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Personal Utility Vehicle Using Arduino

Rahul Kashyap[1], Rohit Kashyap[2]
Computer Engineering, K. J. Somaiya College of Engineering, Mumbai, India[1]
Electronics Engineering, Vivekanand Education Society's Institute of Technology, Mumbai, India[2]
rahul.kashyap@somaiya.edu[1], rohit.kashyap@ves.ac.in[2]

Abstract: Skateboards are annulled in our daily lives especially in India because of many reasons. This personal utility vehicle, made out of a skateboard, is designed to understate the efforts of propelling while using a skateboard. A force sensitive resistor is placed on the top of the skateboard. It measures the force applied by the user on the skateboard and puts the skateboard into motion. The motive is to introduce a product that inevitably fits in the range of a bicycle and a Segway with much more portability and cheaper price.

Keywords: Skateboard, force sensitive resistor, Arduino, belt drive.

I. INTRODUCTION

The pleasure of semblance the speed, the aura of air and running ubiquitously around is something that all of us love doing; it reminds us of our tender age. We all must have given skating a chance or must have thought of it and maybe avoided it with the fear of being injured or assume it to be tedious.

How about getting back to your tender age and enjoying to skate without any fear of injuries. Our project aids all the propelling efforts required in skateboarding. This personal utility vehicle mentioned is essentially a *Programmed Electronic Skateboard*. The objective of making an electronic skateboard is to bring really great design and capabilities to something that wouldn't cost much and can be easily used in our day to day life. Figure 1 shows the use of personal utility vehicle in a lounge.

Figure 1: Demonstration.

The primary motive of making an electronic skateboard is because they are currently not renowned as well as not manufactured in India. Also, importing the spares to make one may result in high expenditure or even if a common man thinks to buy one he would prefer a two wheeler instead because of its cost.

A. *Existing System*

Existing skateboards require the following:

1. Propelling

A skateboard is propelled by pushing with one foot while other remains on the board. Propelling is a skating term used to define the efforts required to move a skateboard ahead [1]. Propelling is tiring and is a hinder for users to use a skateboard as a conveyance.

2. Turning

Whenever a person riding a skateboard wants to take a turn, the person depending on the stance and the turn to be taken (right/left) has to shift the body weight forward or backwards from the ankle. The amount of pressure applied depends on the amount of turn required and the rigidness of the skateboard's trucks [1]. This at times is inconvenient and can lead to great falls causing serious injuries.

3. Balancing

The foremost thing to do on a skateboard is not how to roll. It's how to keep your balance. Balancing on a moving wagon is very important and is a must for moving in desired direction [2]. To use the skateboard efficiently, one needs to get used to standing on it.

B. *Drawbacks of the existing system*

Skateboarding requires a lot of propelling efforts that's one of the reasons why they aren't used in our day to day lives. It is unsafe and accident prone with no safety precautions except for the wearable's like helmets, elbow and knee pads, etc. Also, to travel a mediocre distance a good amount of stamina is required to complete the journey. The cost of existing electrical skateboards are not acceptable as per the Indian market.

II. PROPOSED SYSTEM

This personal utility vehicle can be easily distinguished from the electrical skateboards available around the globe. Those available have substantially higher costs. Figure 2 shows the price comparison of various electric skateboards. However, the sole purpose of the personal utility vehicle proposed is to be such that it can be easily prototyped by hobbyists around the globe, is cheap and easily affordable.

The efforts in propelling are eliminated with the force sensitive resistor mounted in the top of the skateboard. The force

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applied on the sensor is measured and is effectively used for accelerating the skateboard.

