Your Paper

You

March 22, 2018

Abstract

Your abstract.

1 Introduction

Your introduction goes here! Some examples of commonly used commands and features are listed below, to help you get started. If you have a question, please use the help menu ("?") on the top bar to search for help or ask us a question.

2 Some examples to get started

2.1 How to include Figures

First you have to upload the image file from your computer using the upload link the project menu. Then use the includegraphics command to include it in your document. Use the figure environment and the caption command to add a number and a caption to your figure. See the code for Figure in this section for an example.

3 Code

3.1 complex.h

Listing 1: code 1 1

```
struct complex
{
double r;
double i;
};

struct complex16
{
short r;
short i;
};

struct complex32
{
int r;
int i;
};
```

Listing 2: code 2

```
struct complex{
double r;
double i;
};

struct complex16{
int16_t r;
int16_t i;
};

struct complex32{
int32_t r;
int32_t i;
};
```

3.2 fft.c

Listing 3: code 3

```c
void twiddle(struct complex *W, int N, double stuff){
W->r=cos(stuff*2.0*PI/(double)N);
W->i=-sin(stuff*2.0*PI/(double)N);
}


void twiddle_fixed(struct complex16 *W, int N, double stuff){
W->r=(int16_t)(32767.0*cos(stuff*2.0*PI/(double)N));
W->i=(int16_t)(-32768.0*sin(stuff*2.0*PI/(double)N));
}


void twiddle_fixed_Q17(struct complex32 *W, int N, double stuff){
W->r=(int32_t)(131071.0*cos(stuff*2.0*PI/(double)N));
W->i=(int32_t)(-131072.0*sin(stuff*2.0*PI/(double)N));
}
```

Listing 4: code 4

```c
void bit_r4_reorder_fixed_Q15(
struct complex16 *W,
int N,
char scale)
{
int bits, i, j, k;
int16_t tempr, tempi;

for(i=0; i<N; i++){
  W[i].r=W[i].r>>scale;
  W[i].i=W[i].i>>scale;
}

for (i=0; i<MAXPOW; i++)
if (pow_2[i]==N) bits=i;

for (i=0; i<N; i++){
  j=0;
  for (k=0; k<bits; k+=2){
    ...
  }

if (j>i){
  tempr=W[i].r;
  tempi=W[i].i;
  W[i].r=W[j].r;
  W[i].i=W[j].i;
  W[j].r=tempr;
  W[j].i=tempi;
}
}
}
```

Listing 5: code 5

```c
void bit_r4_reorder_fixed_Q15(
struct complex16 *W,
int N,
char scale)
{
int bits, i, j, k;
short tempr, tempi;




for (i=0; i<MAXPOW; i++)
if (pow_2[i]==N) bits=i;

for (i=0; i<N; i++){
  j=0;
  for (k=0; k<bits; k+=2){
    ...
  }

if (j>i){
  tempr=W[i].r>>scale;
  tempi=W[i].i>>scale;
  W[i].r=W[j].r>>scale;
  W[i].i=W[j].i>>scale;
  W[j].r=tempr;
  W[j].i=tempi;
}
}
}
```

