Design Document

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CSSE 232 Computer Architecture I

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Link to the Google Doc DesignDocument

Description:

Our design uses a single register accumulator to store data and compare it to inputs. At all times we only use one register and use an allocated space in Memory for data. For our addresses we will use sign extensions to target specific places in memory to receive either data for destination. The input must have the correct first bit to target the proper place in memory.

We are going to use 2 registers, the accumulator($acc) and stack pointer($sp). The accumulator is the only register available by the programmer.

I:

Opcode	Immediate	Unused
5	8	3

AI:

Opcode	Address	Immediate
5	8	3

PC relative for bne and beq

A:

Opcode	Address	Unused
5	8	3

We left shift by 1 bit then we sign extent (the most significant bit will be 1 if it is a data and 0 if it is a instruction)

Instructions

Name	Type	Operation	Opcode

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load a:
Takes an 8 bit address a and loads the value at memory address a to the accumulator, using the address rule.

save a:
Take an 8 bit address a and save the value in the accumulator into the memory with address a, using the address rule.

loadui:
Takes an 8 bit immediate and load it to the upper 8 bits of the accumulator

beq a imm:
Takes an 8 bit address and a 3 bit immediate. If the value stored at address a is equal to the value of the accumulator, then jump to the address calculated from the immediate using the branch address rule.

bne a imm:
Takes an 8 bit address and a 3 bit immediate. If the value stored at address a is not equal to the value of the accumulator, then jump to the address calculated from the immediate using the branch address rule.

slt a:

Compare the value in the accumulator with the value stored at address a, if the accumulator is less than a then we set the accumulator to 1, else we set the accumulator to 0.

slti imm:
Compare the value in the accumulator with the immediate, if the accumulator is less than the immediate then we set the accumulator to 1, else we set the accumulator to 0.

j a:
Jump to the instruction with address a, calculated using the address rule.

jal a:
Jump to the instruction with address a, calculated using the address rule. Store the current PC + 2 to a fix memory location.

sw imm:
Stored the value in the accumulator in to the stack where it is of offset imm to the stack pointer.

lw imm:
Stored the value from stack where it is of offset imm to the stack pointer to the accumulator.

sub a:
Subtract the value stored at address a from the accumulator and store the result in the accumulator

add a:
Add the value stored at address a to the accumulator and store the result in the accumulator

addi imm:
Add the sign extended immediate to the accumulator and store the result in the accumulator

and a:
And the value stored at address a to the accumulator and store the result in the accumulator

or a:

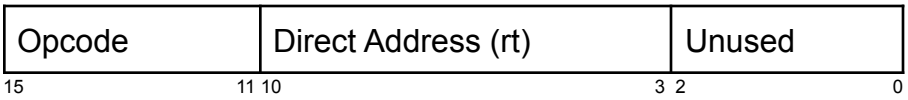
Or the value stored at address a to the accumulator and store the result in the accumulator

ori imm:
Or the zero extended immediate to the accumulator and store the result in the accumulator

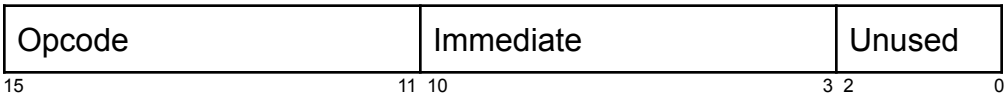
Address rule: We left shift by 1 bit then we sign extent (the most significant bit will be 1 if it is a data and 0 if it is a instruction)
Branch address: Left shift the immediate by 1, sign extend it to 16 bits then add it to the value of the current PC plus 2.

Types

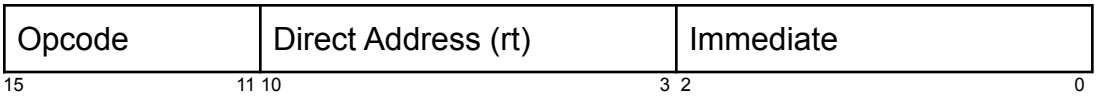
A:



I:



AI:



Assembly Sheet

Name	**Type**	**Operation**	**Opcode**
load	A	acc = rt	00001
save	A	Mem[getAddr(rt)] = acc	00010
loadui	I	acc = {imm, 8b'0}	00011
bne	AI	if(acc != Mem[getAddr(rt)]) PC = PC + 2 + getAddr(imm)	00100
beq	AI	if(acc == Mem[getAddr(rt)]) PC = PC + 2 + getAddr(imm)	00101

slt	A	acc = acc < Mem[getAddr(rt)] ? 1:0	00110
slti	I	acc = acc < SignExtent(imm) ? 1:0	00111
j	A	PC = getAddr(rt)	01000
jal	I	Men[ra] = PC + 2 PC = getAddr(imm)	01001
sw	I	sp + SignExtent(imm) = acc	01010
lw	I	acc = sp + SignExtent(imm)	01011
ms	I	sp = sp + SignExtent(imm)	01100
sub	A	acc = acc - Mem[getAddr(rt)]	01101
add	A	acc = acc + Mem[getAddr(rt)]	01110
addi	I	acc = acc + SignExtent(imm)	01111
and	A	acc = acc & Mem[getAddr(rt)]	10000
or	A	acc = acc | Mem[getAddr(rt)]	10001
ori	I	acc = acc | ZeroExtent(imm)	10010
loadi	I	acc = SignExtent(imm)	10011
getAddr = {7{address[7]}, address, 1'b0} ZeroExtent = {8b'0, imm} SignExtent = {8{address[7]},imm} ra = 0xFFFE sp = 0x1FFF			

Call procedure

We will store the arguments in memory and the callee will read data directly from memory. If we need to use the arguments after the call we will store their value on stack. The return value will be passed back via the accumulator

Example program(s)

High Level Code	Assembly	Machine Code	Addresses

int **relPrime**(int n)
{
  int m;
 	
  m = 2;
  while (gcd(n, m) != 1) {
  m = m + 1;
  }
  return m;
}
	loadi 2
	save m
	ms -12
	loop: load m
	sw 0
	save a
	load n
	sw 4
	save b
	load ra
	sw 8
	jal gcd
	save o
	lw 0
	save m
	lw 4
	save n
	lw 8
	save ra
	loadi 1
	bne o, end
	load m
	add 1
	save m
	j loop
	end: ms 12
	j ra
		10011 00000010 000
		00010 10000011 000
		01100 11110110 000
		00001 10000011 000
		01010 00000000 000
		00010 10000000 000
		00001 10000100 000
		01010 00000100 000
		00010 10000001 000
		00001 11111111 000
		01010 00001000 000
		01001 11100111 000
		00010 10000101 000
		01011 00000000 000
		00010 10000011 000
		01011 00000100 000
		00010 10000100 000
		01011 00001000 000
		00010 11111111 000
		10011 00000001 000
		00100 10000101 100
		00001 10000011 000
		01110 00000001 000
		00010 10000011 000
		01000 00011011 000
		01100 00001100 000
		01000 11111111 000
			0x 0030
			0x 0032
			0x 0034
			0x 0036
			0x 0038
			0x 003A
			0x 003C
			0x 003E
			0x 0040
			0x 0042
			0x 0044
			0x 0046
			0x 0048
			0x 004A
			0x 004C
			0x 004E
			0x 0050
			0x 0052
			0x 0054
			0x 0056
			0x 0058
			0x 005A
			0x 005C
			0x 005E
			0x 0060
			0x 0062
			0x 0064

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int **gcd**(int a, int b) {
  if (a == 0) {
  return b;
  }
 	
  while (b != 0) {
  if (a > b) {
  a = a - b;
  } else {
  b = b - a;
  }
  }
 	
  return a;
}
	gcd:
	  loadi 0
	  bne a, loop
	  load b
	  j ra
	loop:
	  loadi 0
	  bne b, go
	  j end
	go: load b
	  slt a
	  save i
	  loadi 1
	  bne i, else
	  load a
	  sub b
	  save a
	  j loop
	else: load b
	  sub a
	  save b
	  j loop
	end: load a
	  j ra
		10011 00000000 000
		00100 10000000 010
		00001 10000001 000
		01000 11111111 000
		
		10011 00000000 000
		00100 10000001 001
		01000 00010110 000
		00001 10000001 000
		00110 10000000 000
		00010 10000010 000
		10011 00000001 000
		00100 10000010 011
		00001 10000000 000
		01101 10000001 000
		00010 10000000 000
		01000 00000101 000
		00001 10000001 000
		01101 10000000 000
		00010 10000001 000
		00010 00000101 000
		00001 10000000 000
		00010 11111111 000
			0x 0002
			0x 0004
			0x 0006
			0x 0008
			0x 000A
			0x 000C
			0x 000E
			0x 0010
			0x 0012
			0x 0014
			0x 0016
			0x 0018
			0x 001A
			0x 001C
			0x 001E
			0x 0020
			0x 0022
			0x 0024
			0x 0026
			0x 0028
			0x 002A
			0x 002C
			0x 002E

Data: 0xFF00 a(value = m) 0xFF02 b(value = n) 0xFF04 i 0xFF06 m 0xFF08 n 0xFF0A o		Stack: 0x1FFF	

Team repo: set upped, goto link in M1 and join yellow