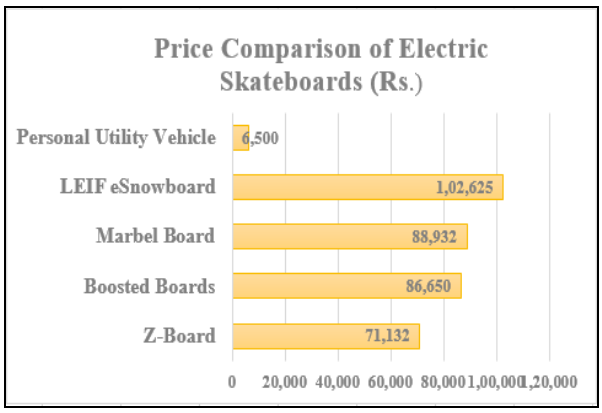

Figure 2: Price comparison of electric skateboards [3]

The objectives to make it cheaper so that it can be easily available to the masses & elimination of propelling efforts are achieved while the design to make it adaptable to the condition of Indian roads still needs a lot of considerations. Figure 3 shows the block diagram of the personal utility vehicle.

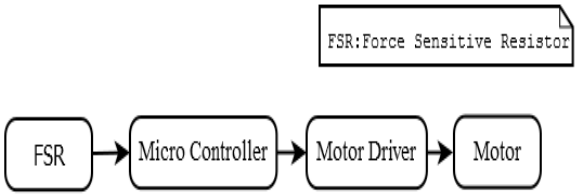

Figure 3: Block diagram

A. Hardware of the Skateboard

1. Arduino Mega 2560

In an attempt to make the vehicle's design simple so that it can be easily redesigned & replicated by hobbyists, the need was to have a microcontroller that is easy to understand and readily available. The Arduino microcontroller boards are one of the most famous boards in today's DIY world because of its open source background and the ease it adds to prototyping [5].

In this design, an Arduino Mega 2560 board as shown in figure 4 has been used as it has plenty of analog and digital pins (16 and 54 respectively) with which any number of desired interfacing devices can be added without much discussion of the availability of pins.

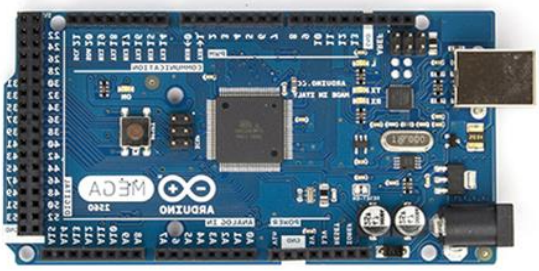

Figure 2: Arduino Mega 2560

2. Force Sensitive Resistor (FSR)

A sensor/device was needed that could be employed to accelerate the skateboard so that the propelling efforts can be eliminated. A FSR as shown in figure 5 is typically a sensor whose resistance varies in proportion with the amount of force applied on its surface. Its typical features that were beneficial for this prototype were the ease with which it can be interfaced to the Arduino, its cost and reliability. The FSR is connected in series with a fixed resistor to a 5V supply. The node common to the FSR and the fixed resistor is connected to the analog pin of the Arduino.

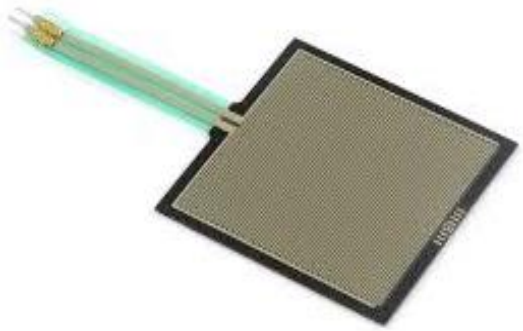

Figure 3: Force Sensing Resistor

3. High Torque Motors

The actuators used to drive the skateboard are side shaft dc motors. The requirement of the actuators was that it should be able to drive the personal utility vehicle when a person is standing on the skateboard and run on a good and acceptable speed. To achieve this, the motors used as shown in figure 6 are 12 V rated DC motors with rated torque of 50 kg-cm. With two such motors, this prototype could easily handle any human of weight close to 100 kg.

Figure 6: High torque DC motors.

4. Dual Channel DC Motor Driver

Motor drivers are devices that are used to connect the motors to a microcontroller to control the operation of the motors. A single channel motor driver is essentially a H-Bridge configuration of transistors or mosfets depending on the current requirements and applications. In this design, as the skateboard had to lift a human, the current requirement of the motors were bound to be high. Also, speed control was another prerequisite. All of these requirements were fulfilled by the Robokits Dual Channel DC Motor Driver shown in figure 7. Its specifications

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were 18V, 20A [4]. It is comparatively cheaper and can be easily interfaced and programmed with any microcontroller.

