**********Draft**********

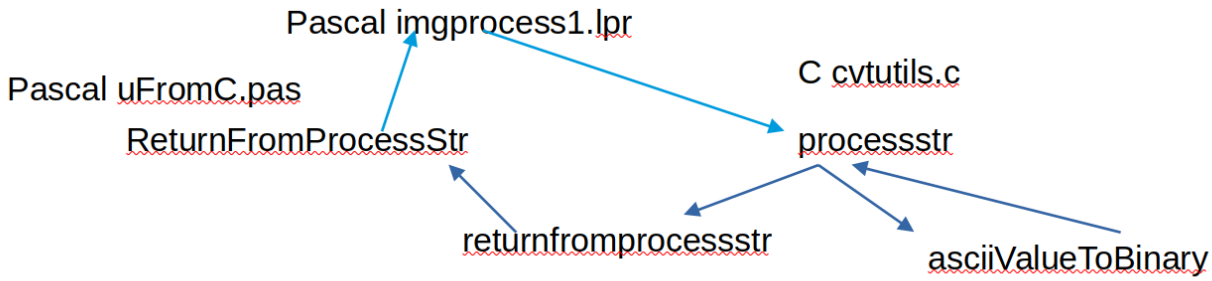
Steganography for Ultibo Bare Metal with Debug using QEMU adding Cryptography Using Crypto & APICrypto from the Ultitbo RTL

02/15/22

**********Draft**********

Several arrays are need to perfrom the next phase of the process.

```
type
  MODR = array[0..255,0..255] of word;          pixel mod 2
  MODRPtr = ^MODR;
  XORR = array[0..255,0..255] of word;          XOR (pixel mod 2) with (LSB
ProcessStrResult)
  XORRPtr = ^XORR;
  TLSB = array[0..255,0..255] of word;
  TLSBPtr = ^TLSB;
  Lsb = array[0..31] of byte;
  lsbPtr = ^Lsb;
  Buffer = String[255];
  BufPtr = ^Buffer;
```



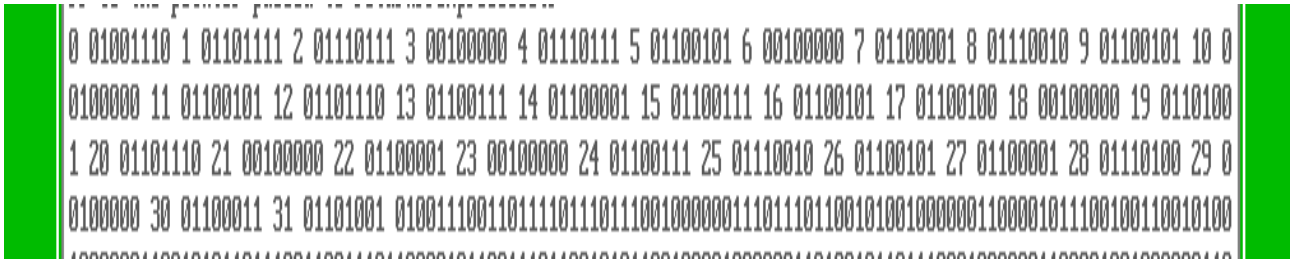
uFPGA now returns the string with the call to **processstr('Now we are engaged in a great ci');** **ProcessStrResult String** For 32 char passed the return string is 32 * 8 which 256 char. Out of every 8 the LSB is the value that will be used to XOR.

```
01001110011011110111011100100000011101110100101001000000110000101110010011001010010000001100101011011100110011101100001011001110110010101100100000100000011010010111000100000011000010010000001100111011100100110010101100001011101000010000001100001101101001
```

0 01001110 1 01101111 2 01110111 3 00100000 4 01110111 5 01100101 6 00100000 7 01100001 8 01110010 9 01100101 10 00100000 11 01100101 12 01101110 13 01100111 14 01100001 15

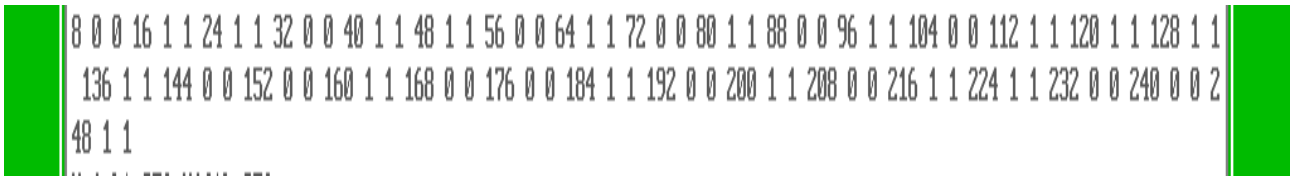
01100111 16 01100101 17 01100100 18 00100000 19 01101001 20 01101110 21 00100000 22 01100001 23 00100000 24 01100111 25 01110010 26 01100101 27 01100001 28 01110100 29 00100000 30 01100011 31 01101001

