

Design, fabrication and analysis of self-balancing electric bike

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Abstract:

This paper describes the design and fabrication of Self-Balancing two wheeler. To maintain balance, it turns the wheels at just the right speed, so you move forward. The Self-balancing two wheeler is an intelligent vehicle which uses gyroscopic sensors detects the motion of rider, so that he can accelerate, brake or steer the vehicle. This self-balancing is absolutely ecofriendly mode of transport which causes zero pollution. There are several ways in order to design an efficient self-balancing bicycle which are by using control moment gyroscope (CMG), mass balancing, steering control and reaction wheel. Based on previous research, the usage of CMG is the suitable choice since it can produce large amount of torque, it has no ground reaction forces, and the system can be stable even when the bicycle is stationary.

Keywords: gyroscope, self-balancing, gyroscope, brakes.

1.Introduction:

A battery electric vehicle (BEV) is a vehicle that is powered by electricity stored on the vehicle in a battery through the use of one or more electric motors. "Electric vehicles" include hybrids as well as pure battery electric vehicles. An electric vehicle, also referred to as an electric drive vehicle, uses one or electric motors or traction motors for propulsion. An electric vehicle may be powered through a collector system by electricity from off-vehicle sources, or may be self-contained with a battery or

generator to convert fuel to electricity. EVs include road and rail vehicles, surface and underwater vessels. EVs typically charge from conventional power outlets or dedicated charging stations, a process that typically takes hours, but can be done overnight and often gives a charge that is sufficient for normal everyday usage. Electric cars are a currently viable alternative to conventionally gasoline powered cars because they are efficient, significantly less complex, more reliable, environmentally friendly, and cost less to operate, despite what the detractors may say. Most Americans drive less than 40 mile per day so EV's make perfect sense as second cars. Per census figures, statistically, the average American household owns more than two cars, so it would be logical that the second car be an electric car, for those local commutes, which is where the wear and tear and pollution) on gasoline powered cars is the most severe, before the engine fully warms up .Electric cars produce no tailpipe emissions, reduce our dependency on oil, and are cheaper to operate. Of course, the process of producing the electricity moves the emissions further upstream to the utility company's smokestack—but even dirty electricity used in electric cars usually reduces our collective carbon footprint.

The methods to achieve a self-balanced bicycle are mainly classified into four types. The first type is using a control moment gyroscope (CMG) [1-4]. This method can provide a large torque, but energy consumption of CMG is very high because the flywheel is spinning all the time. The CMG consists of

a spinning rotor with a large, constant angular momentum, whose angular momentum vector direction can be changed for a bicycle by rotating the spinning rotor. The spinning rotor, which is on a gimbal, applies a torque to the gimbal to produce a precession, gyroscopic reaction torque orthogonal to both the rotor spin and gimbal axes. A CMG amplifies torque because a small gimbal torque input produces a large control torque to the bicycle. These 2 Cond type is mass balancing where mechanical structure of mass balancing is simple, but the torque this method could provide is small. The third type is steering control where a controller controls the amount of torque applied to the steering handlebar to balance the bicycle. Advantages of this system are low mass and low energy consumption, while its disadvantages are it requires ground reaction forces and it cannot withstand large tilt angle disturbance. The energy consumption of steering control is low, but it cannot balance the bicycle at low forward velocity. The fourth type is using a reaction wheel where speed of a reaction wheel is increased or decreased to generate a reactionary torque about the spin axis which is parallel to the bicycle's frame [5]. As the bicycle begins to fall to one side, a motor mounted to the reaction wheel applies a torque on the reaction wheel, generating a reactionary torque on the bicycle, which brings back the bicycle's balance. Advantages of this system are it is low cost, simple and no ground reaction, while disadvantages are it consumes more energy and it cannot produce large amount of torque.