Figure 7: Robokits motor driver.

5. Lead Acid Battery

The need was to have a source with high capacity for longer durability, small size, light weight, small charging time and cheap. A lead acid battery of 12V 12Ah rating as shown in figure 8 was employed for this purpose. It has a good capacity and is cheap. However, it is very big in size and bulky. In the prototype, it is mounted on the top of the skateboard. It powers the Arduino board, the motor driver module and the additional control circuitry.

Figure 8: 12V, 12Ah Lead acid battery.

6. Control Circuit

The source i.e. the lead acid battery in possession was of 12V. The Arduino requires an input voltage of 7-12V for its operation. The other circuit components like the force sensitive resistor voltage divider network and a fan that were connected required 5V and 9V respectively.

The motor driver module didn't include a reverse voltage protection so if the supply was connected in opposite directions then it would damage the entire circuit board and the motor driver.

To protect the circuit from getting damaged a diode (MURB1620CTT4G) was connected in series with the supply. The supply to the motor driver, the Arduino, DC fan and other circuit components was designed in the form of a control circuit as shown in the figure 9. Figure 10 shows the photograph of the circuit mounted under the skateboard in a plastic casing.

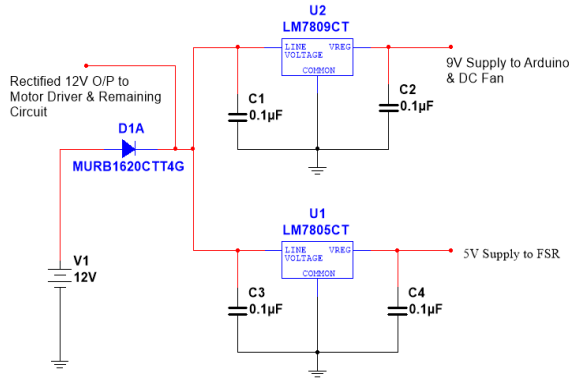

Figure 9: Control circuit schematic

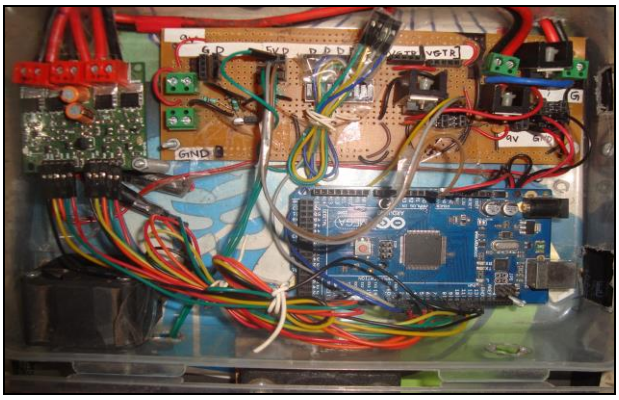

Figure 10: Circuit mounted underneath the board.

7. Belt Drive

A mechanism was needed to couple the shaft of the motors to the rear wheels of the skateboard. Chain-sprockets, belt-pulleys are a few mechanisms that could be used for the purpose. In experimentation, the belt pulley mechanism was found to be much more stable in comparison to chain sprocket mechanism and thus in the final prototype, the belt-pulley mechanism was implemented. With suitable size ratios of the pulleys, they were fitted on the shaft of the motors and the rear wheels of the skateboard. These were coupled by an A-section belt as shown in figure 11.

Figure 11: Belt drive

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B. Software's Used

1. *Arduino IDE* – To interface with Arduino Mega 2560 board.

