Swinging Half Bike

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Abstract- *A batteryless sensorless bicycle speed recorder system with a hub dynamo that functions as both a power source and a speed sensor has been developed. The hub dynamo produces a voltage waveform with more than ten AC cycles per rotation of the bicycle wheel, which enables precise determination of speed and acceleration. The data is stored in a spin-transfer-torque magnetoresistive random-access memory (STT-MRAM) that has perpendicular magnetic tunnel junctions (MTJs) and an infinite rewriting capability.*

Keywords- Batteryless; Bicycle; Speed recorder; Hub dynamo; STT-MRAM

I. INTRODUCTION

India has great potential of wind energy, and holds 5th rank in the world in energy production from wind turbines [I]. Progress of small wind turbines (SWT) is abysmal in India though the potential is estimated to be 83,000 MW [2] which is approximately double that of potential (49, 500 MW) of large wind power in India. Still the penetration and popularity of SWTs is not seen among the wind energy producers as weIl as the wind turbine manufacturers. The resources of large wind power is limited and restricted to some defmite areas like some parts of Tamil Nadu, coastal region of Gujrat, desert region of Rajasthan, etc. because it requires higher average wind speed, but SWTs can work even at wind velocities in the range of 4-6 m/s.

In this study, a batteryless speed recorder was developed that employs a dynamo installed in the hub of a bicycle wheel and an STT-MRAM. The hub dynamo produces a voltage waveform with more than ten AC cycles per rotation of the wheel, thereby enabling precise determination of speed and acceleration. The STT-MRAM employs an intermittent write operation, which involves a high-speed writing with a small duty cycle. This makes the average power dissipation of the MRAM very small. A road test showed that a fabricated recorder mounted on a bicycle stored and reproduced accurate speed and acceleration data during rapid changes in speed

II. LITERATURE REVIEW

A two-seat electric vehicle weighing only 65 kg is possible through a unique structure consisting of a sandwich plate with the 4 wheels and a cabin similar to a safety helmet. Instead of doors the whole cabin is lifted upand swings back.Energyconsumption and battery size arereduced to a minimum. A mechanical „joystick“ is used forsteering, power control and braking.

lmportance of Sm all Wind Turbines (SWTs) for harnessing wind energy in the context of In dia is stated. Relevance of vertical axis wind turbine (V A WT) in the sm all wind is explained. In the present work, a three bladed Small Vertical Axis Wind Turbine (SV A WT) has been designed, manufactured and tested. Three NACA profile blades, namely NACA 0012, NACA 0015 and NACA 0018 were used to conduct the experiment. The blades, link rod, rotor, stator and column can be manufactured with the engineering facilities available even at sub-district (Tehsil) levels. The shaft hub assembly of the conventional system is replaced by the bicycle rear wheel hub shaft, wh ich is easily available in the market, to make it cost effective.

For writing operation, the MRAM employs an intermittent write operation, which involves high-speed writing with a duty cycle of less than 0.01%. This reduces the average power dissipation of the MRAM to that of the standby mode. A road test showed that a fabricated speed recorder mounted on a bicycle stored and reproduced accurate values of a large acceleration and its duration when the brakes were suddenly applied while the bicycle was being ridden

III. METHOD OF SENSING SPEED AND ACCELERATION WITH HUB DYNAMO

In this study, the dynamo was installed in the hub of a 24inch bicycle wheel. It generates an AC voltage waveform when the wheel turns. The measured output waveform of the dynamo for one rotation of the wheel (Fig. 1a) shows that the waveform has fifteen AC cycles with a period of 50 ms. So, the speed of the bicycle (v) is given by

$$v = 2 \pi r \, nACcycle \times TAC, \quad (1)$$

where r is the radius of the wheel, nACcycle is the number of AC cycles per rotation, and TAC is the period of a cycle. The acceleration is calculated from the difference between the current speed and the speed obtained during the previous rotation of the wheel. The graph of the period of an AC cycle and the power generated versus the translational speed of the wheel (Fig. 1b) shows that the period is inversely proportional to the speed, while the power is proportional to the square of the speed.

III. MATERIAL, MANUFACTURING AND INSTALLATION OF SV A WT EXPERIMENTAL SETUP

A. Rotor Blades There are number of options available for selection of material and manufacturing process for the rotor blades of SV A WT experimental setup. For the current setup, curry neem (Murraya Koenigii) is selected as ablade material for manufacturing. This material is very heavy in weight during its wet condition; it is normally three times heavier than when it is dry. It gets very light in weight after drying and its dry density is 463.8 kgfm3. Orying can be done in open sunny environment. Three blades of each NACA profile are manufactured from Murraya Koenigii.

