

```
+++ title = "The Libembroidery 1.0-alpha Manual" author = "The Embroidermodder Team" abbrev = "libembroidery" date = "2022-09-19" weight = 11
+++ # Libembroidery v1.0-alpha
```

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<https://embroidermodder.org>

(Under construction, please wait for v1.0 release.)

libembroidery is a low-level library for reading, writing, and altering digital embroidery files in C.

libembroidery is the underlying library that is used by Embroidermodder 2 and is developed by The Embroidermodder Team. A full list of contributors to the project is maintained in the Embroidermodder 2 github in the file `CREDITS.md`. It handles over 45 different embroidery specific formats as well as several non-embroidery specific vector formats.

It also includes a CLI called **embroider** that allows for better automation of changes to embroidery files and will be more up-to date than the Embroidermodder 2 GUI.

A printer-friendly version of these docs are available on our website.

License Libembroidery is distributed under the permissive zlib licence, see the LICENCE file. This applies to all the source code in this directory.

Demos

We're currently trying out some fill techniques which will be demonstrated here and in the script `qa_test.sh`.

Converts to:

Build

libembroidery and EmbroiderModder 2 use CMake builds so if you are building the project to use as a library we recommend you run:

```
git clone https://github.com/Embroidermodder/libembroidery
cd libembroidery
cmake .
cmake --build .
cmake --install .
```

This builds both the static and shared versions of the library as well as the command line program **embroider**.

Development

Contributing If you're interested in getting involved, here's some guidance for new developers. Currently The Embroidermodder Team is all hobbyists with an interest in making embroidery machines more open and user friendly. If you'd like to support us in some other way you can donate to our Open Collective page (click the Donate button) so we can spend more time working on the project.

All code written for libembroidery should be ANSI C89 compliant if it is C. Using other languages should only be used where necessary to support bindings.

Debug If you wish to help with development, run this debug script and send us the error log.

```
#!/bin/bash
```

```
rm -fr libembroidery-debug
```

```
git clone http://github.com/embroidermodder/libembroidery libembroidery-debug
cd libembroidery-debug
```

```
cmake -DCMAKE_BUILD_TYPE=DEBUG .
cmake --build . --config=DEBUG
```

```
valgrind ./embroider --full-test-suite
```

While we will attempt to maintain good results from this script as part of normal development it should be the first point of failure on any system we haven't tested or format we understand less.

Binary download We need a current `embroider` command line program download, so people can update without building.

Identify the meaning of these TODO items

- Saving CSV/SVG (rt) + CSV read/write UNKNOWN interpreted as COLOR bug #179
- Lego Mindstorms NXT/EV3 ports and/or commands

Progress Chart The chart of successful from-to conversions (previously a separate issue) is something that should appear in the README.

Style Rather than maintain our own standard for style, please defer to the Python's PEP 7 (12) for C style. If it passes the linters for that we consider it well styled for a pull request.

As for other languages we have no house style other than whatever **major** styles exist, for example Java in Google style (13) would be acceptable. We'll elect specific standards if it becomes an issue.

Standard The criteria for a good Pull Request from an outside developer has these properties, from most to least important:

- No regressions on testing.
- Add a feature, bug fix or documentation that is already agreed on through GitHub issues or some other way with a core developer.
- No GUI specific code should be in libembroidery, that's for Embroidermoder.
- Pedantic/ansi C unless there's a good reason to use another language.
- Meet the style above (i.e. PEP 7, Code Lay-out). We'll just fix the style if the code's good and it's not a lot of work.
- **embroider** should be in POSIX style as a command line program.
- No dependancies that aren't "standard", i.e. use only the C Standard Library.

Image Fitting A currently unsolved problem in development that warrants further research is the scenario where a user wants to feed embroider an image that can then be .

To Place A *right-handed coordinate system* is one where up is positive and right is positive. Left-handed is up is positive, left is positive. Screens often use down is positive, right is positive, including the OpenGL standard so when switching between graphics formats and stitch formats we need to use a vertical flip (`embPattern_flip`).

`0x20` is the space symbol, so when padding either 0 or space is preferred and in the case of space use the literal ' '.

To Do We currently need help with:

- Thorough descriptions of each embroidery format.
- Finding resources for each of the branded thread libraries (along with a full citation for documentation).
- Finding resources for each geometric algorithm used (along with a full citation for documentation).
- Completing the full `--full-test-suite` with no segfaults and at least a clear error message (for example `not implemented yet`).
- Identifying **best guesses** for filling in missing information when going from, say `.csv` to a late `.pes` version. What should the default be when the data doesn't clarify?
- Improving the written documentation.

- Funding, see the Sponsor button above. We can treat this as **work** and put far more hours in with broad support in small donations from people who want specific features.

Beyond this the development targets are categories sorted into:

- Basic Features
- Code quality and user friendliness
- embroider CLI
- Documentation
- GUI
- electronics development

Basic features

- Incorporate `\#if 0`ed parts of `libembroidery.c`.
- Interpret how to write formats that have a read mode from the source code and vice versa.
- Document the specifics of the file formats here for embroidery machine specific formats. Find websites and other sources that break down the binary formats we currently don't understand.
- Find more and better documentation of the structure of the headers for the formats we do understand.