2.1 Literature Survey on Design and Development Self Balancing E-bike:

The following literature review is based on different methods used in designing and development of self-balancing two-wheeler. [1] Climate change from increased concentration of carbon dioxide in the

atmosphere was acknowledged already back in the year 1896 (Arrhenius, 1896). It is however not until recent decades that discussions have emerged, and plans been developed, on how our emissions of Green House Gasses (GHG) should be reduced. The transport sector accounted for 13percent of the global GHG emissions in 2004. In addition to the global challenge of GHG emissions, many cities around the world face problems with local air pollution and congestion. Decreasing air pollution on a local — and a global — level can be accomplished by switching to vehicles with fuels that have lower environmental impact than fossil fuels; such as electric vehicles or bio-fuels. However, this does not directly affect congestion. Around a third of the trips made by car in Europe are shorter than 3 km, and half of the trips shorter than 5 km. This means that there is a potential for efficiency and air-quality improvement by switching to more energy efficient and less polluting modes of transport that can replace these short distance trips. One alternative is to increase bicycling which could reduce the need for taking car or public transport short distances as well as reduce congestion. One of the methods to increase bicycling in cities is to set up Bicycle Sharing Systems (BICYCLE) that can be accessed by locals or tourists for a fee. There are currently more than 600 cities with BICYCLE globally. The number of Bicycles in those systems exceeds 700 000. By providing a large network of stations with shared bicycles, it is possible to supply an efficient, convenient and cheap mode of transport. [2] One of the major problem that we face on day to day life is Energy Crisis. Our paper is one of the solutions for energy crisis. The system we implemented is a hybrid electric bike. The project has a number of benefits to both the team members as well as external benefits through increasing awareness of alternative transportation modes. Despite the environmental friendliness of the project or the projected benefits of more people relying on non-polluting modes of transport, the main reason we selected the project was for the level of interaction

between us, the engineers, and our product. Designing a transportation vehicle requires consideration of mechanical objectives, electrical objectives, safety criteria, comfort, user friendliness as well as an array of other objectives which may conflict under various circumstances. We hoped that through navigating our way through this vast set of criteria the satisfaction of completing the project would be much greater than other projects we could have selected. [3] TIG welding was, like MIG/MAG developed during 1940 at the start of the Second World War. TIG's development came about to help in the welding of difficult types of material, example aluminum and magnesium. The use of TIG today has spread to a variety of metals like stainless mild and high tensile steels. Arc welding is a technique to melt and join different materials that is widely used in the industry. The gas tungsten arc welding (GTAW) process is sometimes referred to as TIG, or heliarc. The term TIG is short for tungsten inert gas welding. Under the correct welding conditions, the tungsten electrode does not melt and is considered to be non consumable. To make a weld, either the edges of the metal must melt and flow together by themselves or filler metal must be added directly into the molten pool. Filler metal is added by dipping the end of a filler rod into the leading edge of the molten weld pool. Most metals oxidize rapidly in their molten state. [4] Electrical arc was first described by Davy in England in the year 1809, but the beginning of arc welding could become possible only with the improvements in electric dynamos or generators between 1877 and 1880. Auguste de Meritens established arc welding process in 1881 which was applied to join certain components of electrical storage batteries. Arc and molten pool shielding with an inert gas (CO₂) was advantage by Alexander in USA in year 1928 and the patent for TIG welding was received by Hobart and Devers in 1930 in USA. First gas tungsten arc spot welding torch based upon TIG welding was introduced around 1946. TIG is an abbreviation for tungsten-inert-

