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Cost Effective Way to Control the Speed and Direction of Dc Motor for Driving the Conveyor

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Abstract

conveyor system is widely used in industries which make work easier and faster. Controlling conveyor is an important and essential task. This paper suggest the prototype design of controlling the conveyor as mostly conveyors are running through DC motor and the most appropriate technique to control DC motor is through PWM. Many controllers have built-in PWM feature which is very helpful and user friendly to use. In this paper simulation and experimental work is used to demonstrate the DC motor controlling through arduino Uno (atmega 328) and it also includes the comparison with published results.

Keywords: PWM; DC motors; H-bridge; Conveyor; Arduino Uno (Atmega 328).

1. Introduction

DC motor which is widely used to drive conveyor belt because of its characteristic DC Motor are used in various applications such as robotics, electric vehicles, steel rolling mills and etc [1]. Controlling conveyor is an important task in any industry because now a days majority of work in done with the help of conveyor system. The most appropriate method to control the rpm of the conveyor belt (Dc motor) is through PWM under which the speed of motor varies depending on the variation in duty cycle [2]. And the second most important thing in controlling conveyor belt is to control its direction which is done through H-bridge. Many work in done to control DC motor through different microcontrollers [3,4]. The purpose to use microcontroller is to makethings easier as microcontroller have built-in PWM function so it saves the cost to build any other addition circuit for PWM . This paper proposed the method to control the DC motor presented in 2015 which includes unnecessary component which made circuit slightly costly [5].

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This paper shows the simulated and experimental result and comparison with published result [5].

2. Materials and Methods

2.1. Speed controlling of dc motor using PWM

PWM is used to control the speed of conveyor (DC motor). It is the simple relation between t_{ON} and t_{OFF} which generates square wave through switching , this switching pattern makes voltages full ON (5 volt) and full OFF (0 volt) to achieve the required rpm of the motor switching can be varies by changing the t_{ON} and t_{OFF} .

Formula to derive the duty cycle:-

$$\text{DUTY CYLE} = \frac{t_{ON}}{t_{ON}+t_{OFF}} \; x \; 100 \qquad (I)$$

Suppose:

If t_{ON} = 2 ms & t_{OFF}= 2 ms

$$\text{DUTY CYLE} = \frac{2*10^{-3}}{2x10^{-3} \; x \; 2x10^{-3}} \; x \; 100 = 50\%$$

