LAB 02: Introduction to MIPS Assembly Programing

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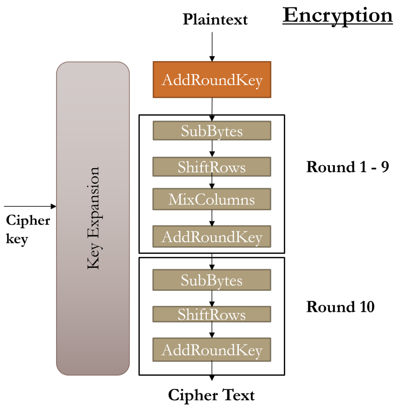
Agenda

Previous Side Project: AES Overview

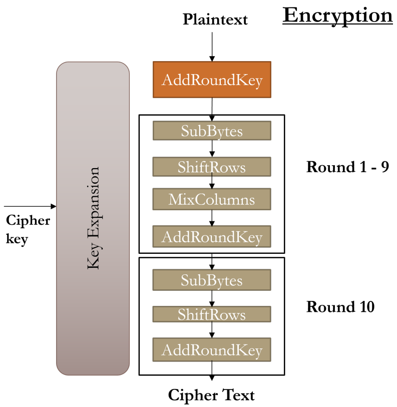
- Advanced Encryption Standard (AES) or Rijndael developed by Vincent Rijmen and Joan Daemesn is a symmetric key encryption and decryption algorithm.
- It was first published in 1998, and standardized in 2001 by U.S. National Institute of Standards and Technology (NIST).
- AES is widely used to secure connection between clients and servers.
- It has fixed data block size (128 bits) but different key lengths (128, 192, and 256 bits).

Previous Side Project: AES Algorithm

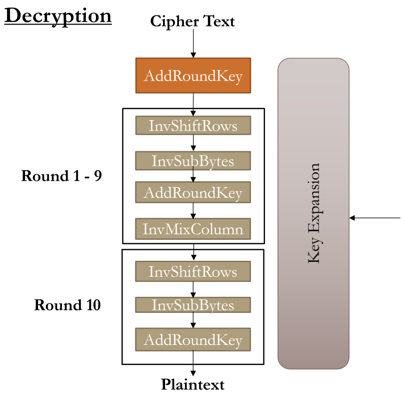


AES Encryption Algorithm

Previous Side Project: AES Algorithm

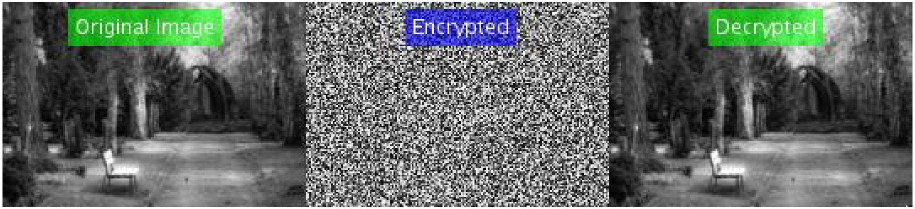


AES Encryption Algorithm



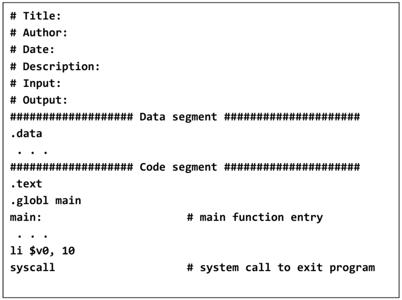
AES Decryption Algorithm

Previous Side Project: MIPS Implementation



AES MIPS Implementation and Example

MIPS Assembly Language Program Template

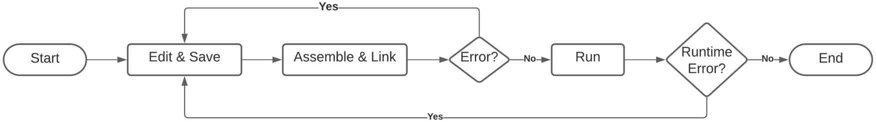


```
# Title:
# Author:
# Date:
# Description:
# Input:
# Output:
################### Data segment #####################
.data
 . . .
################### Code segment #####################
.text
.globl main
main:                      # main function entry
 . . .
li $v0, 10
syscall                    # system call to exit program
```

MIPS Assembly Program Language

- Comments start with '#'
- Directives start with '.'
- Instructions are usually written in lower case; however, you can write them in uppercase as well.
- Registers name or number starts with '$'.

Edit-Assemble-Link-Run Cycle



MIPS Instr. Formats

- R-Type Format
  - Requires two register operands
  - e.g. add $t0, $t1, $t2

op^6	rs^5	rt^5	rd^5	sa^5	$func^6$

R-Type Instruction Format

MIPS Instr. Formats

- R-Type Format
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- I-Type Format
  - Requires two operands: a register and 16-bit immediate value
  - e.g. addi $t0, $t1, 301

op^6	rs^5	rt^5	rd^5	sa^5	$func^6$

R-Type Instruction Format

op^6	rs^5	rt^5	$immediate^{16}$

I-Type Instruction Format

MIPS Instr. Formats

- R-Type Format
  - Requires two register operands
  - e.g. add $t0, $t1, $t2
- I-Type Format
  - Requires two operands: a register and 16-bit immediate value
  - e.g. addi $t0, $t1, 301
- J-Type Format
  - Used for jump instructions with 26-bit immediate value
  - e.g. j loop

op^6	rs^5	rt^5	rd^5	sa^5	$func^6$

R-Type Instruction Format

op^6	rs^5	rt^5	$immediate^{16}$

I-Type Instruction Format

op^6	$immediate^{26}$

J-Type Instruction Format

MIPS General Purpose Registers

Register Name	Register No.	Register Usage
$zero	$0	Always zero, forced by hardware
$at	$1	Assembler Temporary register, reserved for assembler use
$v0 - $v1	$2 - $3	Results of a function
$a0 - $a3	$4 - $7	Arguments of a function
$t0 - $t7	$8 - $15	Registers for storing temporary values
$s0 - $s7	$16 - $23	Registers that should be saved across function calls
$t8 - $t9	$24 - $25	Registers for storing more temporary values
$k0 - $k1	$26 - $27	Registers reserved for the OS kernel use
$gp	$28	Global Pointer register that points to global data
$sp	$29	Stack Pointer register that points to top of stack
$fp	$30	Frame Pointer register that points to stack frame
$ra	$31	Return Address register used to return from a function call

System Calls

System calls provide system services, mainly for input and output, are available for use by your MIPS program.

Partial List of System Calls

Service	**code in $v0**	**Arguments**	**Results**
Print Integer	1	$a0 = integer to print	
Print String	4	$a0 = address of null-terminated string	
Read Integer	5		$v0 = integer read
Read String	8	$a0 = address of input buffer $a1 = maximum number of characters	
Exit Program	10		Terminate Program
Print Character	11	$a0 = character to print	
Read Character	12		

Live Examples

Task #1

Write a MIPS program where you ask the user to enter 3 integers **a**, **b**, and **c**. Then, calculate and print the value of **z** based on the following equation.

$$z = (6a - 4b) - (3c - 20)$$

Sample Run

```
Enter a: 4
Enter b: 6
Enter c: 2
z = 14
```

Task #2

Write a MIPS program where you prompt the user for his **name**. Then, print the following message

“Welcome to COE301, <name> ”

Assume the maximum length for a name is 20 characters.

Sample Run

```
Enter your name: Khalid
Welcome to COE301, Khalid
```