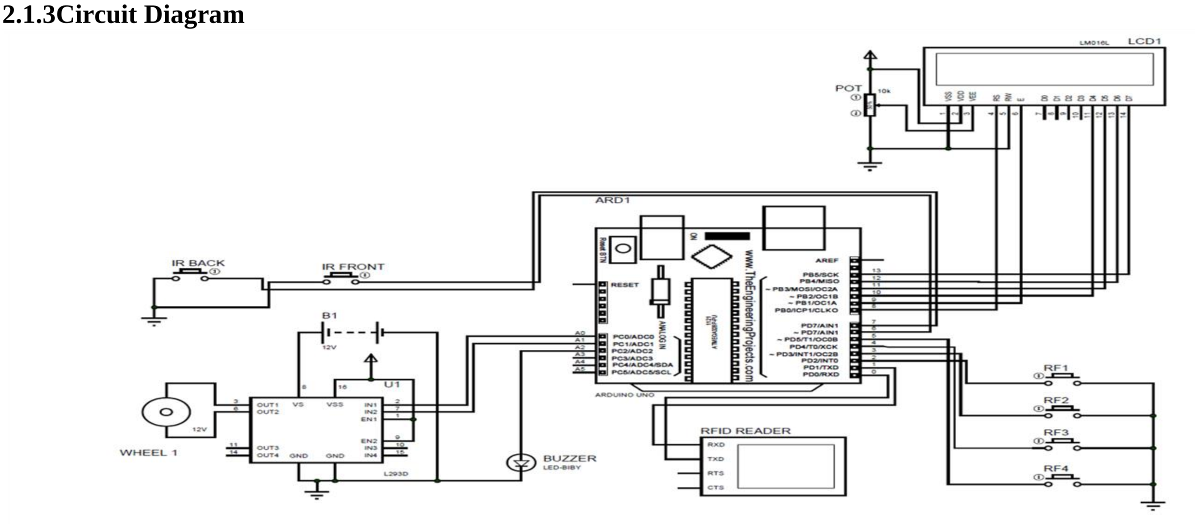

Figure 2: Circuit Diagram

In the circuit diagram shown arduino uno with ATmega328p chip is used as the controller.It has 14 input output pins out of which 6 can be used as pwm output 6 analog input pins,ausbconnection,a power barrel jack,and a reset button. 2 HC-HR04 ultrasonic sensors are used for obstacle detection which are integrated in to the Arduino uno .Ultrasonic sensors have 4 terminals VCC ,Trigger,Echo,Ground .Trigger pin used to trigger ultrasonic pulses and echo pin produces a pulse when the reflected signal is received.VCC and Ground is connected to the corresponding power sockets of arduinouno.The signal from ultrasonic sensor is fed to the general input output pins 6 and 7 .It is mainly used for obstacle detection whenever a obstacle is detected by the sensor stop command is given to the motor.4 RF switches have chosen. The output from 4 RF switches is connected to 2,3,4,5 input pins of arduino uno respectively.

The next input device is RF id reader. RXD terminal of RF ID reader is connected to the TXD terminal of Arduino uno and TXD terminal is connected to the RXD terminal of Arduino uno.

A DC motor controller L298 it allows speed and direction control of 2 DC motor at the same time. Only one 12 V DC motor is connected to the output terminal 3 and 6 of the output terminals of L298 .The input pins 2 and 7 of motor controller is connected to the analog pins A0 and A1 and analog pin A2 is connected to the buzzer .

A 16*2 LCD display is used .The digital input pins D4,D5,D6,D7 are connected to the Arduino pins 10,11,12,13 respectively and the LCD display is powered by 5v supply all common negative pins of components are grounded. We have 4 RFID tags each have its own identification (UID) .Reader that sends a signal to the tag and read its response . Each RF switch has its own corresponding location . If RF switch 1 is enabled the microcontroller will identify the destination 1 , the motor will receive start command and activated till the destination 1 is reached (met with the corresponding tag).This is same for all other RF switches 2,3,4. The corresponding destination is will be displayed on the LCD display along with current location and the location will be updated in web page also .