0 0, 1 1,2 1,3 0..29 0,30 1 31 1 in the image below

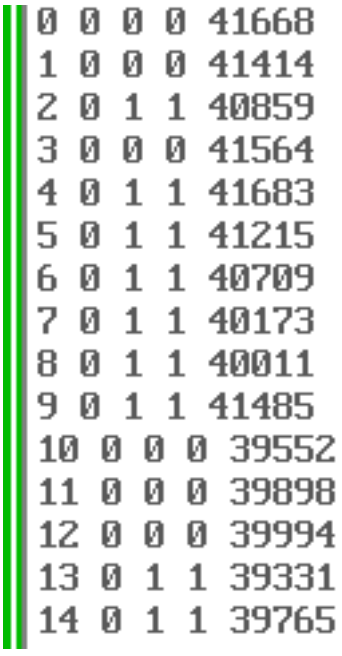


The array bb holds the LSB of every 8. 8 16 24 32 .. 48 the first is the LSB and next value is what is placed in bb byte array.

8 0 0, 16 1 1, 24 1 1...232 0 0, 240 0 0, 248 1 1 in the image below



Next the pixel of the image need to be reviewed to determine if the LSB is 0 or 1. The image below the first is col row (pixel mod 2), XOR 0 (pixel mod 2) pixel.



Next the pixel of the image need to be reviewed to determine if the LSB is 0 or 1. The image below the first is col row (pixel mod 2), XOR 1 (pixel mod 2) pixel.

```
0 0 0 1 41668
1 0 0 1 41414
2 0 1 0 40859
3 0 0 1 41564
4 0 1 0 41683
5 0 1 0 41215
6 0 1 0 40709
7 0 1 0 40173
8 0 1 0 40011
9 0 1 0 41485
10 0 0 1 39552
11 0 0 1 39898
```

Current Issues:
1. Conversion of RGB to gray scale using fcl-image fpimage.pp
This issue can be resolved by adding to WriteOptions := 'P GrayScale';
. This requires writing to the disk.img.
10-2-22 16:34:52 57612 GrayScale.png

```
clr.red:=round(clr.red*0.29900);
clr.blue:=round(clr.blue*0.11400);
clr.green:=round(clr.green*0.58700);
clr.green:=clr.red+clr.blue+clr.green;
clr.red:=clr.green;
clr.blue:=clr.green;
```

11-2-22 12:31:41 73068 GrayScale.png
This makes red, blue, and green all the same value. Which is what WriteOptions := 'P GrayScale'; did.

Note: The size of GrayScale.png is 26.8%

2 Need to determine how to return the results of calling processstr(S1); back to improcessing1.

Ultibo has provided some ideas on this I just do not under the steps.

This project Goal: To learn steganogrphy based on code
https://github.com/TheAlgorithms/MATLAB-Octave/blob/master/algorithms/ImageProcessing/LSB%20based%20Image%20Steganography/steganography.m
The file steganography.m RPi4B Octave only works by commenting some lines
and creating bit string of the of the desired text to embed in the image.

This repo git@github.com:develone/MATLAB-Octave.git
   which was forked from https://github.com/TheAlgorithms/MATLAB-Octave
   required minor modification to run on Raspberry Pi 4B 8Gb.

The following C program was written:

```
#include <stdio.h>
#include <string.h>

int asciiValueToBinary(int asciiInput)
{
        int res = 0, i = 1, rem;

        while (asciiInput > 0)
        {
                rem = asciiInput % 2;
                res = res + (i * rem);
                asciiInput = asciiInput / 2;
                i = i * 10;
        }
        //printf("%x\n",res);
        return(res);
}

void processstr(char  *x) {
int i,l;
l=strlen(x);
int outstr[l];
//printf("C %d %s\n",l,x);
for(i=0;i<l;i++) {
        printf("%d %08d ",i,asciiValueToBinary(*x));
  //printf("%08d",asciiValueToBinary(*x));
  outstr[i]=asciiValueToBinary(*x);
        x++;
}
printf("\n");
for(i=0;i<l;i++) printf("%08d",outstr[i]);
printf("\n");
}
```

```
int main() {
        char *p;
        char a[]="Now we are engaged in a great ci";
        p = a;
        processstr(p);
return (0);
}
```