gas (fig-1). The process is also termed as gas-tungsten arc welding and designated as GTAW. In this process, an arc is struck between a non-consumable tungsten electrode and the base metal. The arc is shielding by the inert argon or helium or argon-helium mixture. A filler wire may or may not be used. When it is used, it is fed externally into the arc in the form of rod or strip by the welder. The welder also has to control the arc length and travel speed. [5] The main aim of this review paper is to present the idea of harnessing the various energy and use it in today's existence of human life. For human being travelling has become vital. In order to sustain in this fast forward world he must travel from place to place. It is very important that time taking for travelling should be less, also it should be economical and easily available. With the fast depleting resources of petrol and diesel, there is need to find intermittent choice. Taking all this into account, a shift away from conventional based fuels to using a renewable sources of energy is a must. Electric bike which will be driven with the help of battery and thus provide required voltage to the motor. The focus of this report is to perform power calculations and system design of this Electric Bike. This bike can be driven with the help of electricity or also with the help of solar energy. Therefore the manufacturing of such bike is indispensable. [6] This paper describes the design and fabrication of Self Balancing two wheeler. The Self balancing two wheeler is based on the principle of Segway knows when you are learning forward. To maintain balance, it turns the wheels at just the right speed, so you move forward. The Self balancing two wheeler is an intelligent vehicle which uses gyroscopic sensors detects the motion of rider, so that he can accelerate, brake or steer the vehicle. This self balancing is absolutely ecofriendly mode of transport which causes zero pollution. [7] The large use of the travelling vehicles has increased the problems connected to the air quality and to the use of petroleum [1, 2]. The human sensibility for the energetic and environmental problems is encouraging the research in alternative solutions for the automotive

field, as multiple-fueling, hybridization and electrification. At the same time, particularly as concerns urban areas, new standards have imposed substantial modifications in the mobility. In this context, a vehicle as the electrically assisted bike [3 – 5] can be considered a promising alternative vehicle for both personal mobility and goods delivery, especially for small and medium distances: an assisted bike is able to move with an average speed equal to the typical one of the town traffic but it requires energy for its mobility that is very close to the necessary energy for the displacement of the transported people. [8] Welding is a process of joining of two metals. It is most economical process than casting and riveting. There are several methods of welding processes. Of all the arc welding processes, Metal Inert Gas (MIG) welding is capable of achieving the highest quality welds. MIG welding is one of the most widely used processes in industry. It can be used with virtually any weld-able metals, including dissimilar metals, and thicknesses from 0.5mm upwards. MIG welding is a commonly used high deposition rate welding process. The input parameters play a very significant role in determining the quality of a welded joint. In fact, weld geometry directly affects the complexity of weld schedules and thereby the construction and manufacturing costs of aluminum structures and mechanical devices reduces. Therefore, these parameters affecting the arc and welding path should be estimated and their changing conditions during process must be known before in order to obtain optimum results, in fact a perfect arc can be achieved when all the parameters are in conformity. These are combined in two groups as first order adjustable and second order adjustable parameters defined before welding process. Former are welding current, arc voltage and welding speed. These parameters will affect the weld characteristics to a great extent. Because these factors can be varied over a large range, they are considered the primary adjustments in any welding

operation. Their values should be recorded for every different type of weld to permit reproducibility. [9] A bicycle, often called a bike or cycle, is a humanpowered, pedal-driven, single-track vehicle, having two wheels attached to a frame, one behind the other. The bicycle has undergone continual adaptation and improvement since its inception. These innovations have continued with the advent of modern materials and computer-aided design, allowing for a proliferation of specialized bicycle types. Bicycles can be categorized in many different ways: by function, by number of riders, by general construction, by gearing or by means of propulsion. The more common types include utility bicycles, mountain bicycles, racing bicycles, touring bicycles, hybrid bicycles, cruiser bicycles, and BMX bikes. Less common are tandems, low riders, tall bikes, fixed gear, folding models, amphibious bicycles and recumbents. Unicycles, tricycles and quadracycles are not strictly bicycles, as they have respectively one, three and four wheels, but are often referred to informally as "bikes". [10] Bicycles are a common form of exercise, recreation and transportation used by billions. They can also serve to provide physical therapy, as they are a low impact form of exercise that can train balance, strength, stamina and coordination. Though one may consider riding a bicycle to be a fairly simple task, this is not the case for many people. This includes young children, adults who have never learned to ride a bicycle, injured people, or people suffering from developmental or cognitive disabilities. A system that could provide balancing assistance to a bicycle rider without otherwise affecting the experience of riding a bicycle could provide great benefit to these groups of individuals. Such a system could be used both as a teaching tool, and as a physically therapeutic device. This problem of balancing a bicycle is analogous to what is known as the invertedPendulum problem. An inverted pendulum is a pendulum which has its mass above its pivot .The pendulum can be anything forms a simple mass and rod, to a full system. While a normal pendulum is

stable, an inverted pendulum is inherently unstable, and must be actively balanced to remain upright. In the case of a bicycle, the bicycle is a rigid body which can rotate around its contact point with the ground. Although a bicycle motion has multiple degrees of freedom, the particular type of motion which this project aims to stabilize is this tilt angle around the point of contact with the ground relative to the direction of gravity. [11]