2.2 WHEEL RETRACTION

Figure 3: Balancing Wheels

A wheel driven by Brushless DC motor powered by battery in which the motor is rugged within the wheel itself called as HUB Motor.The motor driven mechanism includes mainly a hub motor which is of Brushless DC motor type driven by a motor driver circuit and battery backup for self-starting.In BLDC motor input DC voltage supplied to the motor is converted into corresponding AC by inverter circuits and it is fed into the AC windings so that the rotating magnetic field is created and it is called as electronic commutation. This magnetic field will interact with magnetic field created by the permanent magnet to induce a voltage in the winding so that the rotation can be enabled. The windings used for making stator windings are made from laminated copper wires and the rating of material used may selected depends on the power rating of the motor and current flow through the conductor.The hub motor requires rotor part as the external part to fix the wheel drum and DC supply from the battery bank is given to stator part of the motor through motor driver circuit. The motor driver circuit consists of pulse generation part. The pulse generated is purely depends on the output from the hall sensors. A three-phase voltage source inverter is used to convert the DC supply from the battery bank to corresponding AC supply. The rotation of the BLDC motor can be enabled only by this mechanism.

BLDC motors are widely used in industries due to its advantages. The application of BLDC motors is increasing due to consumers demand for lower energy costs, better performance and reduced noise.

2.3 REAR WHEEL MOTION

Figure 4: Balancing Wheels

Rear wheel motor provides the motion for the entire bicycle.The bicycle has two modes of operation, one is user driven mode and other is autonomous mode. In autonomous mode mode the motion of bicycle is completely depending on the rear wheel motor which helps to drive the bicycle.The motor used for rear wheel is rectangle dc geared motor of 12V, 14W rating which is mounted on the side frame of the bicycle and the power is transmitted through chain. The bicycle can be used in user driven mode and when user request for a ride the rear wheel motor action takes place through Arduino UNO. The required torque and speed of motor is determined by calculating the wind resistance, aerodynamic resistance, ground resistance. The torque required for overcoming these factors are considered and corresponding motor with required rating is chosen. The motor controller used is L298N with a power rating of 250W, operating voltage of 12V and maximum current of 20A.

III. SIMULATION RESULTS

The simulation results in Figure 5 and Figure 6 shows the different status of bicycle before and after the call. When the bicycle is not moving the LCD display shows "IDEAL " status. And when user calls and choose the required destination and the bicycle moves in autonomous mode the status corresponding to position and motion is displayed.

