Implementation of Motor Control using ARM Cortex-M7 Microcontroller

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Introduction

➢The space, robotics, and automation industries require precise and efficient motor control systems.

➢The objective of this project is to implement motor control on Brushless DC Motors (BLDC) using an ARM Cortex-M7 microcontroller since this particular microcontroller offers high speeds and performance.

➢The control concept used is Field Oriented Control (FOC) with PI Controller and Space Vector Pulse Width Modulation (SVPWM), which is more efficient than Sinusoidal Pulse Width Modulation (SPWM).

➢The purpose of this project is to demonstrate that the proposed design is effective in achieving precise and efficient motor control in these fields.

➢Applications includes: Controlling the Satellite's Vibration and Reaction Wheels, Antenna Movement, Robotic Arms Movement, Satellite Thrusters, etc.

Problem Definition

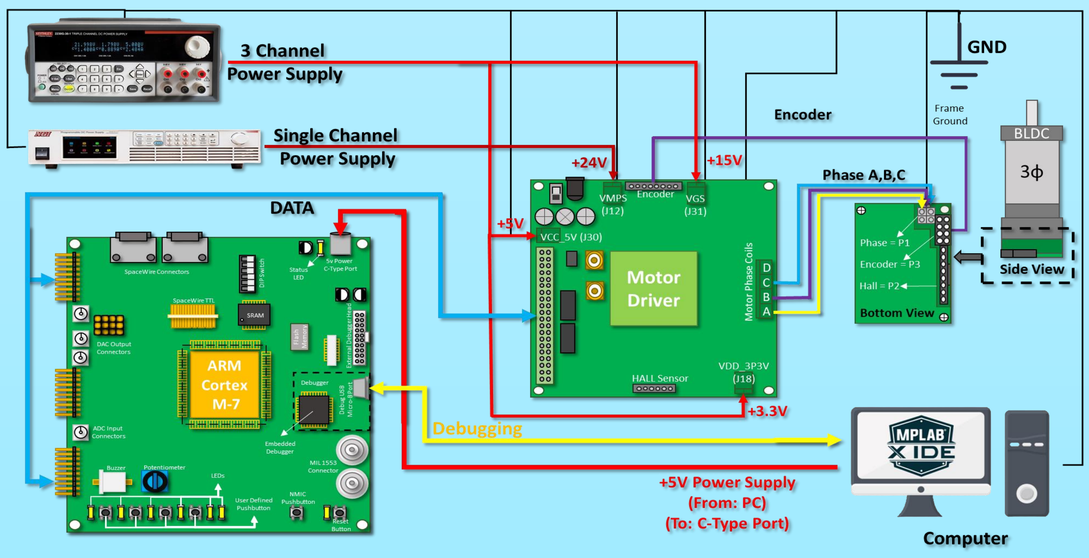
➢ This project is focused on the control of BLDC motors and not on other types of motors such as stepper motors or induction motors. The reason for this is that control challenges associated with BLDC motors require more efficient techniques.

➢The integration of motor control systems with microcontrollers can be challenging, especially when dealing with BLDC motors. In this regard, it is recommended that the PI Parameters (Kp, Ki and Kc) and the ADC Offset calibration be set every time the device is modified or updated.

Literature Survey

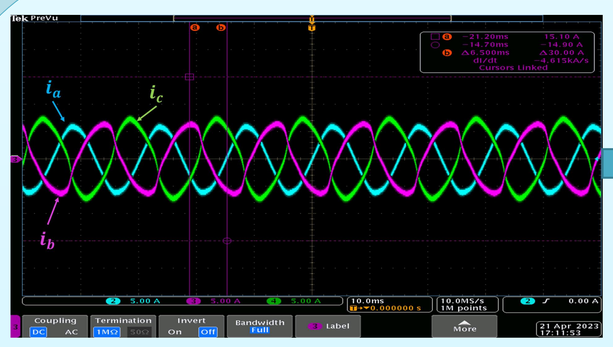
Sr. No.	Project Title	Conclusion
1.	Comparative analysis of Field oriented control of BLDC motor using SPWM and SVPWM Techniques. Authors: Meghana N Gujjar and Pradeep Kumar	Concluded that the SVPWM-based system has superior performance than the SPWM system. It provides high efficiency and low torque ripple, making it suitable for high-performance variable frequency drives. The system analysis was performed using MATLAB & Simulink. [1]
2.	Space Vector Modulation of a 3- Phase BLDC Motor with the Z32F128 MCU Link: http://www.zilog.com/docs/appnotes/AN0379.pdf	In this paper, a 3-phase BLDC motor is controlled using space vector modulation (SVM) techniques. According to the study, consumer goods motors must be designed in a manner that maximizes their performance at the lowest possible cost. The paper demonstrates SVM's efficiency and cost-effectiveness in controlling BLDC motors. The use of three Hall sensors for angular position feedback is also discussed. [2]

