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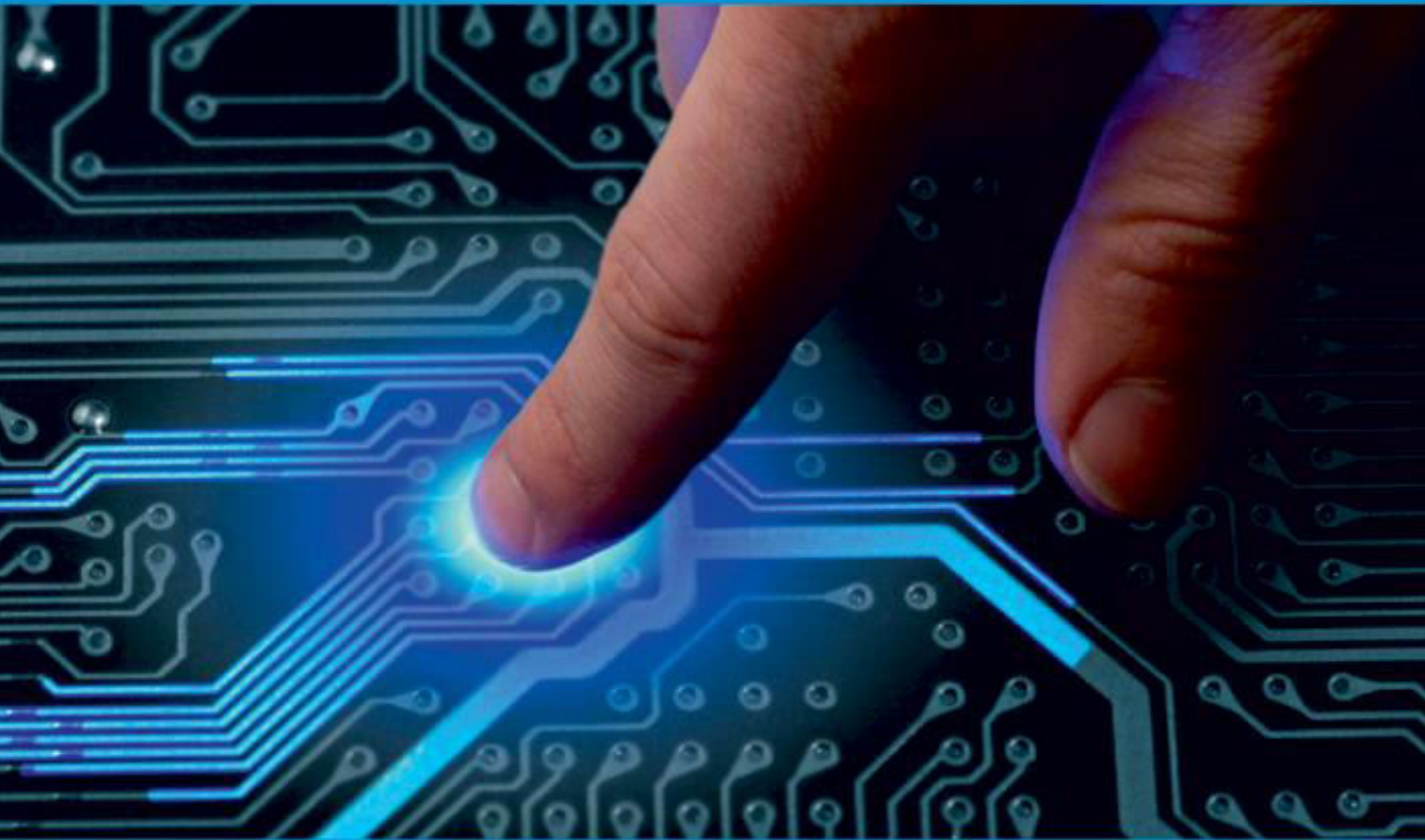

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Speed Control of Electrical Bike Using Embedded System