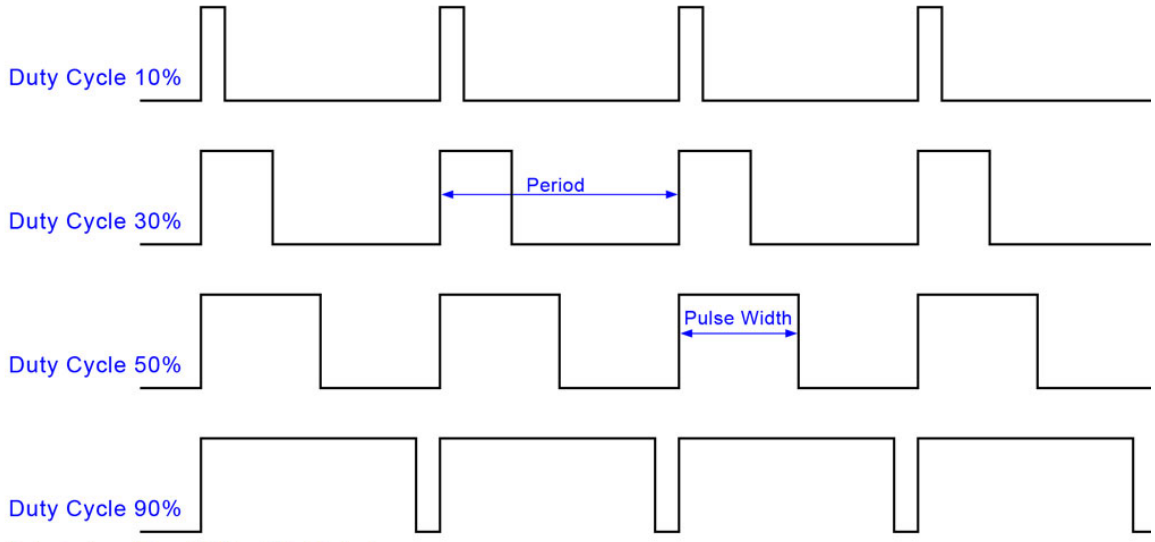

Figure 1: Graph of different Duty Cycle

Above figure 1 shows that as duty cycle increase t_{ON} also increases and t_{OFF} decreases and amplitude remain same.

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2.2. Direction controlling using h-bridge

TO change the direction of the DC motor h-bridge is generally used based on transistor, Mosfet , IGBT and many other switching device. As DC motor change its direct when the polarity is revert. It consist of four switching element and to change the direction, two switches put open and two switch put close depending on the condition required. To make DC motor rotate forward in fig 2A [6], switch S2 and S3 are switched ON (S1 and S4 are switched off) so motor is start rotating clockwise and when S1 and S4 are switched ON (and S2 and S3 are switched OFF) which make polarity reverse and make motor rotate anti-clockwise.

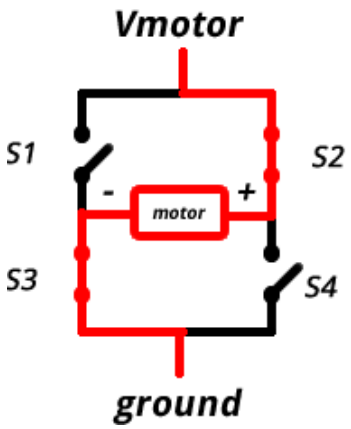


Figure 2A: Forward Direction

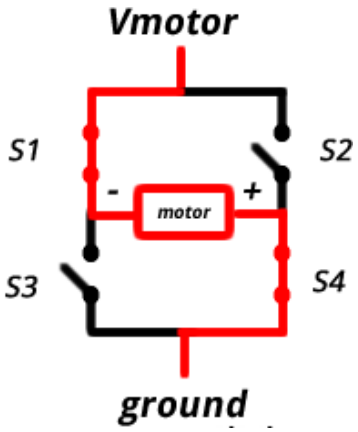


Figure 2B: Reverse Direction

Table 1: H-Bridge working

S1	S2	S3	S4	Motor Rotation
1	0	0	1	Anti-clockwise
0	1	1	0	clockwise
0	0	0	0	Motor Free Runs
1	1	0	0	Motor Stops
0	0	1	1	Motor Stops

2.3. Suggested design

Arduino Uno is used to operate the controlling of DC motor so that conveyor belt can run according to user need and requirement, as arduino can generate PWM signal which will be helpful to control the speed of conveyor belt, this signal will transmit to H-bridge which will make motor rotate according to user need.