Proposed Design/Block Diagram

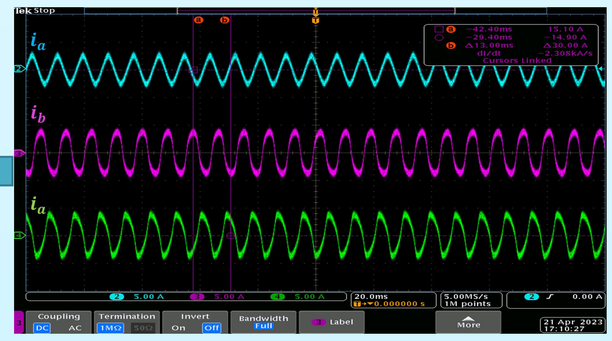


Harness Setup and Hardware Connections

Results

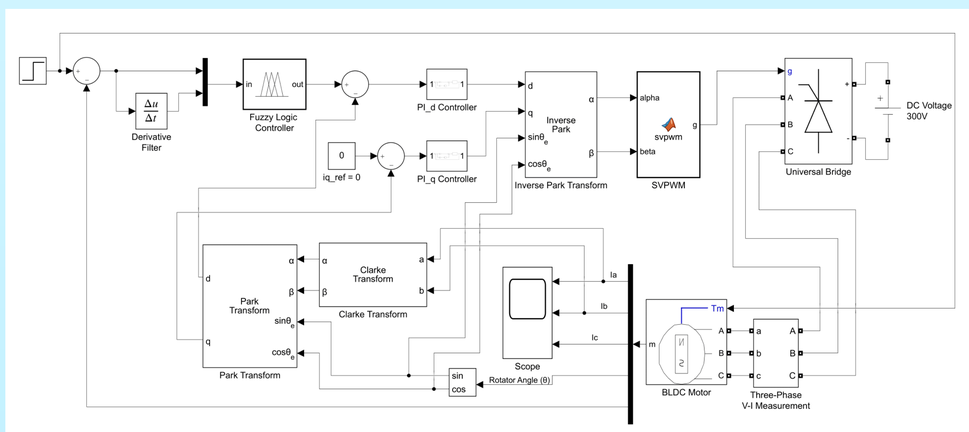


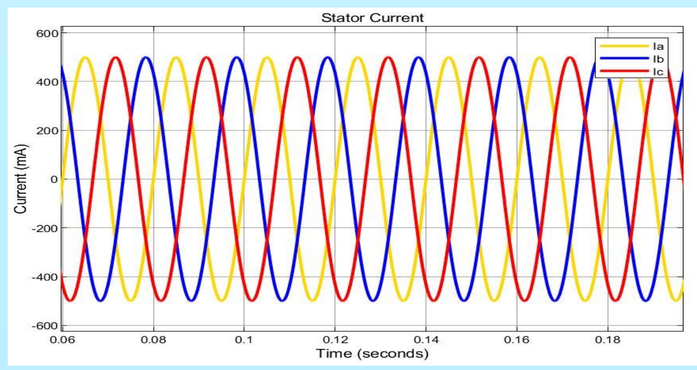
This shows a 120° phase shift in motor current's sinusoidal profile. [Scale: 5A/div]



i_a, i_b and i_c refer to the currents in Phase A, B, and C, respectively. [Scale: 5A/div]

Simulation Model & Results





Conclusion

➢ This project has successfully designed and implemented a motor control system for a Hurst's 3-phase BLDC motor using ARM Cortex-M7 microcontroller and Microsemi LX7720DB Motor Controller. The results demonstrate that the system using SVPWM is reliable and efficient, making it a promising solution for motor control in various fields. Further research and development could be undertaken to improve the accuracy and functionality of the system, opening up opportunities for wider applications in the future.

References

➢ [1] "Comparative analysis of field oriented control of BLDC motor using SPWM and SVPWM techniques" by - Meghana N Gujjar and Pradeep Kumar from Dept. of Electrical and Electronics, NMAMIT, Nitte, India. Published in: 2017 2nd IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT).

➢ [2] "Application Note on Space Vector Modulation of a 3- Phase BLDC Motor with the Z32F128 MCU - AN037901-0216" by - Zilog Company.

➢ [3] "Field-oriented Control (Vector Control) for Brushless DC Motors", by - Damond Goodwin, Control Automation (2023).