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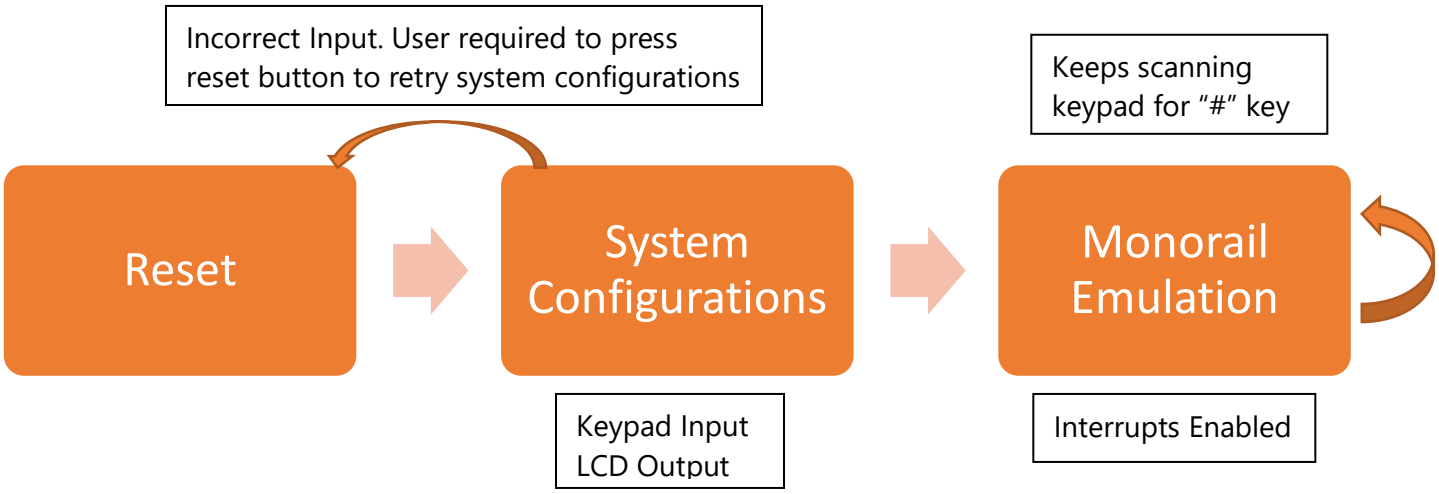
A MONORAIL EMULATOR

COMP2121 PROJECT 17s2

DESIGN MANUAL

SYSTEM FLOW CONTROL



1. The program starts off in RESET, which initialises the stack pointer, data segment variables, ports and their directions, the LCD, keypad.
2. The program then goes through system configurations through taking input from the keypad storing variables into the data segment, and displaying this on the LCD. If user input is incorrect, the user is required to press the reset button to pass the system configurations.
3. The program then decides what to do with the variables in the data segment created from system configurations and enters monorail emulation. In monorail emulation, the timer, LED and motor ports are initialised here and the interrupts for the buttons and holes. The monorail emulation also keeps scanning the keypad for a "#" key user input. The other actions that are performed on the monorail are performed through interrupts which are supported through calling functions in other modules.
4. For additional details on how the actions are performed see the module specification below. The modules are source files in our project which contain functions related to the module name

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MODULE SPECIFICATION

- The module "main.asm" contained the main project file where the whole program runs.
- The module "init.asm" contains all the definitions, constants, LCD settings, macros and data segments
- The module "Sysconfig_test.asm" contains the demo test where it displays on LCD confirmation of user input and requires any key to be pressed on keypad to confirm

