

组会报告

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1 工作内容

1. 学习 High-Throughput Multi-Core LDPC Decoders Based on x86 Processor。
2. 学习相关代码。

2 论文对 layered-ms 算法的改进

2.1 原数据结构

```
int t_deg_cn[n-k] = { 4, 3, 4, 3, 4 };
unsigned short indicies[ ] = {
    0, 1, 2, 3, // VN nodes for C0
    3, 4, 5,    // VN nodes for C1
    1, 4, 6, 7, // VN nodes for C2
    0, 3, 6,    // VN nodes for C3
    0, 2, 3, 6  // VN nodes for C4
};

// decoder description (init + iteration loop)
for(n=0; n<C; n++)
    unsigned char deg_cn = t_deg_cn[n];
    for(i = 0; i < deg_cn; i++){ /* COMPUTE CN value */ }
    for(i = 0; i < deg_cn; i++){ /* UPDATE MSG&VN values */ }
}
// end of decoding process description (hard decision)
```

图 1: Naive decoder kernel description using constant arrays

空间占用情况:

$$\Delta = 4 \times n + 4 \times m + 2 \times m + (n - k). \quad (1)$$

2.2 msg 类型优化

从 float 变成 int8_t

空间占用情况:

$$\Delta = n + m + 2 \times m + (n - k). \quad (2)$$

2.3 基于交织的并行计算

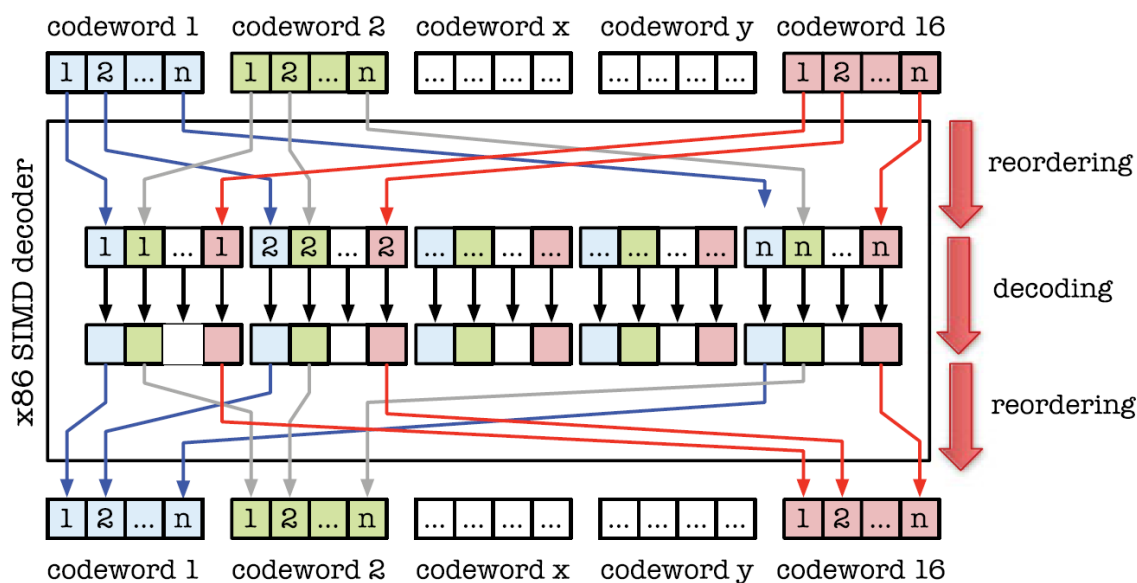


图 2: Data interleaving and desinterleaving processes

空间占用情况:

$$\Delta = q \times n + q \times m + 2 \times m + (n - k). \quad (3)$$

2.4 重新排布校验矩阵

$$\begin{array}{c}
V_0 \quad V_1 \quad V_2 \quad V_3 \quad V_4 \quad V_5 \quad V_6 \quad V_7 \\
\begin{pmatrix} C_0[\delta_0=4] \\ C_1[\delta_1=3] \\ C_2[\delta_2=4] \\ C_3[\delta_3=3] \\ C_4[\delta_4=4] \end{pmatrix} \begin{pmatrix} 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 1 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 & 1 & 1 \\ 1 & 0 & 0 & 1 & 0 & 0 & 1 & 0 \\ 1 & 0 & 1 & 1 & 0 & 0 & 1 & 0 \end{pmatrix} \begin{array}{c} \text{Pentagon} \\ \text{Pentagon} \\ \text{Pentagon} \\ \text{Pentagon} \\ \text{Pentagon} \end{array} \\
\begin{array}{c} C_0[\delta_0=4] \\ C_2[\delta_1=4] \\ C_4[\delta_2=4] \\ C_1[\delta_3=3] \\ C_3[\delta_4=3] \end{array} \begin{pmatrix} 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 & 1 & 1 \\ 1 & 0 & 1 & 1 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 1 & 1 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 & 1 & 0 \end{pmatrix} \begin{array}{c} \text{Pentagon} \\ \text{Pentagon} \\ \text{Pentagon} \\ \text{Pentagon} \\ \text{Pentagon} \end{array} \\
\begin{array}{c} C_0[\delta_0=4] \\ C_4[\delta_4=4] \\ C_2[\delta_2=4] \\ C_1[\delta_1=3] \\ C_3[\delta_3=3] \end{array} \begin{pmatrix} 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & 1 & 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 & 1 & 1 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 & 1 & 0 \end{pmatrix} \begin{array}{c} \text{Pentagon} \\ \text{Pentagon} \\ \text{Pentagon} \\ \text{Pentagon} \\ \text{Pentagon} \end{array}
\end{array}$$

