

DC Motor-Clutch-Generator Control Workstation
Functional Description and Complete System Block Diagram

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Introduction:

The goal of this senior capstone project is to create a control workstation for a DC motor-clutch-generator system. The workstation will consist of the DC motor-clutch-generator system, a Simulink modeling of the system including a real time user interface for simulation, and a microcontroller subsystem for control of the DC motor-clutch-generator system.

The control objectives will be to control velocity, acceleration, torque, and possibly more parameters of the motor operation with multiple control theory methods. The motor will be coupled to a variable load DC generator which will serve as disturbance to the motor control system. Coupling between the DC motor and the DC generator will be attained by the use of an electrically controlled clutch. The goal is to implement the controller on the EMAC 80515 development board while using C as the primary programming language.

Simulink modeling will include a model of the entire system, including a nonlinear modeling of the DC motor, the clutch coupling and DC load generator modeling, the controller modeling, and the sensor feedback. Control command signals will be user selectable through a keypad or joystick. Additional methods, including a serial interface between the microcontroller and Simulink may be considered for using the microcontroller generated command signal. Also, a serial interface between the microcontroller and Matlab will be used to capture data from the system and upload it to Simulink for data analysis rather than using an oscilloscope.

High Level Block Diagram:

The high level block diagram is shown in figure 2-1. The primary subsystems are the microcontroller subsystem, the DC motor-clutch-generator and its electronic hardware as a subsystem, and the Matlab and Simulink subsystem.

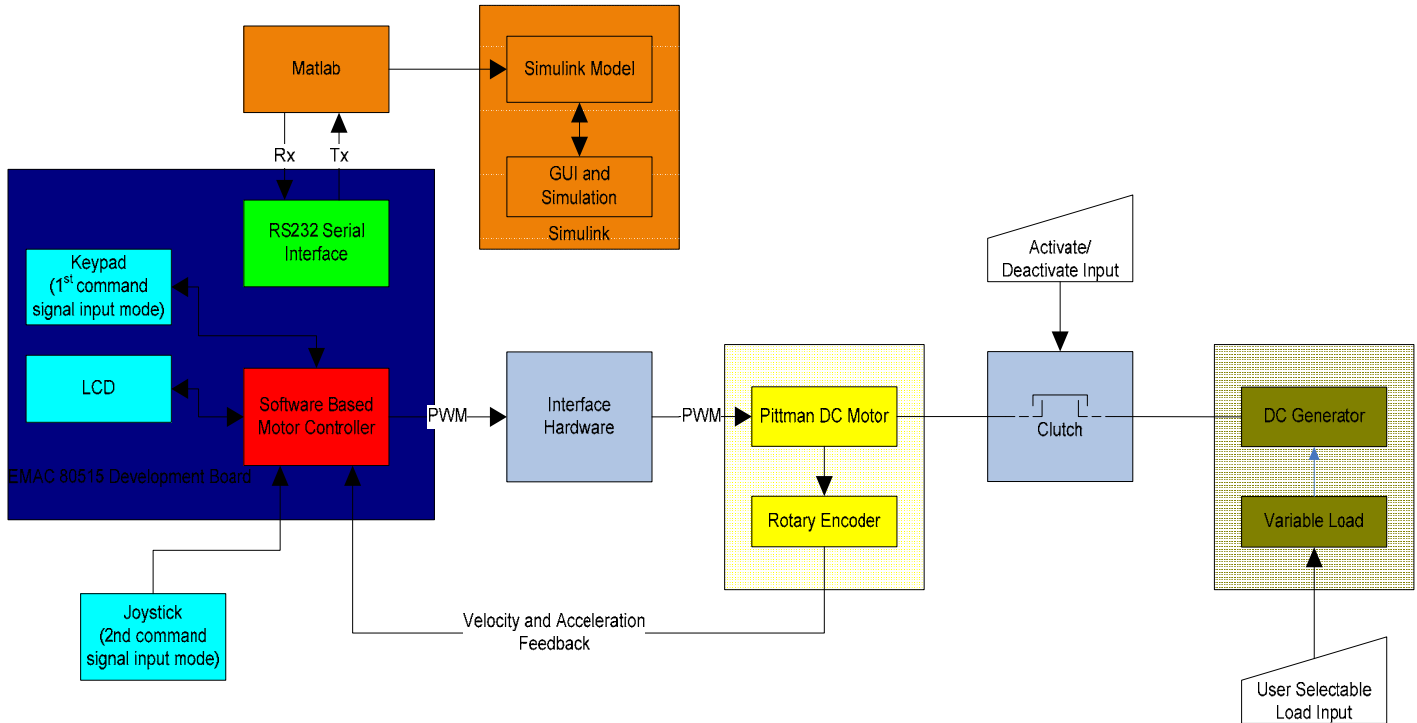


Figure 2-1: High Level Block Diagram

The microcontroller subsystem is where much of the design effort is concentrated. The EMAC 80515 development board will provide a user interface through a keypad and LCD. A joystick will also allow the user to control the command signal for the microcontroller subsystem. The microcontroller will be programmed with algorithms to implement closed-loop control of the motor. Additionally, the microcontroller will interface with Matlab on a PC through a RS232 serial connection.

Using the RS232 serial connection, the Matlab and Simulink subsystem will send and receive data. The data will consist of command signal waveforms that are easily created in Simulink and data from the microcontroller with feedback information on the actual motor-clutch-generator system. This real time operation information will be used to compare the physical system to the simulated operation of the system. By sending this information to the PC, the data can be easily analyzed with versatile methods in Simulink and Matlab. The simulation will be realized by a nonlinear model of the physical system. This model and the simulation of the model will have parameters that are adjustable through a graphical user's interface (GUI). The GUI will also have the potential of interfacing with the physical system, again through the RS232 line.