Dr. KATHIRVEL.R, HARIPRIYA.N, KOWSALYA. A, ANANTHI. A, GOWSALYA.P

Professor, Department of ECE, Mahendra Engineering College, Namakkal, India

Department of ECE, Mahendra Engineering College, Namakkal, India

ABSTRACT: Speed control is not a prevalent feature found in electric bicycles. Many electric bicycles implement a pseudo speed controller that does not include feedback based on sensing speed. As with automobiles, speed control can be desirable for driver comfort and safety. Additionally, accurate speed control is also very helpful when validating dynamic models of single-track vehicles, which is our motivation. This paper describes a low cost feedback speed controller for an instrumented electric bicycle. To achieve this, we used grey box system identification to fit a second order linear model of the longitudinal dynamics of the bicycle to a measured step time response. The resulting fitted plant model was used to design a robust PID controller. We implemented the controller with a custom Arduino-based microcontroller. The resulting implementation was able to maintain the interquartile range of measured speeds at steady state within ±0.1m/s of a desired setpoint speed.

I. INTRODUCTION

A bicycle is common man's vehicle. Irrespective of the age, people love to ride it. But it is mainly used for joy riding nowadays. It is primarily because of the fatigue that is caused by pedalling the bicycle. Nowadays people don't develop enough stamina to ride bicycle for long distances. They want the machine to take the control whenever they want to. At this context, the electric bicycle come into a great help. The fundamental motivation for the electric bicycle is to deal with the issues of pollution and those related with human nature of seeking comfort. Another purpose is about making a comfortable journey more economical. The electric bicycle is a battery-operated vehicle that is exceptionally affordable, with low upkeep cost and absolutely zero contamination. Ebicycles are an alluring option in contrast to ordinary bikes, giving a naturally benevolent, fun, productive and advantageous approach to travel. In future E-bicycle will be the best-specialized application as an answer for the mobility issues, creating a better world for upcoming age.

Fig 1: The retrofitted motorbike with the battery and BLDC motor

Our electric vehicle can switch between the pedalling mode and the battery mode according to the rider's convenience. When the rider gets tired of pedalling, the operation can be shifted to the battery mode, with the help of a switch. The battery powered electric motor takes the control after that. When the bicycle is operated in the battery mode, the speed can be controlled by the rider. The state of charge of the battery is continuously monitored and displayed so that the rider can get the information about the balance charge in the battery and can plan for a recharge according to the nature of the drive. When the bicycle is running in battery, the speed is continuously monitored and displayed. The continuous

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monitoring, controlling and displaying of the speed and battery level help the rider to plan and enjoy his ride in a better way.

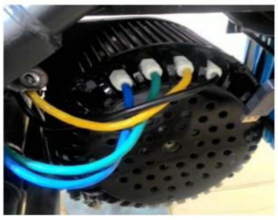

Fig 2: for 5kW BLDC 48V motor

The speed controlling is carried out with IC 555 timer as the main component, it is used to create time delays and pulses in digital form. The throttle is connected to the 6th pin which is the threshold pin, this pin sets the threshold for the motor which in turn controls the speed of the motor. The IC is called 555 timer because the resistors used in the internal circuit of the IC are each 5k ohms. The capacitor of range 1000uf is connected across pins 1 and 2, the pin 1 is termed as ground pin and the voltages are measured with respect to this pin. The pin 2 is termed as trigger pin which is used to feed the trigger input, it is an inverting input of a comparator which is responsible for the transition of flip flop from set to reset. The 3rd pin is the output of the timer, here the output is connected between pin 3 and pin 8 which is the VCC this connection is known as normally on-load connection. This output pin produces digital output in the form of 0’s and 1’s this circuit is then connected to MOSFET Z44. The motor is connected across MOSFET and schottky diode. Thus, the speed is controlled.

II. BACKGROUND WORK

In prior work, a theoretical model of a bicycle-rider control system was developed based on previous pilot modeling efforts [1]. This model includes a Handling Quality Metric (HQM) that, based on physical parameters and speed of the bicycle, predicts the handling quality of the bicycle. The quantification of bicycle handling based on its geometry can enable designers to create safer bicycles potentially reducing bicycle related accidents. This predictor relies on the Whipple-Carvallo bicycle dynamics model [2] that is linearized about specific operating speeds. It is also well known that the dynamics [2] and handling [1] are very sensitive to speed, especially when the speed is low.