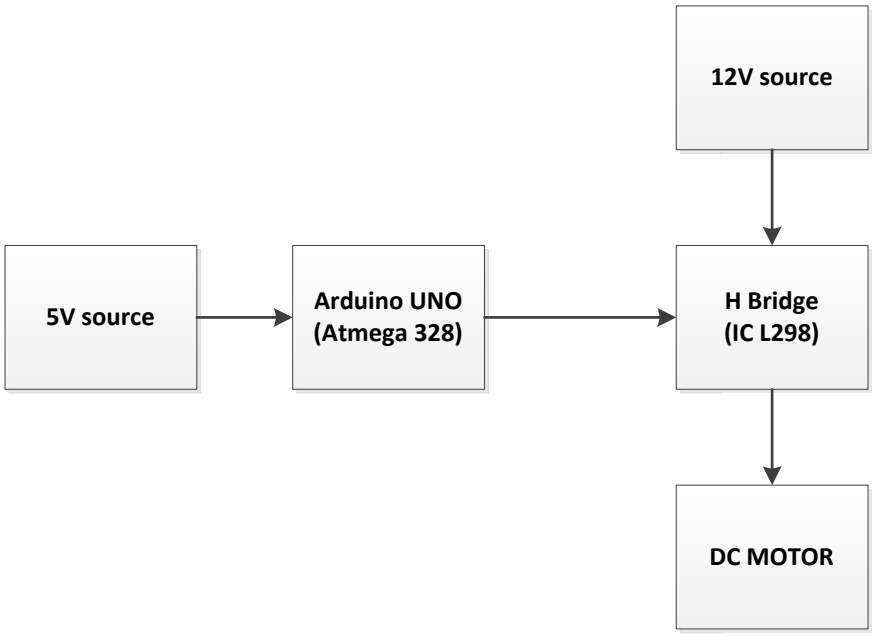


Figure 3: Block diagram of the circuit

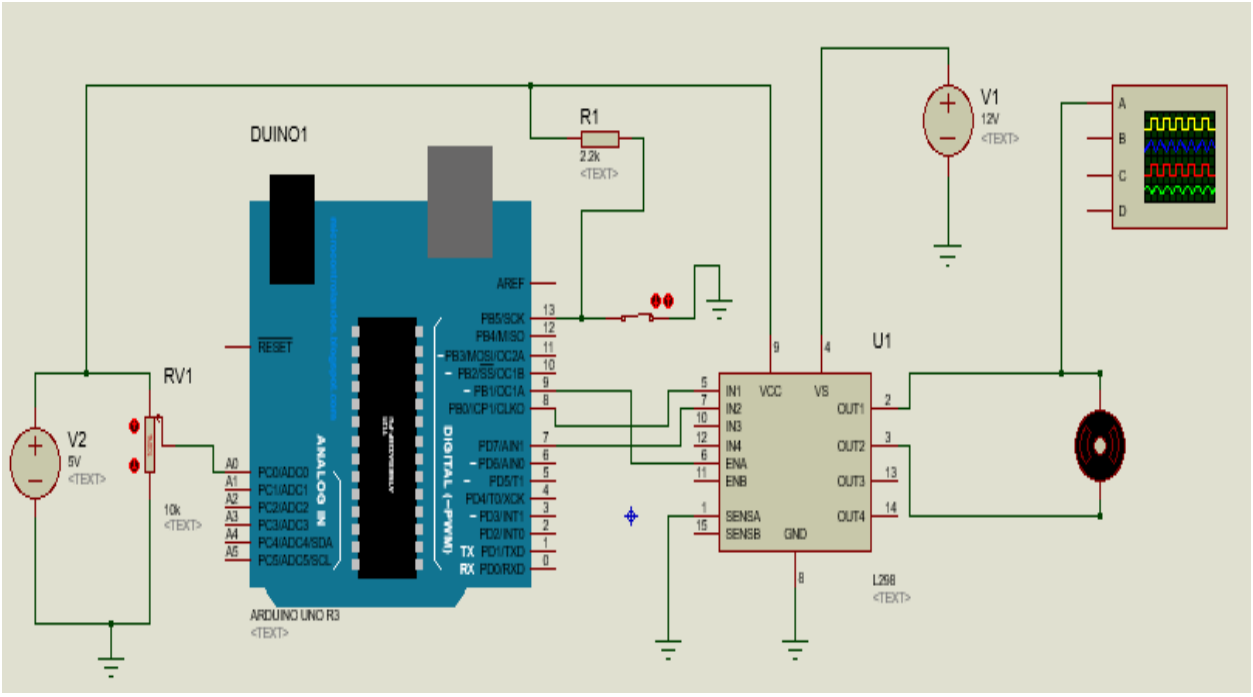


Figure 4: Circuit design to drive DC motor

For the H-bridge, L298 IC is used as this IC as it is H-bridge IC and can drive two motor at a time and can able to drive up to 4amp motors, a switch is used to generate the logic “0” or “1” , at first motor will start rotating clockwise as logic is “0” so arduino with make its pin8 HIGH which is connected with pin5 of IC but when switch is pressed so it will give logic 1 to the arduino controller and as per coding it will make pin7 HIGH of L298 IC and make motor rotate anti-clockwise. On the other hand 10K ohm potentiometer is used on the analog pin A0 of arduino Uno through which PWM signal pulse can be vary and by which speed of the motor can be control by user.