The physical system of the motor-clutch-generator is interfaced to the microcontroller through circuitry, primarily an H-bridge that will use the microcontroller PWM signal to drive the DC motor. The motor will operate in one direction due to clutch limitations. The motor has attached to it a clutch that has the ability to couple the motor to a DC generator with a variable load when it is

activated electrically. This activation will be controlled by the user either through the EMAC development board's keypad, joystick, or possibly the GUI in Simulink. The DC generator will cause a disturbance to the desired operation of the motor. The operation will be monitored by the microcontroller via velocity feedback using a rotary encoder on the DC motor. The method for varying the load of the generator will either be through physical adjustments on a potentiometer, or possibly through software implementation.

Software design:

Software will be designed in modular programming to meet the requirements of the overall system design. A high level flow chart for the system is shown on the next page. The system will have several operation modes, and depending on these modes specific modules will override others, and some modules may be annulled during operation modes both to avoid conflict between modules and also to enhance performance and efficiency. The system begins in its default interface of keypad and LCD. The user will select operation modes such that the user interface will shift to including joystick or Simulink interfaces as well, however, keypad and LCD will remain as the primary root interface from which all other options are controlled. The control method algorithm module will be where feedback control theory will be utilized to maintain command signal operation of the motor. Simulink simulation and GUI will function outside of this main overall software system.

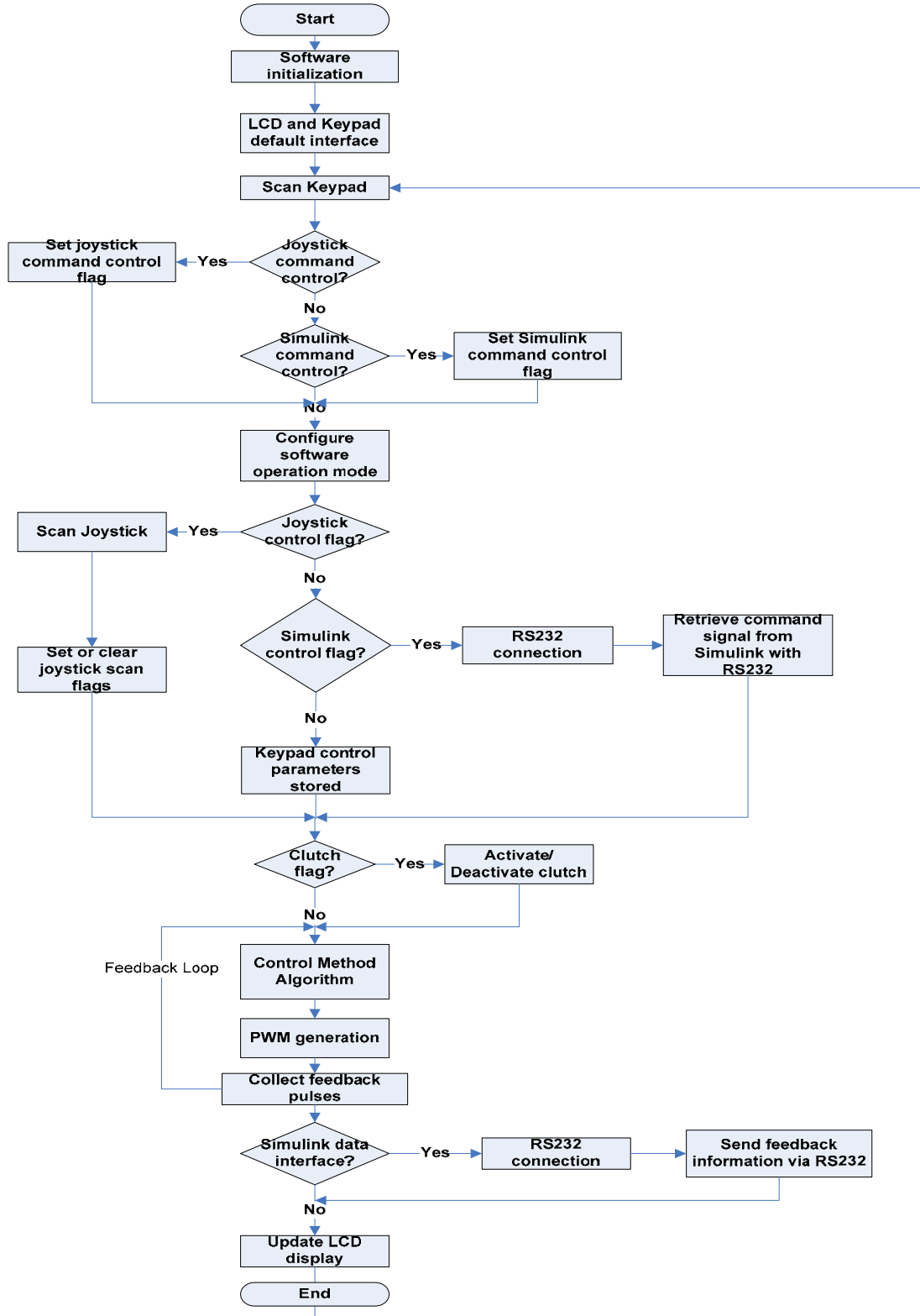


Fig. 5-1: High level software system flowchart.

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