This handling prediction model carries the assumption that longitudinal speed does not vary during lateral maneuvers, thus it is helpful if the speed of an actual bicycle can be both accurate and precise (non-varying). Figure 1 shows attempts at maintaining 2.2 m/s with a factory electric bicycle pseudo speed controller, which we call “throttle lock” , during six short runs from a set of experiments on level ground in which the rider rides the bicycle as slowly as they can over a marked line [3]. At these low speeds, inaccuracy of hitting the 2.2 m/s mark and the variation in speed on reasonably flat ground is too high for model validation purposes. Uneven surfaces, wind, larger lateral maneuvers, and variations in rolling resistance all exacerbate this error further.

Road accidents have earned India a dubious distinction. With over 130,000 deaths annually, the country has overtaken China and now has the worst road traffic accident rate worldwide [1]. This has been revealed by the World Health Organization (WHO) in its first ever Global Status Report on Road Safety. The report pointed to speeding, drunk driving and less use of helmets, seat belts and child restraints in vehicles as the main contributing factors. The total number of deaths every year due to road accidents has now passed the 135,000 mark, according to the latest report of National Crime Records Bureau or NCRB. The NCRB report further states that drunken driving was a major factor of road accidents and mostly they are due to bike accidents .It's growing day by day because liquor is a state subject and its happening everywhere in the country, The time for action is now: Road deaths increased by nearly 40 percent between 2003 and 2008 in India and the more progressive and developed states like Andhra Pradesh, Maharashtra and Tamil Nadu are the ones most affect [1].

To prevent or to reduce these road accidents we introduce the SMART BIKE. At the present scenario, we know that motorcyclists are at high risk in traffic crashes. Our project SMART BIKE aims to increase the rate of road safety among motorcyclists and to reduce the increasing number of fatal road accidents over the years. It also reduces the road accidents caused due to alcohol consumption. The motorcyclist cannot start the vehicle unless he wears the smart helmet. Alcohol sensor senses if the driver has drunk. The ignition turns on only when alcohol test is negative and helmet sensor result is positive. There will be two sections, one will be in helmet and the other one is in vehicle. Both

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these sections communicate by means of a wireless technology, ZIGBEE. Also when an accident occurs, the information will be passed to concerning officials and individuals through mobile sms.

III. METHODS

The proposed system is designed for the complete safety to the rider and for the bike to avoid the bike accidents and bike theft. This system based on the combined work of Arduino Controllers and Biometric system. This system is used to overcome the disadvantages of the existed systems. Security in today's world has become more advanced because of technology. In preventing theftsfor instance, there are different kinds of authentication that are used to increase security features in different kinds of devices such as fingerprint, retinal, iris and face recognition. Among the types of security features mentioned, face recognition is one of the most sophisticated and secured. By using this device, the authorized person, X and Y persons (friends, relatives and neighbors).

Fig 3: complete set up for speed control using BLDC motor

So, that it avoids the theft possibility and useful for emergency purposes too. It also has the unlock system provided in built of the bike for the use of emergency time. The speed control is made by the Arduino controller connected with the BLUETOOTH module by using the mobile app. The main notice is that the bike can run only by fixed range of speed. The bike speed can be control by using the Bluetooth which has the options to fix the speed ranges. The maximum speed can be fixed in the program used for ARDUINO and it makes the bike to run at that particular speed. The rider cannot ride over that speed, if he rides, then the bike get slowdown automatically by the control of ARDUINO. From the above proposed system, there will not have any demerits and it is very useful for nowadays bike protection. This system plays a vital role in protecting the bike and the rider without harming others.
The methodology used in this paper is the experimental method. The data collection carried out by systematically recording the results of the influence of relationships and differences in the changes that have been investigated. In taking the technical data used is a trial error technique and look for the optimal motor rpm that will be used to solve the problem.

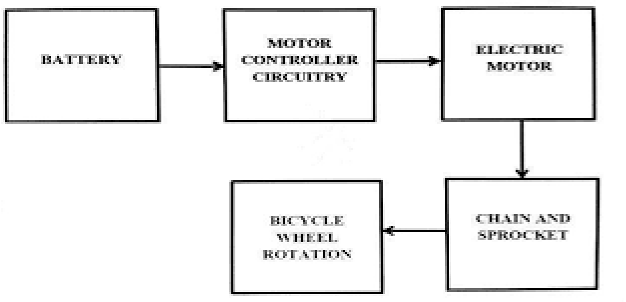

Fig 4: Design of Electric Bicycle

Arduino's analog inputs can be used to measure DC voltage between 0 and 5V (when using the standard 5V analog reference voltage) and this range can be increased by using two resistors to create a voltage divider. The voltage divider decreases the voltage being measured to within the range of the Arduino analog inputs. Nowadays, the bikes are widely used by everyone in the fast moving world. But, they are not drive with safety precautions. Hence, we have made