Welding is a joining process usually metals or alloy by causing coalescence. In which process coalescence of materials is produced by heating them to recrystallization temperatures with or without use of pressure and with or without the use of filler material. Welding is used for permanent joints of metals. TIG welding is a part of welding process and it can be widely used in modern industries for joining either similar or dissimilar materials. Tungsten inert gas (TIG) welding is also called the gas tungsten arc welding (GTAW). TIG welding advantages like joining of similar and dissimilar metals at very high quality weld, low heat affected zone, absence of slag etc. Gas tungsten arc welding widely uses a nonconsumable tungsten electrode to produce the weld because it created a very high temperature to weld the metals. Weld zone is protected by a shielding gas (usually inert gas such as argon) from atmospheric air or gases and a filler material is normally used for fill the gap of metal. [12]

Suspension is the definition given to the system of springs, shock absorbers and linkages that joints a vehicle to its wheels and allows relative motion between the two. Suspension systems allow dual purpose contributing to the vehicle's road holding/handling and braking for good active safety and driving pleasure, and keeping vehicle occupants comfortable and reasonably well isolated from road noise, bumps, and vibrations, etc. If a road surface were perfectly flat and had no irregularities in it, then suspensions would not be required. But roads are far from flat, even freshly paved motorways/highways have subtle imperfections that can interact with the wheels.

It's these imperfections that apply forces to the wheels and suspension components and causes handling imbalances in compromised set ups. The MacPherson strut is a type of car Suspension system commonly used in many modern motor vehicles. This includes both front and rear suspensions, but usually located at the front of the car. The McPherson strut normally also has a steering arm built into the lower inner portion. This assembly is extremely simple and can be pre manufactured into a unit at the assembly line. [13]

With the development of robots and flexible automatic technology, all kinds of joint robots have been applied widely. Research on flexible robot, which has been a hot point of research all over the world, extends application fields of robots and makes mechanism properties of robot accord with human being. Due to the fact that flexible robots have flexible units, it is easy to produce bend deformed during movement and brings many difficulties for the dynamic model building and controlling of flexible robots. While the establishing of accurate and practical dynamic model is the premise to design the controller with high performance. Recent years many scholars all over the world study the problem of building the dynamic model of flexible robots and have gained achievements mostly in research about flexible arms, such as Low and Vidyasagar, Kan reveals the phenomenon of heat strengthen dynamics, also the documents research on flexible arms. Many researchers all over the world has done a lot of research on the mobile wheeled inverted pendulum model and the balance control technology of two wheels mobile, appeared many robots just like Quasimoro and Joe etc. For the robot, form is very agile, and this kind of robots' behavior is great similar to flying rocket and moving robot with two legs, therefore, the research on mobile robots control and theory is so active field that it has been paid attention both at home and abroad. However, there is not researching the flexible problems of two-wheeled self-balancing robots. [14]

A spring is defined as an elastic body, whose function is to distort when loaded and to recover its original shape