B. Link Rod: Murraya Koenigii material is selected for the link rod. The link rod has enough strength to take the load and it is very light in weight. Light weight link rod contributes less in cogging torque, leading to low cut in speed.

C. Hub shafl assembly: For the present experimental setup, hub shaft assembly is readily available in the market. Bicycle rear wheel hub is taken as a hub shaft assembly. It has ball bearings at the two ends of the hub shaft assembly. The load capacity of this hub shaft assembly is quite enough to bear the load of blades at high speed. D. Concrete Base

The base of the experimental setup is chosen as concrete base. The main interest in selecting the concrete base is that, a 4 feet tall column of the building is readily available at the site. Stator and base are connected with the four iron bars each having 20 mm diameter.

IV. BATTERYLESS SPEED RECORDER SYSTEM WITH HUB DYNAMO

The batteryless sensorless bicycle speed recorder developed in this study (Fig. 3) consists of two main components: a hub dynamo and a speed recorder module containing an STTMRAM, which can continuously perform write operations. The module calculates the speed and stores it in the STT-MRAM.

Fig. 3. Photograph of batteryless sensorless speed recorder system with hub dynamo installed on bicycle. The system (Fig. 4) consists of a hub dynamo, an AC-DC converter, a pulse converter, and two digital components, namely, an MPU and an STT-MRAM. The dynamo provides both power to the digital components thorough the AC-DC converter, and also a signal to the pulse converter. The pulse converter contains a full-wave rectifier and a Schmitt-trigger inverter. It converts an AC voltage into digital pulses. The number of pulses per rotation of the wheel (N) is twice the number of AC cycles per rotation (nACcycle); and thus the period of the pulses (Tpulse) is one-half that of the AC cycles (TAC). So, the speed of the bicycle (v) is given by

$$v= 2 \pi r N\times Tpulse. \quad (2)$$

The MPU measures the period of each pulse at a sampling frequency of 5 kHz and calculates the speed from equation (2). The speed calculated from the pulse period may vary over the time interval required for N pulses because the period of the AC cycles may vary. So, a moving average is used to suppress the speed variation.

Fig. 4. Block diagram of speed recorder system. Figure 5 shows a timing chart for the calculation of the moving average, and also the time sequence for a write operation, which stores the moving average of the speed in the STT-MRAM. In this study, the moving average was calculated from fifty values of the speed over a time span of 20 ms. If there is no pulse in that time span, the value of the speed is set to the previously calculated one; and if there are two or more pulses, the last one is used. Every 100 ms, the moving average of the speed is calculated and stored in the STT-MRAM.

DESIGN AND DATA

An attempt of design of experimental setup has been made here by the past experience of researchers and industrialists of the field. For this design of rotor blades, link rod, hub shaft assembly, generator rotor, stator and base structure has been done, before manufacturing the experimental setup.

A. Link rod:

Three supporting link rods have been used to connect rotor blades to central shaft. Each link rod is 527 mm in length, 100 mm in width and 10 mm in height. This dimension is found comfortable with the other parameters. The link rod shall transmitt windforce acting on the blade as torque on the shaft.

B. Hub Shaft Assembly:

The main function of the central shaft is to transmit the torque to the rotor ofthe generator. 1) Conventional Design: For the current experimental setup a conventionally designed hub shaft assembly has been selected to compare it with new design ofhub shaft assembly. Two 6000zz roller bearings have been used.

V. SPECIFICATIONS

COLOUR

The Halfbike comes in five different color combinations. Black (all black), White (white frame and natural color handlebar), Pink (pink frame and black handlebar), Lime (green frame and black handlebar) and Mint (blue frame and black handlebar)

SIZE

Three sizes are available. Depending on the rider's height we recommend: Size S - for people from 150 to 170 cm tall Size M - for people from 170 to 185 cm tall Size L - for people from 185 to 195 cm tall The maximum weight of the rider is 95kg/210lbs. Please note that a Halfbike with a longer handlebar may feel slightly easier to ride while you're learning. However this will be an advantage only in the first few days. Once you have more practice it will be easier to ride the smaller size especially on longer distances. Therefore if someone is in between two sizes we'd recommend the smaller one.