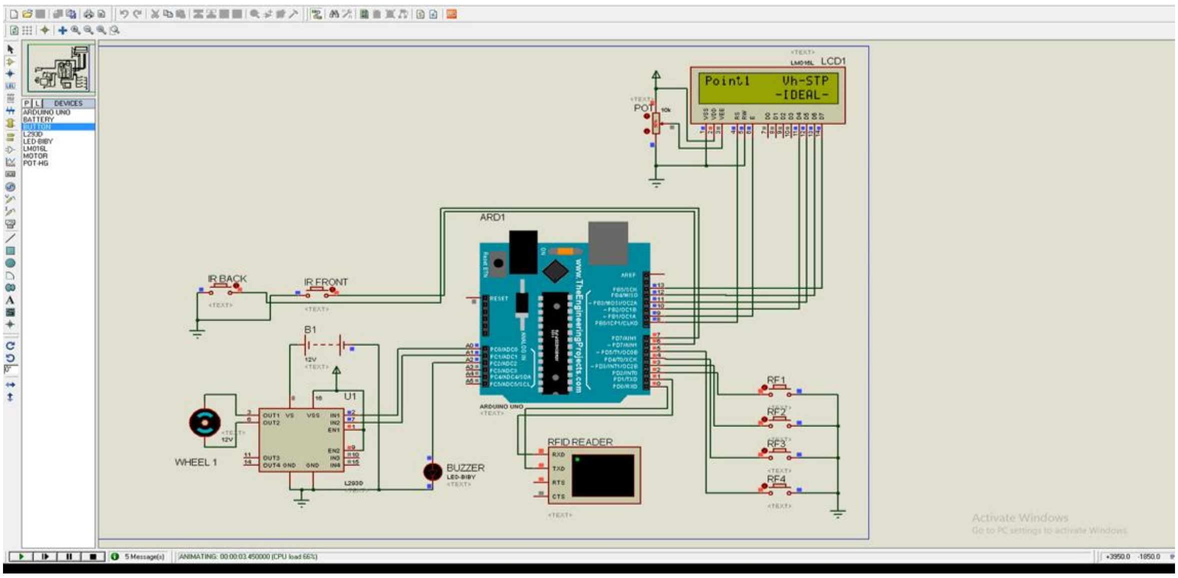

Figure 4: Vehicle Stop Mode

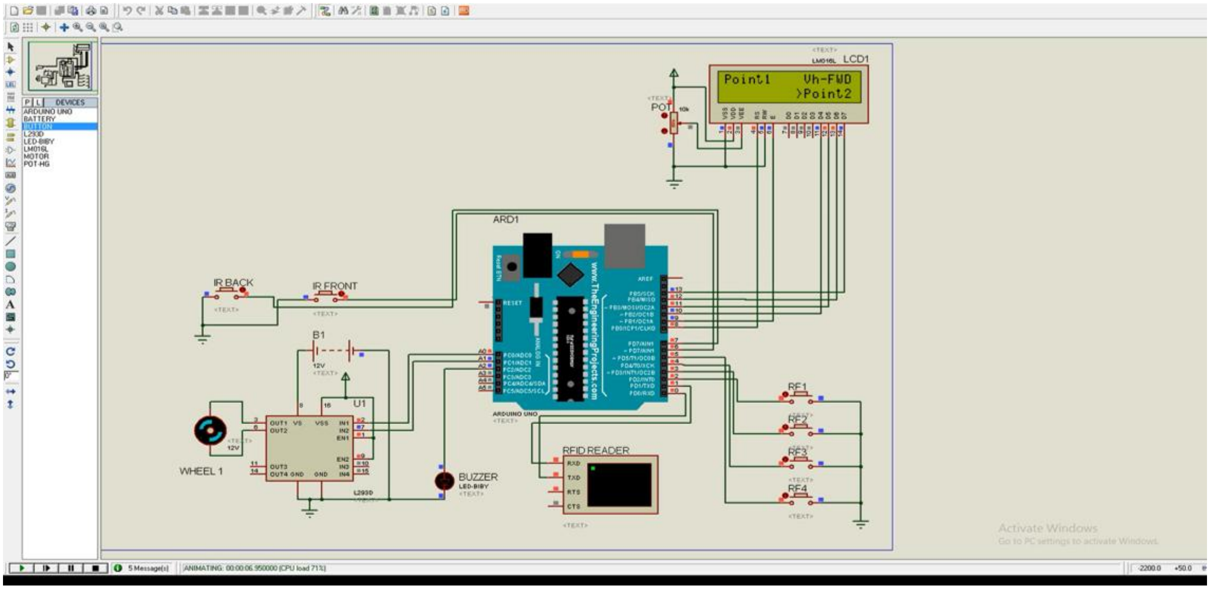

Figure 5: Vehicle Forward Mode

IV. HARDWARE IMPLEMENTATION

The hardware implementation consisting of the RFID based Navigation System , Wheel retraction and the rear wheel motion is provided below.

Figure 6: Automatic Navigating Bicycle

V. CONCLUSION

Inthe current paradigm of rapid urban growth, it is critical to find innovative mobility solutions that ensure efficient transportation in cities. Here, we present the implementation ofautonomous-driving technology as a new approach to bike-sharing. We also tackle the problemof lateral-stability, which is the biggest challenge in the mechanics of making a bicycle moveautonomously, by designing and prototyping a solution to it. The proposed system could solvesome of the current challenges of bicycle-sharing systems.For the operators, one of the mainbenefits of having autonomous bicycles would be the reduction in costs derived from the absence of rebalancing and smaller fleet size. For the users, eliminating the problem of finding availablebikes or stations would solve one of the main pain points and would increase the reliability of thesystem. Lastly, eliminating walking distance would greatly improve convenience, incentivizingits use and supporting a more robust micro mobility network

REFERENCES

[1]. Sanchez, NaroaCoretti, Luis Alonso Pastor, and Kent Larson[1]. “Autonomous Bi- cycles:A New Approach To Bicycle-Sharing Systems.” 2020 IEEE 23rd International Conference on Intelligent Transportation Systems (ITSC) IEEE, 2020.

[2]. Erik Wilhelm, Abhishek Gupta, SelvasurendhiranModurpalayam, Sirui Wang, Bran- don,Walton, Adam Wootton, Tim Jeruzalski, Andrew Andrade, Soh Gim Song. “AutoBikes:Autonomous Electric Bicycles for First and Last-mile Mobility on Demand"EVS28 International Electric Vehicle Symposium and Exhibition, 2020

[3]. Ziad Fawaz, Ronald Smith, Paul Muench, Sridhar Lakshmanan, Alireza Mohammadi."Design and Benchtop Validation of an Autonomous Bicycle with Linear ElectricActuators" University of Michigan-Dearborn Dearborn, MI 48128, US.

[4]. P. Dinesh; P. Kishore; B. Vivekanandan; S. Moorthi."RFID based navigation system forunmanned material handling vehicles" IEEE International Conference on IntelligentSystems and Signal Processing (ISSP), 2019

[5]. Sunhong Park and Shuji Hashimoto;"Autonomous Mobile Robot Navigation Using PassiveRFID in Indoor Environment" IEEE Transactions of Industrial Electronics,July2020