To drive the heavy load, combination of power mosfet can be used to make H-bridge, or even Darlington pair transistor can also be used to make H-bridge (figure 2A).

3. Result

The results are proved through simulation and experimental mean and output have been measured through DC voltmeter and oscilloscope , output voltage reading can be seen in table 2 with respect to duty cycle for coding arduino IDE software is used to burn the coding into arduino and logic is created so that direction can be triggered by using switch.

Table 2: output voltage on the based on Duty cycle

Duty cyle %	Voltage/V
0%	0.1
25%	2.58
50%	5.15
75%	8.01
100%	10.72

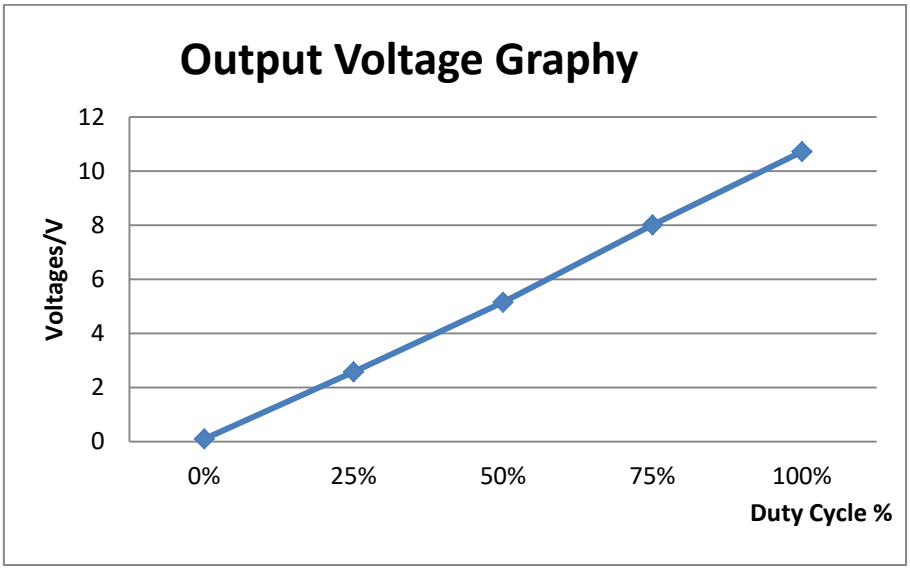
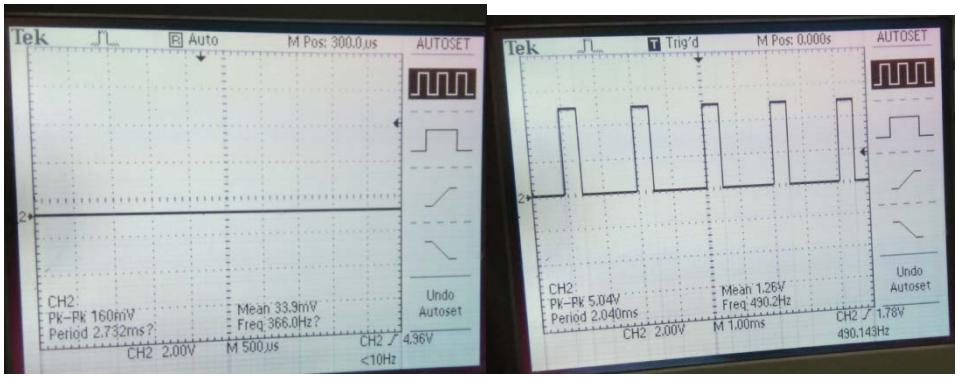
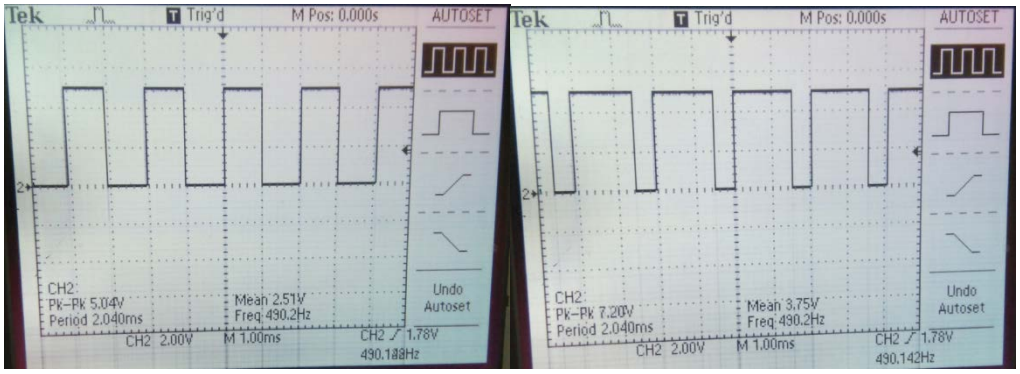