FRAME

The frame is laser cut and made of aerospace grade aluminum. This makes it light and yet strong enough to endure years of riding. Once we have the frames ready we send them to a paint shop where they're powder coated. The paints that we use are from the automobile industry so durability is guaranteed.

TRUCK

We went to great lengths to design and test one that fits the Halfbike like a glove. At first we used a standard mountainboard truck for the job but despite choosing one of the best trucks available on the market its limitations soon became obvious. So now we have one of our own design that functions much better and has an integrated brake system.

HANDLEBAR

We use good quality water resistant beech plywood for the handlebar. It's lighter compared to aluminum plus it gives a nice flex to the handlebar that in our opinion improves the ride. We've also developed a special technology to impregnate all plywood pieces to ensure they stay intact rain or shine.

GEARS

Hub with three internal gears by Sturmey Archer - a prime European manufacturer with over a century of experience in making internal gear hubs. We're confident that this is one of the best hubs on the market and will endure years of use with practically no maintenance whatsoever.

CRANK SET AND PEDAL

The crank is made of aluminum, has a hollow axle and is used primarily for downhill bikes. In combination with high end pedals and a custom bottom bracket that we've developed to meet the greater stress endured by a Halfbike makes for a rigid and reliable system.

TIRES

Both tires and tubes are supplied by Schwalbe - yet another well renowned European manufactur

WORKING

Do you remember what it felt like the first time you rode a bicycle? All the excitement from trying something new? Learning how to ride a Halfbike from scratch and improving your skills would certainly be an amazing new experience! We recommend that you find an empty open space with a smooth pavement. Having a little patience and determination will surely help as well. Learning to ride a Halfbike from scratch takes time and practice so don't expect to just pop on and cruise away. Imagine learning to ride a bicycle for the first time. Most people are able to get the basics and ride in a straight line in under 10-15 minutes. All starts with feeling the ride and finding your balance. From then on riding will gradually start to feel less of a struggle and more fun. Have in mind that it's more challenging than it may seem from the videos. However it only takes a few days of practice for most people to be able to ride with such an ease.

Your first goal is to ride in a straight line, so don't try to turn at the beginning. It's not as easy as it may seem. Try to relax and find your balance. The handlebar will help you balance but keep in mind that it takes very little effort to do so. Be gentle with it! Your arms need to be totally relaxed. Putting too much force on the handlebar won't improve your balance and usually means you're doing it wrong.

Turning the Halfbike works by shifting your weight to either direction. A gentle push on the handlebar is all that it takes to start moving in the desired direction. Don't try to turn or twist the handlebar either as this won't help you steer unlike on a bicycle. Always move the handlebar sideways instead.

If you feel like you are losing your balance, just let go of the Halfbike and try to step to the side. You'll probably find jumping off quite easy and intuitive, as if you are just continuing to walk or run. Attempting to remain on the Halfbike until the last moment rather than just jumping off may result in a fall. Be cautious for your own safety and the safety of those around you. Learning takes time and practice. Be patient and don't get disappointed if you don't master it overnight. Riding safely should always come first.

If you feel that the handlebar of your Halfbike tends to keep to one side while riding on a flat surface then you probably need a tune up. You can easily fix this problem if you follow the steps in the video below. This will attribute to a far better Halfbike experience. Note that this tutorial only concerns a handlebar that keeps off-center while you ride on flat ground. The Halfbike is sensitive to cross slopes. So it's normal if the handlebar is not perfectly centered if you ride on banked road or other tilted surfaces.

Before you begin have in mind that it's not particularly difficult to repair a flat tire on a Halfbike. However there are a few steps that require extra caution and you'd like to get those right. So please pay attention to the original position of all components when you disassemble the Halfbike. You'd like to return them to exactly the same configuration to ensure that your Halfbike is properly assembled and tuned.

VI. CONCLUSION

The rising cost of energy and global warming will force road vehicles to become much lighter and more energy efficient in the future. At the same time the limited road space in densely populated Asian cities requires vehicles that are as compact as possible. A unique two seat vehicle with four wheels that needs no more road space than two bicycles and weighs no more than two electric bicycles is presented. Its structure consists of a sadwich plate and a foam cabin with the function of a safety helmet, which is lifted up for access. Steering is with a mechanical joystick, equipped with a sliding sleeve for power control and a brake lever.

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