when the load is removed. It is an elastic object used to store mechanical energy. Springs are usually made out of spring steel. Small springs can be wound from pre-hardened stock, while larger ones are made from annealed steel and hardened after fabrication. Some non-ferrous metals are also used including phosphor bronze and titanium for parts requiring corrosion resistance and beryllium copper for springs carrying electrical current (because of its low electrical resistance). When a spring is compressed or stretched, the force it exerts is proportional to its change in length. Helical springs are simple forms of springs, commonly used for the suspension system in wheeled vehicles. Vehicle suspension system is made out of springs that have basic role in power transfer, vehicle motion and driving. Therefore, springs performance optimization plays important role in improvement of car dynamic. The automobile industry tends to improve the comfort of user and reach appropriate balance of comfort riding qualities and economy. [15] A vehicle suspension system is a linkage to allow the wheel to move relative to the body and some elastic element to support loads while allowing that motion. Most practical vehicles have some form of suspension, particularly when there are four or more wheels. The basic criterion to achieve better handling was to have camber gain in roll. In other words, as the car corners, the goal is to gain negative camber at the outer wheels and to gain positive camber at the inner wheels of the vehicle. By providing sufficient camber gain the wheels remain vertical to the ground even when the body rolls, which provides better grip while cornering. Also the roll centre of the rear suspension was kept higher than the roll centre in front to decrease oversteering of the vehicle. The roll centre has a significant impact on a suspension's steering response; moreover, there is a direct correlation between roll centre location and oversteer, understeer, or neutral steer suspension behaviour depicted. [16] A weld is defined in the Australian Standards [AS2812] as "A

joint in a material produced by means of heat or pressure or both in such a way that there is continuity in the nature of the metal between the parts. A filler metal, the melting point of which is of the same order as that of the parent metal, may or may not be used". Welding is usually the most economical way to join components in terms of material usage and fabrication costs. An alternative mechanical method of assembly requires more complex shape alterations and addition of fasteners. GMAW and GTAW Welding is one of the most widely method used for fabrication work in industries. The main concern with welding process in the past is generally concentrated with productivity and quality. [17] Wide variety of steels has been developed, amongst which, IS304 series are particularly used for general structural purposes, for sheet applications in automotive industries and in military also. In this series, IS304 being an important grade has been identified for welding. Automatic gas metal arc welding (GMAW) was used for the process of welding because of its high reliability, all position capability, ease of use, low cost and high productivity . The mixture of 80% Argon 18% Carbon Dioxide and 2% Oxygen was used as shielding gas. [18] In 1765, Leonhard Euler first laid out the mathematical foundations for the gyroscope theory in his work on the dynamics of rigid bodies. Later, Sir Isaac Newton and many other scientists developed and added new interpretations for the gyroscope phenomenon. The primary attribute of a gyroscope is a rotor that persists in maintaining its plane of rotation, creating a gyroscope effect. Gyroscope effects are used in many engineering calculations of rotating parts, and a gyroscope is the basic unit of numerous devices and instruments used in aviation, space, marine and other industries. Many publications discuss the gyroscope theory and the many approaches and mathematical solutions describing some of the new properties of gyroscopes. The most fundamental textbooks of classical mechanics have chapters representing gyroscope theory [1 - 4]. There are also many publications dedicated to theory and applications of gyroscope in

engineering [5 - 8]. A simple explanation of the gyroscope effect is the rate of change in angular momentum vector that creates the precession torque. However, practice demonstrates this approach does not give the full picture of gyroscope motions. Analyzing gyroscope properties under the action of an applied force, occasionally leads to problems that need to be solved using a clear and understandable presentation of gyroscope motions. Gyroscope theory still attracts many researchers who continue to discover new properties of gyroscopic devices [9 - 11]. There are many publications that detail results that not well-matched with analytical calculations and practice [12 - 14]. [19] GYROSCOPIC effects are relayed in many engineering calculations of rotating parts and gyroscope properties enable function the numerous gyroscope devices in aviation, space and other industries [1, 2]. There are many publications regarding the gyroscope theory as well as many approaches and mathematical solutions that describe the gyroscope properties [3, 4]. There are many valuable publications dedicated to the gyroscope effects and applications in engineering [5, 6]. All publications in the area of gyroscope theory describe gyroscope effects in terms of conservation of kinetic energy and the change in the angular momentum [7]. However, the nature of gyroscope effects is more complex and known theory and mathematical models do not match practice of gyroscope devices [8, 9]. This unaccountable situation with gyroscope effects spawned terms like gyroscope resistance, gyroscope couple and fantastic properties like non inertial, non gravitational, etc. [10, 11]. This is the reason that the gyroscope theory still attracts many researchers who continue to discover new properties among gyroscope devices. [20] Motorcycle road accidents are increasing annually. Among the efforts in overcoming this dire scenario, motorcycle simulators were developed. The Postura Motergo™ which was developed by researchers at the Motorcycle Engineering Technology Lab (METAL) is an example