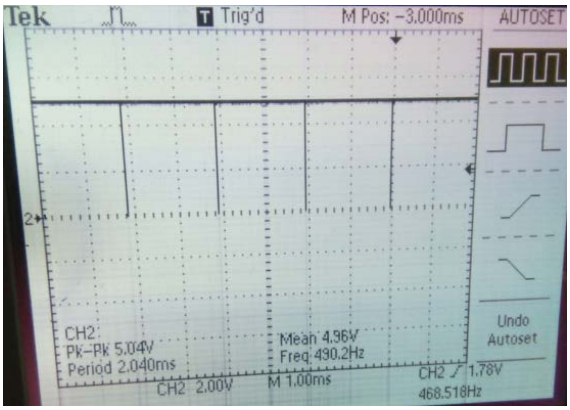
Figure 5: graph of output voltage according to PWM



a. b.



c. d.



e.

Figure 6: Experimental Results of PWM measured through oscilloscope

a. Duty cycle 0% b. Duty cycle 25%

c. Duty cycle 50% d. Duty cycle 75%

e. Duty cycle 100%

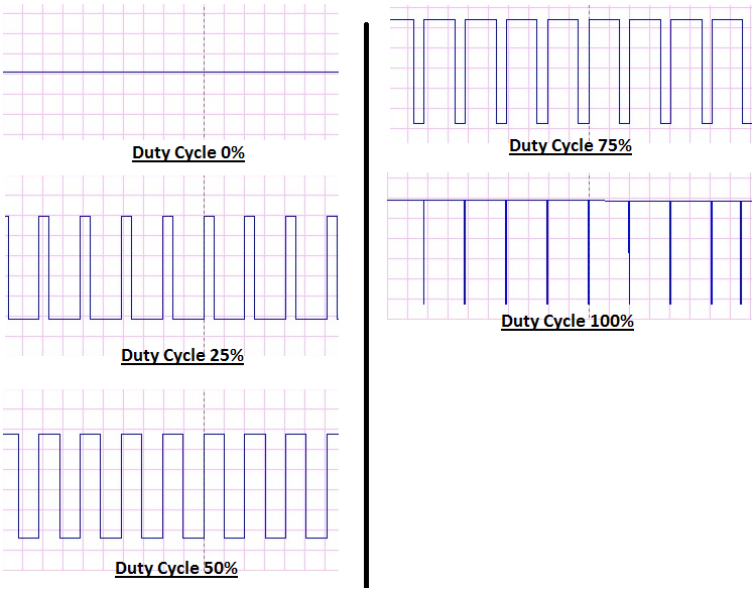


Figure 7: simulation result of PWM

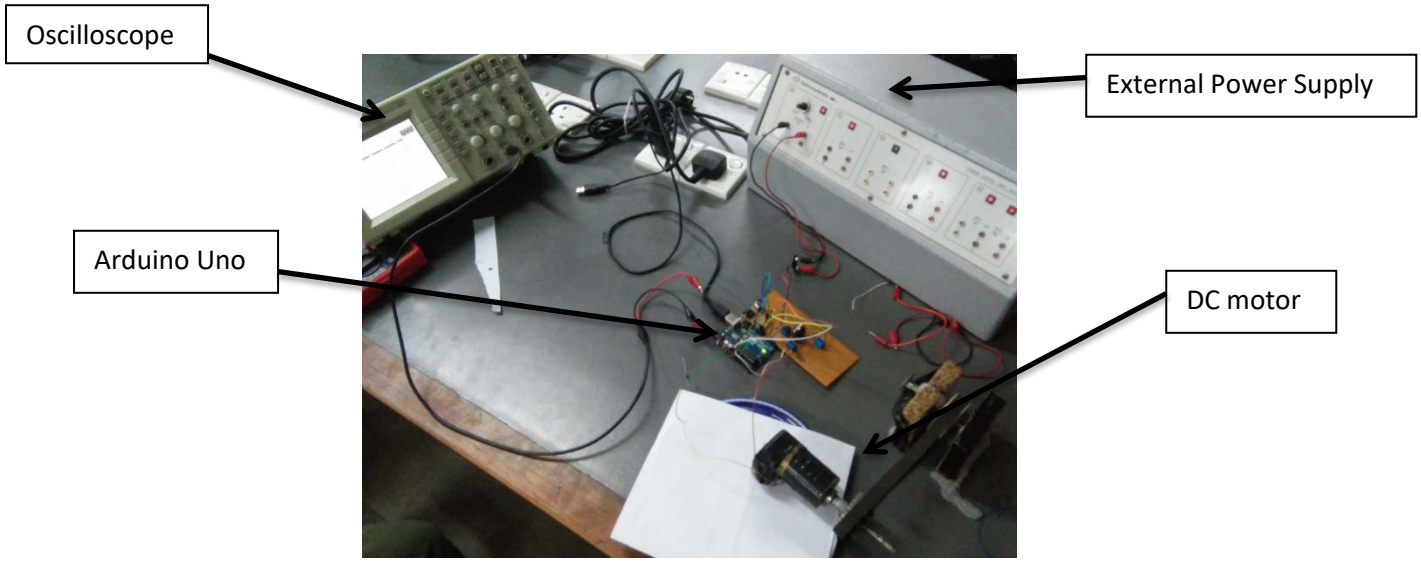


Figure 9: Experimental setup

Above experimental setup indicates dc motor attached with the belt connected with h-bridge circuit and that h-bridge circuit is attached through arduino and external power supply is used to get 12V Dc power to drive the motor through circuit and for arduino external 5V is taken from adapter.

4. Comparison

In past arduino Uno is used to drive Dc motor for conveyor but it uses optocoupler [5], as optocoupler have slow speed and also there is a chance of signal coupling in a high power signals and as well as it increases the complexity of a circuit and also its cost whereas rest of the phenomena of using h-bridge and PWM through

arduino Uno has been same as compared with this above mentioned design, but the cost and complexity is decreases as compared to previous work [5].

5. Recommendation

For vast expansion plc can be used to drive conveyor as it convert hard wire logic into soft wire logic and make system more accurately, method will remain same to drive conveyor, PWN and H-bridge can be used and we can use power mosfet to make H-bridge as output voltage of plc is 24V so power mosfet can be operated easily.

6. Conclusion

This suggested design is helpful to drive Dc motor easily and cost effectively and can be implemented in various applications also such as line follow robot, rollers, and other robotics. It is also very useful to operate conveyor belt for any industries or even in grocery stores, only few changes is required to make it work according to the users need.

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