MODULE	FUNCTIONS	INPUT	OUTPUT
Buttons	Initialise buttons		Trigger interrupt on falling edges Enable external interrupts
	Increases tourist on	Data Segment byte: tourist on	Writes to data segment tourist on and tourist count
	Increases tourist off	Data Segment byte: tourist off and count	Writes to data segment tourist off and tourist count
DC Motor	Initialise motor		Initialise PWM in Timer 3 Initialise DDRE Initialise related variables
	Measure RPS	Data Segment byte: holes	Writes to data segment current RPS
Delay	Sleep 1ms		Software delay of 1ms
	Sleep 5ms		Software delay of 5ms
	Sleep 20ms		Software delay of 20ms
	Sleep 1000ms		Software delay of 1000ms
	Sleep 5000ms		Software delay of 5000ms
Keypad	Initialise Keypad		Initialise Keypad Initialise DDRL
	Keypad Scan	Keypad input	Stores in register keypad input
	Read Character	Keypad input	Converts digit to character A-Z
	Read Station Number	Keypad input	Write to LCD Station number

			Write to data segment station number
	Read Station Name	Keypad input	Write to LCD Station name Write to data segment station name
	Read Travel Time	Keypad input	Write to LCD Travel Time Write to data segment Travel Time
	Read Stop Time	Keypad input	Write to LCD Stop Time Write to data segment Stop Time
LCD	Initialise LCD		Initialise LCD
	LCD Output One		Writes to LCD
	LCD Output Two		Writes to LCD
	LCD Output Three		Writes to LCD
	LCD Output Four		Writes to LCD
	Print Number Station		Writes to LCD
	Print Incorrect Input		Writes to LCD
	Print Finish		Writes to LCD
	Print Name Station		Writes to LCD
	Emulator LCD Display	Data Segment byte: Station Name, Measured RPS, Target RPS, Tourist Count, Tourist On, Tourist Off, Seconds Counted, Monorail Status	Writes to LCD

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LED	Initialise LED		Initialise LED Sets all LED bit to 0
	LED ON		Sets all LED bit to 1
Timer	Initialise Timer		Writes to data segment temp counter and second counter Initialise TIMSK0
	Increment seconds passed		Writes to data segment third of second passed, seconds passed
	Check order stop	Data Segment byte: order to stop, third of second passed, current time to next station	Writes to data segment target RPS, order to stop, monorail stopping or moving
	Stop Station	Data Segment byte: monorail stopping or moving, stopping time, seconds passed	Writes to data segment target RPS, monorail stopping or moving, third of second passed, seconds passed
	Update Station	Data Segment byte: monorail stopping or moving, current time to next station, seconds passed, tourist on, tourist off, tourist count, next station, number of stations	Writes to data segment monorail stopping or moving, current time to next station, seconds passed, tourist on, tourist off, tourist count, next station

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INTERRUPT SPECIFICATION

INTERRUPTS	INPUT	OUTPUT
Reset		Initialises stack pointer Initialises data registers and clears ports Initialises LCD Initialises keypad Initialises variables and data segments
Right button		Increases tourist off and decrease tourist count
Left button		Increases tourist on and increase tourist count
Interrupt 2	Holes	Writes to data segment holes counted
Timer 0 Overflow	Local counter stored in data segment Power level	If local counter reaches 2604 (0.33s): Update stations, LEDs, measured RPS, Motor speed, LCD display.

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DATA STRUCTURES

REGISTERS

Registers were used for storing values of temporary variables for the keypad along with loading, storing the values of the data segment variables. Three registers (R17-19) are specifically used as storing the current row and column when keypad scans and for holding the values of the row mask. Register 16 (R16) was reserved for storing and writing outputs. Four registers (R20-23) were defined for temporary registers for holding temporary variables to load and store data segment variables and to pass values to other functions. Two registers (R24:25) were used to store a two-byte number to allow for easy output address from calculation subroutines or for general temporary storage.

DATA SEGMENT VARIABLES

Data segment variables stored the values of variables amongst timer counters, button de-bouncing state, hole count and monorail emulation variables. These monorail emulation variables included the number, names, travel times, stop time of stations, tourist on, off and count, current RPS and target RPS and general helper variables. These general helper variables included the next station, monorail status, third of second passed and second passed, the current time to next station, and the order to stop the monorail.

CONSTANTS

Constants were set (set/equ) to make the code maintainable and readable. Constants were used for LCD settings and instructions, keypad variables (I/O port masks) and delay constants.