图 3: CN Computation Reordering

空间占用情况:

$$\Delta = q \times n + q \times m + 2 \times m. \quad (4)$$

2.5 其他

1. 预先计算好 E_n 地址;
2. 使用最新的指令集;
3. 多核计算。

3 代码学习

Algorithm 1. Horizontal TDMP Min-Sum algorithm

```

1: Kernel 1: Initialization
2: for all  $m \in C, n \in \Psi(m)$  do
3:    $L_{mn}^{(0)} = 0$ 
4: end for
5:  $\triangleright$  Process iter_max decoding iterations
6: for all  $t = 1 \rightarrow (\text{iter\_max})$  do
7:   Kernel 2: For each check node in the code
8:   for all  $m \in C$  do
9:      $\triangleright$  Compute  $L_{nm}$  message
10:    for all  $n \in \Psi(m)$  do
11:       $L_{nm}^{(t)} = E_n - L_{mn}^{(t-1)}$ 
12:    end for
13:     $\triangleright$  Compute  $L_{mn}$  message
14:    for all  $n \in \Psi(m)$  do
15:       $\text{sign}(L_{mn}^t) = \left[ \prod_{(n' \in \Psi(m)/n)} \text{sign}(L_{n'm}^{(t)}) \right]$ 
16:       $|L_{mn}^t| = \left[ \min_{(n' \in \Psi(m)/n)} |L_{n'm}^{(t)}| \right]$ 
17:    end for
18:     $\triangleright$  Immediately update  $E_n$ 
19:    for all  $n \in \Psi(m)$  do
20:       $E_n = L_{nm}^t + L_{mn}^t$ 
21:    end for
22:  end for
23: end for
24: Kernel 3: Hard decision
25: for all  $n \in V$  do
26:    $\hat{c}_n = \begin{cases} 0 & \text{if } E_n \leq 0 \\ 1 & \text{if } E_n > 0 \end{cases}$ 
27: end for

```

4 存在问题

```
sherlockhsu@lab: ~/Github/Fast_LDPC_decoder_for_x86/bin
ipo: warning #11021: unresolved _ZNKSt5ctypeIcE13_M_widen_initEv
      Referenced in /tmp/ipo_icc7h0DvI.o
ipo: warning #11021: unresolved _Znwm
      Referenced in /tmp/ipo_icc7h0DvI.o
ipo: warning #11021: unresolved _ZNKSt7__cxx1112basic_stringIcSt11char_traitsIcE
SaIcEE7compareEPKc
      Referenced in /tmp/ipo_icc7h0DvI.o
ipo: warning #11021: unresolved _ZNSt7__cxx1112basic_stringIcSt11char_traitsIcES
aIcEE9_M_createERmm
      Referenced in /tmp/ipo_icc7h0DvI.o
ipo: warning #11021: unresolved _ZSt19__throw_logic_errorPKc
      Referenced in /tmp/ipo_icc7h0DvI.o
ipo: warning #11021: unresolved _ZNSt7__cxx1112basic_stringIcSt11char_traitsIcES
aIcEE10_M_replaceEmmPKcm
      Referenced in /tmp/ipo_icc7h0DvI.o
ipo: warning #11021: unresolved __cxa_call_unexpected
      Referenced in /tmp/ipo_icc7h0DvI.o
ipo: warning #11021: unresolved _ZSt4cout
      Referenced in /tmp/ipo_icc7h0DvI.o
ld: 找不到 -lboost_system-mt
ld: 找不到 -lboost_timer-mt
Makefile:44: recipe for target 'main.icc' failed
make: *** [main.icc] Error 1
sherlockhsu@lab:~/Github/Fast_LDPC_decoder_for_x86/bin$
```

5 下阶段计划

1. 使程序正常运行；
2. 尝试与原仿真程序结合。