III. WORKING

The aim was to make a prototype that is portable, can be used for a long time and doesn't require propelling efforts. The end product as shown in figure 13 works in such a way that whenever the user places his foot over the force sensing resistor, the skateboard moves. The speed at which it moves depends on the force applied by the user on the force sensitive resistor. The Arduino board measures the variations in the resistance of the force sensitive resistor and maps it into equivalent PWM signals to control the speed of the motors with the help of the motor driver. Figure 12 shows a flow chart representation of the working of the skateboard.

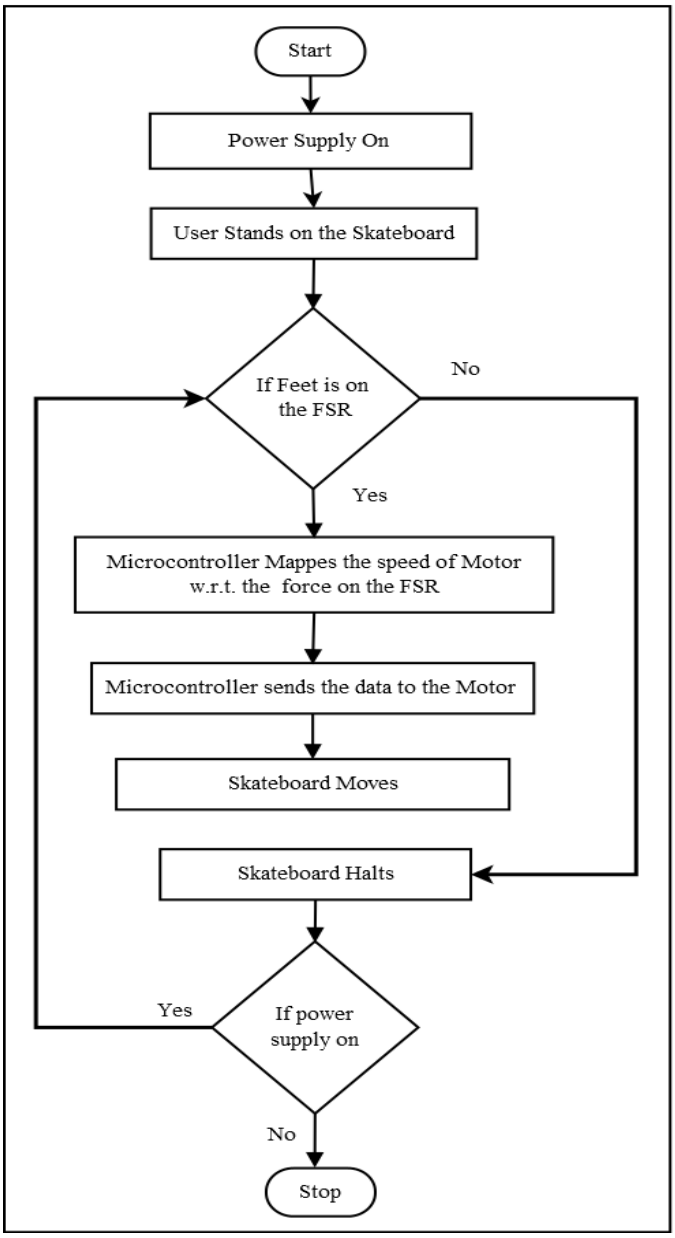

Figure 12: Flow Chart.

IV. ADVANTAGES

- The design requirements of the personal utility vehicle were fulfilled in the final design to the fullest.
- With this, it eventually falls under the category of battery operated vehicles with a speed of 6 km/hr. Therefore, if used it can result in saving fuel.
- It is portable and handy and saves time required for searching private vehicles to travel short distances.
- It makes skateboarding possible without learning it and at zero efforts.
- It is the cheapest available electronic skateboard as compared to other electric skateboards or Board of Awesomeness available around the globe.
- It can easily adopt to any environment.
- It can be easily replicated by hobbyists; prerequisite is Embedded System Programming and basic knowledge of the electronic components.