Listing 6: code 5

```c
void radix4_fixed_Q15(struct complex16 *x,    // Input in Q15 format
int N,                    // Size of FFT
unsigned char *scale,    // Pointer to scaling schedule
unsigned char stage)     // Stage of fft
{
```

```c
int     n2, k1, N1, N2;
struct complex16 W, bfly[4];

N1=4;
N2=N/4;

// Do 4 Point DFT
for (n2=0; n2<N2; n2++){
// scale Butterfly input
x[n2].r           >>= scale[stage];
x[N2+n2].r        >>= scale[stage];
x[(2*N2) + n2].r >>= scale[stage];
x[(3*N2) + n2].r >>= scale[stage];
x[n2].i           >>= scale[stage];
x[N2+n2].i        >>= scale[stage];
x[(2*N2) + n2].i >>= scale[stage];
x[(3*N2) + n2].i >>= scale[stage];

// Radix 4 Butterfly
bfly[0].r = SAT_ADD16(  SAT_ADD16(x[n2].r, x[N2 + n2].r)  ,
SAT_ADD16(x[2*N2+n2].r, x[3*N2+n2].r)
);
bfly[0].i = SAT_ADD16(  SAT_ADD16(x[n2].i, x[N2 + n2].i)  ,
SAT_ADD16(x[2*N2+n2].i, x[3*N2+n2].i)
);
bfly[1].r = SAT_ADD16(  SAT_ADD16(x[n2].r, x[N2 + n2].i)  ,
-SAT_ADD16(x[2*N2+n2].r, x[3*N2+n2].i)
);
bfly[1].i = SAT_ADD16(  SAT_ADD16(x[n2].i, -x[N2 + n2].r)  ,
SAT_ADD16(-x[2*N2+n2].i, x[3*N2+n2].r)
);
bfly[2].r = SAT_ADD16(  SAT_ADD16(x[n2].r, -x[N2 + n2].r)  ,
SAT_ADD16(x[2*N2+n2].r, -x[3*N2+n2].r)
);
bfly[2].i = SAT_ADD16(  SAT_ADD16(x[n2].i, -x[N2 + n2].i)  ,
SAT_ADD16(x[2*N2+n2].i, -x[3*N2+n2].i)
);
bfly[3].r = SAT_ADD16(  SAT_ADD16(x[n2].r, -x[N2 + n2].i)  ,
SAT_ADD16(-x[2*N2+n2].r, x[3*N2+n2].i)
);
bfly[3].i = SAT_ADD16(  SAT_ADD16(x[n2].i, x[N2 + n2].r)  ,
SAT_ADD16(-x[2*N2+n2].i, -x[3*N2+n2].r)
);

// In-place results
x[n2].r = bfly[0].r;
x[n2].i = bfly[0].i;

for (k1=1; k1<N1; k1++){
twiddle_fixed(&W, N, (double)k1*(double)n2);
x[n2 + N2*k1].r = SAT_ADD16( FIX_MPY(bfly[k1].r, W.r)  ,
-FIX_MPY(bfly[k1].i, W.i) );
x[n2 + N2*k1].i = SAT_ADD16( FIX_MPY(bfly[k1].i, W.r)  ,
FIX_MPY(bfly[k1].r, W.i) );
}
}

// Don't recurse if we're down to one butterfly
```

Item	Quantity
Widgets	42
Gadgets	13

Table 1: An example table.

```
if (N2!=1)
for (k1=0; k1<N1; k1++){
radix4_fixed_Q15(&x[N2*k1], N2, scale, stage+1);
}
}
```

Comments can be added to your project by clicking on the comment icon in the toolbar above. To reply to a comment, simply click the reply button in the lower right corner of the comment, and you can close them when you're done.

Comments can also be added to the margins of the compiled PDF using the todo command, as shown in the example on the right. You can also add inline comments:

<div style="border:1px solid green; background:#aaffaa;">This is an inline comment.</div>

> Here's a comment in the margin!

3.3 How to add Tables

Use the table and tabular commands for basic tables — see Table 1, for example.

3.4 How to write Mathematics

LaTeX is great at typesetting mathematics. Let $X_1, X_2, \ldots, X_n$ be a sequence of independent and identically distributed random variables with $\mathrm{E}[X_i] = \mu$ and $\mathrm{Var}[X_i] = \sigma^2 < \infty$, and let

$$S_n = \frac{X_1 + X_2 + \cdots + X_n}{n} = \frac{1}{n} \sum_{i}^{n} X_i$$

denote their mean. Then as n approaches infinity, the random variables $\sqrt{n}(S_n - \mu)$ converge in distribution to a normal $\mathcal{N}(0, \sigma^2)$.

3.5 How to create Sections and Subsections

Use section and subsections to organize your document. Simply use the section and subsection buttons in the toolbar to create them, and we'll handle all the formatting and numbering automatically.

3.6 How to add Lists

You can make lists with automatic numbering ...

1. Like this,

2. and like this.

... or bullet points ...

- Like this,

- and like this.

3.7 How to add Citations and a References List

You can upload a `.bib` file containing your BibTeX entries, created with JabRef; or import your Mendeley, CiteULike or Zotero library as a `.bib` file. You can then cite entries from it, like this: [?]. Just remember to specify a bibliography style, as well as the filename of the `.bib`.

You can find a video tutorial here to learn more about BibTeX.

We hope you find Overleaf useful, and please let us know if you have any feedback using the help menu above — or use the contact form at https://www.overleaf.com/contact!

References