The methods void processstr(char *x) & int asciiValueToBinary(int asciiInput) are found in a program cvtutils.c. The is compiled for usewith Ultibo using
./libuild.sh in Ultibo_Projects/imgconv/QEMU

gcc bitstring.c -o bitstring

./bitstring
0 01001110 1 01101111 2 01110111 3 00100000 4 01110111 5 01100101 6 00100000 7 01100001 8 01110010 9 01100101 10 00100000 11 01100101 12 01101110 13 01100111 14 01100001 15 01100111 16 01100101 17 01100100 18 00100000 19 01101001 20 01101110 21 00100000 22 01100001 23 00100000 24 01100111 25 01110010 26 01100101 27 01100001 28 01110100 29 00100000 30 01100011 31 01101001
01001110011011110111011100100000011101110110010100100000011000010111001001100101001000000110010101101110011001110111000010110011101100101011001000010000001101001011011100010000001100001001000000110011101110010011001010110000101110100001000000110001101101001

This information is part of readme.md provided in the original repo.
The encoding is done using the following steps:

1. Convert the image to greyscale
2. Resize the image if needed
3. Convert the message to its binary format
4. Initialize output image same as input image
5. Traverse through each pixel of the image and do the following:
   - Convert the pixel value to binary
   - Get the next bit of the message to be embedded
   - Create a variable temp
   If the message bit and the LSB of the pixel are same, set temp = 0
   If the message bit and the LSB of the pixel are different, set temp = 1
   This setting of temp can be done by taking XOR of message bit and the LSB of the pixel
   Update the pixel of output image to input image pixel value + temp

   Keep updating the output image till all the bits in the message are embedded
   Finally, write the input as well as the output image to local system.

The decoding/decryption is done using the following steps:

1. Get the output image which was encoded earlier.
2. Input the length of the encoded message (character count).
3. Retrieve the LSBs of each pixel
4. Form a bit sequence from these LSBs
5. Arrange the bit sequence into a matrix of 8 rows and total_message_bits/8 columns
   (each column will represent a character of 8 bits, hence 8 rows)

- Convert the binary value to decimal
- Get the corresponding char from ascii

Finally, display the original message.

Now we are engaged in a great ci

octave
GNU Octave, version 6.2.0
Copyright (C) 2021 The Octave Project Developers.
This is free software; see the source code for copying conditions.
There is ABSOLUTELY NO WARRANTY; not even for MERCHANTABILITY or
FITNESS FOR A PARTICULAR PURPOSE. For details, type 'warranty'.

Octave was configured for "arm-unknown-linux-gnueabihf".

Additional information about Octave is available at https://www.octave.org.

Please contribute if you find this software useful.
For more information, visit https://www.octave.org/get-involved.html

Read https://www.octave.org/bugs.html to learn how to submit bug reports.
For information about changes from previous versions, type 'news'.

octave:1>steganograpyhy


```
1989.00,  173.346
```

octave:2> decrypt

Enter the length (character count) of the message you are looking for:
Enter the length (character count) of the message you are looking for: 32
The original message is: Now we are engaged in a great ci
octave:3>