of such simulators. The Postura Motergo™ has a unique capability in replicating various riding postures according to the Riding Posture Classification (RIPOC) system. However, there is the need for a novel database that gives information on the workstation design parameters of various motorcycles. Hence, a specifically built mannequin (the D5EM110N) was developed as a tool to measure various workstation dimensions on actual motorcycles. As of April 2015, the mannequin's design is being filed for an intellectual property (IP) protection. The motorcycles' design parameters which were collected via the D5EM110N mannequin was then tabulated into the Motorcycle Design Parameter Database (MDPD). The database is then could be utilized to set up the Postura Motergo™ to accurately replicate the desired motorcycle model's workstation design parameters. This is vital in ensuring that the motorcycle simulator could accurately simulate an immersive user experience to the subject in utilizing the desired motorcycle model. By having this novel database and mannequin design, researchers have greater opportunity in conducting various studies in a controlled laboratory setting with respect to motorcycle workstation designs and its possible connection with road accidents. [21] Shock Absorber is composing of mainly two parts spring and damper. Spring are helical compression spring made of Spring Steel which absorb the shock and Damper is Damp the vibration of spring. Damping Force produced by converting kinetic energy of shock into heat energy. Currently all shock absorber working in two wheeler automobile are Passive, it absorb the shock very less and directly transmit it to rider. It's very jerky drive on Bad condition road where pot holes and surface finish broken .outcome of it uncomfortable ride. Following Researcher developed certain active and semi active shock absorber concept which capacity of damp the vibration is higher comparatively passive suspension. [22] Balancing any two wheeled vehicle is always a challenging task for human and robots both form long time. Leaning a bicycle driving is long time process

and goes through building knowledge base for parameter decision making while balancing robots. To establish this machine learning phase with embedded system we are proposing the system. This proposed system aimed to make a bicycle bot, powered by an electric motor, which could balance by itself and move along a particular path. This path could be wavy with bumps and varying widths. The primary aim was to make the cycle balance on its own by controlling its handle. In order to turn, a shift in center of mass was achieved. In order to maintain its stability, the bot automatically turned the handle and thus took a turn. Speed, Steering mechanism through mass distribution (leaning), Center of mass location and Gyroscopic effect of its wheel were the main challenges faced by the team. The idea has potential applications in automated transport. Academically, the project provided a platform to integrate control system theory, visual image processing and microcontroller robot programming. [23] This paper presents a comparative study of three equivalent circuit models for lithium-ion batteries used in electric vehicles (EVs). Model parameters are all obtained by cooperative particle swarm optimization algorithm on the Dynamic Stress Test data, not the traditional hybrid pulse power characteristic (HPPC) test procedure. A 1372s Federal Urban Driving Schedule test are used to validate and compare model's performance. Compared with voltage error between simulation result and test data, it is concluded that all the three models can simulate the dynamics of battery well, while the first-order with one-state hysteresis seems to be the best choice for lithium iron phosphate battery used in electric vehicle. [24] There are various types of parallel spin axis wheeled two-wheeler vehicles. They are typically used for commuting or for pleasure. Lighter vehicles with smaller engines are usually cheaper than their heavier counterparts and is the primary means of transport in a lot of Asian countries. Nowadays maximum road accidents are of the two wheelers.