V. LIMITATIONS

- Owing to the limitations of cost and various other parameters, the speed achieved is unsatisfactory.
- At present the skateboard can last for a maximum duration of 3 hours when tried on full speed. For longer durations the requirement of highly durable battery still persists.
- It can be efficiently used only on plain terrains. It cannot be used on slopes due to poor road clearance.
- Also, there is no provisions for turning, the user still has to rely on his skills to turn the board.
- Owing to the weight of the lead acid battery (3 Kg), the skateboard is very bulky. Also, it is placed on the top of the skateboard, which restricts the freedom available to the user.
- The DC motors used have a very noisy operation. The entire circuit is enclosed in a plastic case underneath the skateboard.
- Also the size of the motors mounted underneath is very big. It gives the vehicle a very poor road clearance.
- Therefore, the present design needs a lot of design considerations.

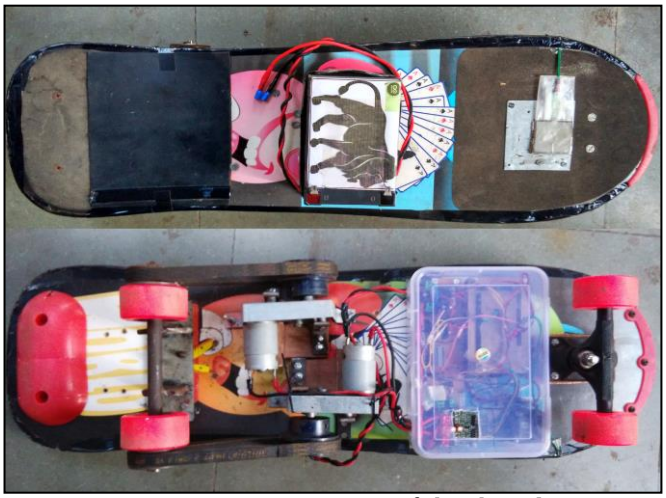

Figure 13: Various views of skateboard.

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Figure 14: The complete Personal Utility Vehicle.

VI. TROUBLESHOOTING

- The drawbacks of the source can be fulfilled with the used of lithium-ion or lithium polymer batteries with similar capacity of the battery used at present.
- The advantage in using these batteries would be that for the same capacity, its size and weight are considerably very less.
- Also the charging time of these batteries is very less as compared to lead acid batteries. Therefore, it can be easily mounted underneath the skateboard without affecting the road clearance.
- The brushed DC motors can be replaced with brushless motors with much higher ratings, less noisy operation and smaller sizes.
- The circuit enclosed in the plastic case is divided into discrete elements. With design methods like VLSI it can be easily fabricated in very small sizes. This overall will provide a very good road clearance.

Table 1: Expenses

Sr. No.	Component	Price (Rs.)
1.	Arduino Mega	800
2.	Old Skateboard	300
3.	Force Sensitive Resistor	800
4.	Robokits Motor Driver	700
5.	Motors	2200
6.	Drive Mechanism Components	300
7.	Circuit Components	300
8.	Other accessories	100
9.	Machine Work	1000
	Total	6500

VII. APPLICATIONS

- Such personal utility vehicles can be used within the college campus; in educational institutes that are spread over acres of land making the travelling between departments or various buildings easier.
- It can also be used in smart cities, industries, IT parks, in various plants or departments that are at remote corners.
- This portable vehicle can be used to travel distances ranging from 1 – 5 kilometres.
- It can also be used on skywalks and malls that adhere to its requirement of plain terrains.

VIII. CONCLUSION

An end product with the aim reducing the propelling efforts in skateboarding was designed. It can be effectively used as a personal utility vehicle in day-to-day life. In an effort to make it open source and easily reproducible, open source tools were exploited to the maximum. Owing to the existing flaws, the design still need a lot of improvements before being manufactured as a competent product.

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BIOGRAPHY

Rahul Kashyap is currently pursuing his B.Tech. in Computer Engineering at K. J. Somaiya College of Engineering, Mumbai, India. His research interests include Robotics, Image Processing, Artificial Intelligence and Embedded Systems.

Rohit Kashyap is currently pursuing his B.E. in Electronics Engineering at Vivekanand Education Society's Institute of Technology, Mumbai, India. His research interests include Embedded Systems, Robotics and Image Processing.