Testing using lena_rgb_256.png in input.png

octave:1>steganograpyhy

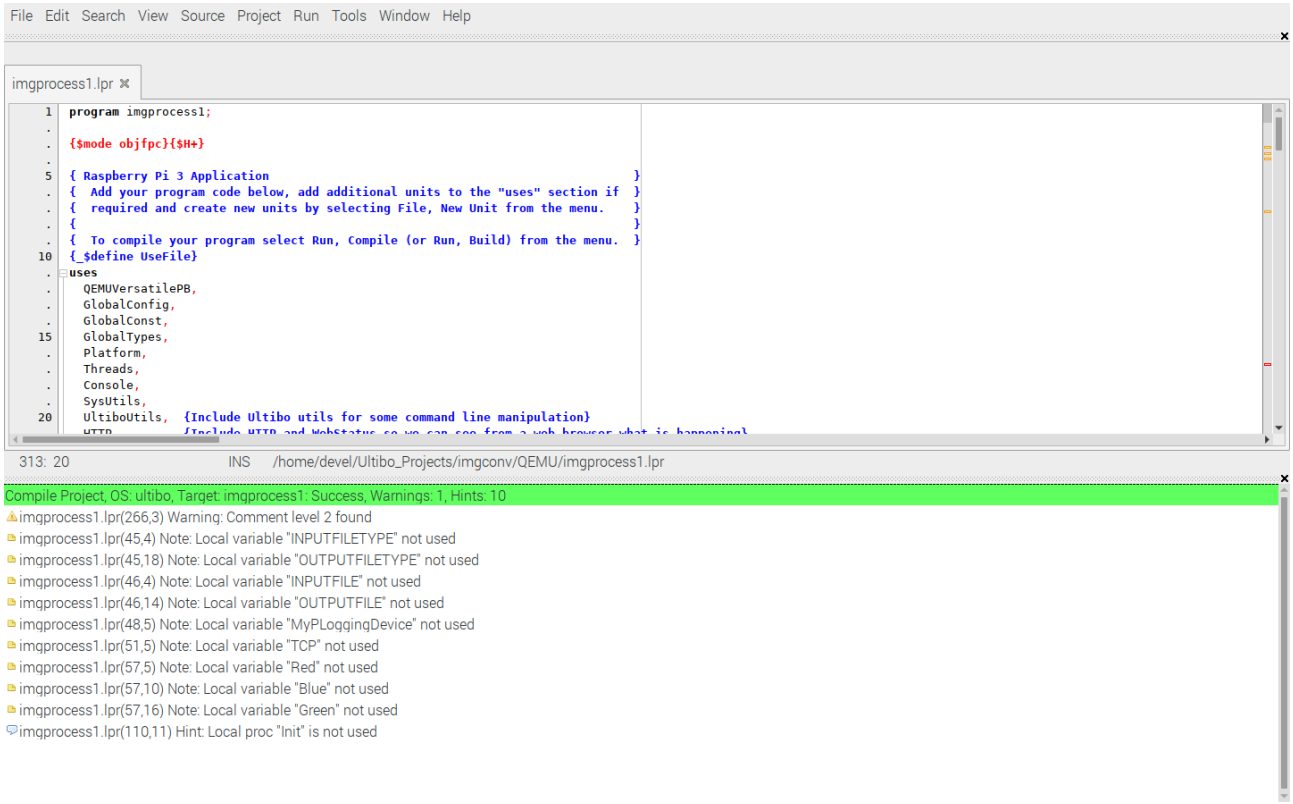
Input Image

Image with Hidden Data

325.825, -27.3639

octave:2> decrypt
Enter the length (character count) of the message you are looking for:
Enter the length (character count) of the message you are looking for: 32
The original message is: Now we are engaged in a great ci
octave:3>

The Lazarus IDE (Ultibo Edition) is used to create the "kernel.bin"



From the main menu Run/Compile. If no errors a green bar appers.

. Ultibo_Projects/picoultibo.sh This sets the PATH

/home/devel/ultibo/core:/home/devel/qemu-6.1.0-rpios/bin:/home/devel/local/openocd/bin:/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/local/games:/usr/games

./libuild.sh in Ultibo_Projects/imgconv/QEMU

cd Ultibo_Projects/imgconv/QEMU

~/Ultibo_Projects/imgconv/QEMU $ ./startqemu.sh

While QEMU is running telnet, tftp and a webserver are provided.

~/Ultibo_Projects/imgconv/QEMU $ telnet xx.xx.xx.xx 5023
(Type HELP for a list of available commands)
>dir
Directory of C:\

28-7-21 18:41:54 53 Another File.txt
28-7-21 18:41:54 31 Test File.txt
28-7-21 18:41:54 <DIR> www
10-1-22 12:25:18 24 testfile
10-1-22 23:54:30 24 junk
10-1-22 12:25:18 24 256com
5-2-22 17:32:46 65536 red
28-7-21 18:44:28 24 256decom

```
28-7-21 18:44:28          196730  lena_rgb_256.bmp
28-7-21 18:44:28          196730  MyBitmap.bmp
5-2-22 17:41:56             7848  test.j2k
5-2-22 17:32:48            65536  green
5-2-22 17:32:48            65536  blue
5-2-22 17:32:48           196730  test_wr.bmp
5-2-22 17:57:08           125663  lena_rgb_256.png
7-2-22 12:54:36           196662  lena_rgb_256_fpng.bmp
       15 file(s) 1117151 bytes
       1 dir(s)

C:\>logout
Goodbye!
Connection closed by foreign host.

~/Ultibo_Projects/imgconv/QEMU $ tftp xx.xx.xx.xx 5069
tftp> binary
tftp> get lena_rgb_256_fpng.bmp
Received 196662 bytes in 2.8 seconds
tftp> quit
```

http://xx.xx.xx.xx:5080/status

Ultibo Core (Release: Beetroot Version: 2.1.279 Date: 5 January 2022)

General | Platform | Memory | Heap Blocks | CPU | FPU | GPU | RTL | Clock | Locale | Threading | Thread List | Scheduler | Devices | Drivers | Handles | USB | PCI | MMC / SD / SDIO | Network | Storage | Filesystem | Disk Cache | Keyboard | Mouse | Touch | Framebuffer | Environment | Page Tables | Vector Tables | IRQ / FIQ / SWI | GPIO | Configuration | Device Tree

General

Release Name:	Beetroot
Release Version:	2.1.279
Release Date:	5 January 2022
Time (Local):	7-2-22 13:02:05
Time (UTC):	7-2-22 13:02:05
Timezone:	UTC
Daylight Start:	None
Daylight Date:	N/A
Standard Start:	None
Standard Date:	N/A
Temperature (SoC):	0 degrees Celcius
Uptime:	0 days 00:07:46

xxx