Needless to say, a lot of investment goes into manufacturing and development of state-of-the-art high technology motor bikes but none can guarantee road safety and it solely depends upon the rider and hence road accidents occur as the person riding the bike loses control over it and the bike falls. Also while learning to ride bicycles children are often afraid to ride as there is a fear of falling. To avoid such tragic scenarios, a mechanical gyroscope can be installed in the vehicles. It works on the principle of inverted pendulum and employs the use of electromechanical components which can be used as a means of transportation for a single person. The two-wheeled, self-balancing vehicle is a non-linear multivariable and naturally an unstable system. Controlling such a system is a hard task and thus it is the topic of research. It will move forward if the user tilts in forward direction and backward if the user tilts in backward direction. This paper presents a vehicle in which all components (mechanical, electrical) have been designed from ground up, produced, coupled together and tested. This vehicle can be viewed as ecological, battery operated and very easy to be used as system. [25] Regenerative brake system is generally implemented in electric bikes, electric and hybrid cars. These all are completely electrical regenerative brake systems in which driving motor of the bike/car acts as generator during braking and the captured energy is redirected to the battery for charging. Provision for electrical regenerative brake is naturally, not possible in man powered typical bicycle. Few initiatives however, taken by some other peoples to arrange the mechanical regenerative brake system for bicycle but all these are complicated and not accepted in practical field. The proposed brake system is designed for rear wheel only. Front wheel is to be equipped with conventional brake as usual. Regenerative brake mechanism is not appropriate for front brake application. [26] Every time we step on our car's brakes, we are actually wasting energy. As we know that energy can neither be created nor be

destroyed. It can be just converted from one form to another. So when our car slows down, the kinetic energy that was propelling it in the forward direction has to go somewhere. Most of it simply gets released in the form of heat and becomes useless. That energy, which could have been used to do work, is essentially wasted. The solution for this kind of this problem is Regenerative Braking System. This is a new type of braking system that can recollect much of the car's kinetic energy and convert it into electrical energy or mechanical energy. Regenerative braking is one of the emerging technologies of automotive industry which can prove to be very beneficent. Using regenerative braking system in a vehicle not only results in the recovery of the energy but it also increases the efficiency of vehicle (in case of hybrid vehicles) and saves energy, which is stored in the auxiliary battery. [27] Different brands of Electric bikes are available in the market at present. In all most all Electric bikes a rear wheel BLDC (Brushless DC) hub motor, lead acid battery pack, a light weight chassis, and a controller is placed. The Vehicle speed range from 40-60km/charge. The charging time is 6-8 hrs which is very long and lifespan of batteries is short i.e. around 2 years. Considering these limitations in this paper we are giving solutions to modify the existing design to give a better performance. Super capacitor modules help to increase the lifespan of battery. Regenerative braking or a small solar panel module could be availed onboard so as to charge battery or super capacitor. Along with the inclusion of solar panel modules and super capacitors, pedal system in electric bike also saves lot of battery power. [28] Each and every parts of a two wheeler has been designed well even though some times the braking system of a two wheelers shows poor performance. When the vehicle comes without brakes it turns the passengers into unsafe situation while riding the vehicle. So we should have a brake in our two wheelers which must deliver an optimum performance. The braking force is mainly depends on the following two factors one

is normal reaction of the rear wheels and another one is coefficient of friction between road and tyres. Whenever the vehicle is loaded the normal reaction of the rear wheels also increases. So there is only minimum braking force is requires stopping the vehicle. When the vehicle is running at high speed with fewer loads it will become out of control. If we apply brake in this condition it will make a heavy injury, because the kinetic energy of a vehicle while running stored its total mass. In this paper the inertia force which helps the vehicle while braking without any skidding. Thus the system can deliver an effective braking performance then traditional one. [29] An attempt has been made to solve the braking problem during hard braking. In case of motor bike, It has been seen that when the driver has to stop the motorbike immediately, he becomes confused which brake should applied and then he uses either front brake or rear brake or both brake and due to this an unbalanced is occur between the wheel and caused the accident. To solve this problem a single actuating braking system can be used. In this braking system, the front and rear hydraulic brake are operated by only single actuating system that is the brake pedal assembly. The purpose of the single actuating braking system is for the locking of both front and rear wheel at the same time without slipping and skidding. Since both the brake front and rear are operated by the tandem master cylinder, the pressure to the both calipers will be equal, so the both wheels can be locked and stop at the same time. The design of this braking system increases the simplicity of the actuating system. Since this braking system has only one actuating system, the overall cost is reduced. A tandem master cylinder can be used since it has two outlet valve primary and secondary which will be used for front and rear brake caliper respectively. Also the braking force, braking distance and time will be calculated during braking. [30] Welding is the process of permanent joining of similar or dissimilar metal at their contacting surfaces by application of heat and/or pressure [1], [8]. The welding came into existence from "Bronze Age" about