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biometric system i.e., face recognition system to avoid the theft cases. By using this system, everyone has separate face authentication to ignite their bike engine. Along with this, we provided the password method to overcome the drawback of this system. Next, we introduced the speed controller device which is already programmed to run the bike at a particular speed. The motor gets connected to the accelerator of the bike to control the over acceleration. If the bike gets over speed, it will be gets slowdown automatically. Thus, we can avoid the bike theft and also control the bike speed.

The Ziegler-Nichols method is more robust because it does not require a specific process model. In order to tune a controller using the Ziegler-Nichols method the Integral element of the PI controller are ignored. The Proportional element is used to find a Kc that will sustain oscillation. This value is considered the ultimate gain Kcu. The period of oscillation is the ultimate period Pu. This Ziegler-Nichols method consists of two steps which are determination of the dynamic characteristics of the control loop and estimation of the controller tuning parameters that produce a desired response for the dynamic characteristic from the first step [9]. Consequently, the application of set-point weighting and the modification of the tuning formula can be based simply on the knowledge of the normalised gain [10]. Ziegler-Nichols method are designed to give an amplitude ratio between subsequent oscillations

IV. RESULT ANALYSIS

The derived PID controller was implemented digitally on an Arduino Nano microcontroller integrated into the powertrain of an instrumented electric bicycle. The electric bicycle (Figure 5) consists of a steel frame Surly 1x1 converted to an electric drive using an Amped Electric Bicycle conversion kit. The kit consists of a brushless direct drive hub motor driven by a motor controller and a 36V Lithium-ion battery. The input to the motor controller is a Hall effect sensor-based thumb throttle.
We place an Arduino in line with the voltage signal coming from the Hall effect sensor in the throttle to allow the control system to take over the throttle from the human rider and modulate it to maintain a desired speed. The current speed is measured by a simple generator based speed sensor at the rear wheel and is fed back into the microcontroller. The schematic in Figure 6 shows a detailed view of how the microcontroller is integrated into the existing electronics platform.

Fig 5: speed control

The software on the Arduino implements the control architecture shown in and operates the LCD display and push button array that allows the user to both operate and monitor the status of the speed control. To engage the cruise control, the user simply presses both push buttons at the same time. The Arduino then takes the current speed and sets that at the desired speed which the user can adjust up or down by pressing the pushbuttons. When the cruise control is engaged, the LCD displays for the user both the current and desired speed. To disengage the cruise control, the user simply needs to press the throttle.

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In a previous study, Huda designed an e-Bike using a DC motor with a 350Watt voltage of 36V, a battery that used a type of Lithium 36V12Ah but braking was done mechanically so that the efficiency of energy usage became less [4]. Whereas Rachmadi controls the motor on the e-Bike by using Fuzzy logic has been able to be used to set the motor at a speed of 200RPM [5]. Langford states that e-Bike needs to be limited in speed to maintain the safety of the rider [6]. Whereas Salmeron's research which states that e-Bike designs that are more like traditional bicycles are more attractive to users are used as a foundation to use bicycles that are available in the market as the main material of design [7]. This paper will discuss the design analysis and testing of dc motor speed control for accelerating electric bike using the PI Method.

V. CONCLUSION

The aim of this paper is to minimize the risk of accident and if any accident happens then this intelligence system take corresponding steps. This system follow some steps before the rider start his journey. Initially the system inside the bike check whether the rider placed helmet on his head or not, if he had placed helmet then the system checks for the presence of alcohol presence in the drivers exhaling air[6]. If both conditions are met then only the bike will start. While riding, the system continuously records the speed of the vehicle and this recorded value [3], is accessible through the serial port of the system which can be useful for the police men to identify whether the vehicle had violated the rules or not. If any accident occurs then the intelligence system sends the location details to the nearby police station as well as nearby hospital for the emergency service. Along with this, the system also sends a message about the incident to pre-defined mobile number as well.

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