approximately 2000 years ago known as forge welding. Egyptian people learned to weld iron pieces together during Iron Age.[2], [4-6]. Temperature of the Welding range is in between 1800°F- 3600°F. This has been carried out by melting the work pieces at the interface and a permanent joint can be achieved after solidification.[2]. Filler material is optionally added to generate weld pool of molten material which solidifies as time passes and gives a strong bond between the materials. [4]. Plenty of ways and sources are used in welding process like a gas flame, an electric arc, a laser, an electron beam, friction, and ultrasound.[3]. It can be done in many different environments, including open air, underwater and in space. Welding can be classified in Gas welding contains Oxyacetylene Gas welding, in Arc Welding contains SMAW, GMAW, GTAW, SAW and in Energy Beam Welding contains Laser Beam Welding, Electron Beam Welding etc.[5]. Welding technology is used in every stage of production and manufacturing. To generate high quality welds consistently, arc welding requires experienced welding personnel to avoid distortion.[2]. [31] Metal Inert Gas welding as the name suggests, is a process in which the source of heat is an arc formed between a consumable metal electrode and the work piece, and the arc and the molten puddle are protected from contamination by the atmosphere (i.e. oxygen and nitrogen) with an externally supplied gaseous shield of inert gas such as argon, helium or an argon-helium mixture. No external filler metal is necessary, because the metallic electrode provides the arc as well as the filler metal. It is often referred to in abbreviated form as MIG welding. MIG is an arc welding process where in coalescence is obtained by heating the job with an electric arc produced between work piece and metal electrode feed continuously. A metal inert gas (MIG) welding process consists of heating, melting and solidification of parent metals and a filler material in localized fusion zone by a transient heat source to form a joint between the parent metals. Gas

metal arc welding is a gas shielded process that can be effectively used in all positions. [32] Recently, many investigations have been done regarding to the problems of controlling two-wheeled self-balancing robot. This paper reviewed based on five previous journal in order to find out which method is suitable to design a self-balancing bicycle and it will focus on the control system of the structure. There are several ways in order to design an efficient self-balancing bicycle which are by using control moment gyroscope (CMG), mass balancing, steering control and reaction wheel. Based on previous research, the usage of CMG is the suitable choice since it can produce large amount of torque, it has no ground reaction forces, and the system can be stable even when the bicycle is stationary. [33] This paper focuses on the concept of developing the two-wheeler car & its validation with the help of prototype. This paper deals with an experiment carried out to produce gyroscopic effect on an in-house prototype. The prototype is a two-wheel vehicle in which rotating discs imparted act as gyroscope to produce a counterbalancing force (gyroscopic effect) when the vehicle prototype loses balance on either sides. Thus the vehicle stabilizes itself. This paper also gives a brief of a concept vehicle developed on similar grounds with an added feature. Wherein even if an external force is applied to the system the force sensors deployed in it sense the force and develop a force of similar magnitude but in opposite direction due to presence of two gyroscopes used in the vehicle, thus the vehicle does not lose its balance even if the external force is applied to it. [34] One must first understand what a Hydraulic regenerative braking system is, and how it works. The basic idea of a Hydraulic regenerative braking system is that when the vehicle slows down or decelerates, it will store the kinetic energy that was originally momentum as potential energy in the form of pressure. This is done by using a displacement pump to pump hydraulic fluid into an accumulator. When the vehicle accelerates, the pressure is released from the accumulator which will spin the drive shaft and accelerate

the vehicle. Thus the engine remains idle while the pressure is released and when the accumulator is empty, or the desired speed is achieved, the engine will then engage in order to maintain a constant velocity, or to accelerate the vehicle beyond what the capacity of the accumulator was capable of.

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