Code quality and user friendliness

- Document all structs, macros and functions (will contribute directly on the web version).
- Incorporate experimental code, improve support for language bindings.
- Make stitch x, y into an `EmbVector`.

embroider CLI

- Make `-circle` flag to add a circle to the current pattern.
- Make `-rect` flag to add a rectangle to the current pattern.
- Make `-fill` flag to set the current satin fill algorithm for the current geometry. (for example `-fill crosses -circle 11,13,10` fills a circle with center 11mm, 13mm with radius 10mm with crosses).
- Make `-ellipse` flag to add to ellipse to the current pattern.
- Make `-bezier` flag to add a bezier curve to the current pattern.

Embroider pipeline Adjectives apply to every following noun so

```
embroider --satin 0.3,0.6 --thickness 2 --circle 10,20,5 \
  --border 3 --disc 30,40,10 --arc 30,50,10,60 output.pes
```

Creates:

- a circle with properties: thickness 2, satin 0.3,0.6

- a disc with properties:
- an arc with properties:

in that order then writes them to the output file `output.pes`.

Documentation

1. Create csv data files for thread tables.
2. Convert tex to markdown, make tex an output of `build.bash`.
3. Run `sloccount` on `extern/` and `.` (and `)` so we know the current scale of the project, aim to get this number low. Report the total as part of the documentation.
4. Try to get as much of the source code that we maintain into C as possible so new developers don't need to learn multiple languages to have an effect. This bars the embedded parts of the code.

GUI

1. Make MobileViewer also backend to `libembroidery` with a Java wrapper.
2. Make iMobileViewer also backend to `libembroidery` with a Swift wrapper.
3. Share some of the MobileViewer and iMobileViewer layout with the main EM2. Perhaps combine those 3 into the Embroidermodder repository so there are 4 repositories total.
4. Convert layout data to JSON format and use cJSON for parsing.

Electronics development

- Currently experimenting with Fritzing⁸, upload netlists to embroiderbot when they can run simulations using the asm in `libembroidery`.
- Create a common assembly for data that is the same across chipsets `libembroidery_data_internal.s`.
- Make the defines part of `embroidery.h` all systems and the function list `c code only`. That way we can share some development between assembly and C versions.

Formats

Overview

Read/Write Support Levels

The table of read/write format support levels uses the status levels described here:

Status Label	Score	Description
rw-none		Either the format produces no output, reporting an error. Or it produces a Tajima dst file as an alternative.
rw-poor		A file somewhat similar to our examples is produced. We don't know how well it runs on machines in practice as we don't have any user reports or personal tests.
rw-basic		Simple files in this format run well on machines that use this format.
rw-standard		Files with non-standard features work on machines and we have good documentation on the format.
rw-reliable		All known features don't cause crashes. Almost all work as expected.
rw-complete		All known features of the format work on machines that use this format. Translations from and to this format preserve all features present in both.

These can be split into **r-basic w-none**, for example, if they don't match.

So all formats can, in principle, have good read and good write support, because it's defined in relation to files that we have described the formats for.

Test Support Levels

Status Label	Description
test-none	No tests have been written to test the specifics of the format.

Status Label	Description
<code>test-basic</code>	Stitch Lists and/or colors have read/write tests.
<code>test-thorough</code>	All features of that format has at least one test.
<code>test-fuzz</code>	Can test the format for uses of features that we haven't thought of by feeding in nonsense that is designed to push possibly dangerous weaknesses to reveal themselves.
<code>test-complete</code>	Both thorough and fuzz testing is covered.

So all formats can, in principle, have complete testing support, because it's defined in relation to files that we have described the formats for.

Documentation Support Levels

Status Label	Description
<code>doc-none</code>	We haven't researched this beyond finding example files.
<code>doc-basic</code>	We have a rough sketch of the size and contents of the header if there is one. We know the basic stitch encoding (if there is one), but not necessarily all stitch features.
<code>doc-standard</code>	We know some good sources and/or have tested all the features that appear to exist. They mostly work the way we have described.

Status Label	Description
<code>doc-good</code>	All features that were described somewhere have been covered here or we have thoroughly tested our ideas against other softwares and hardwares and they work as expected.
<code>doc-complete</code>	There is a known official description and our description covers all the same features.

Not all formats can have complete documentation because it's based on what information is publically available. So the total score is reported in the table below based on what level we think is available.

Overall Support Since the overall support level is the combination of these 4 factors, but rather than summing up their values it's an issue of the minimum support of the 4.

Status Label(s)	Description
<code>read-only</code>	If write support is none and read support is not none.
<code>write-only</code>	If read support is none and write support is not none.
<code>unstable</code>	If both read and write support are not none but testing or documentation is none.
<code>basic</code>	If all ratings are better than none.
<code>reliable</code>	If all ratings are better than basic.
<code>complete</code>	If all ratings could not reasonably be better (for example any improvements rely on information that we may never have access to). This is the only status that can be revoked, since if the format changes or new documentation is released it is no longer complete.
<code>experimental</code>	For all other scenarios.

Table of Format Support Levels Overview of documentation support by format.

Format	Ratings	Score
Toyota Embroidery Format (.100)	rw-basic doc-none test-none	unstable
Toyota Embroidery Format (.10o)	rw-basic doc-none test-none	unstable
Bernina Embroidery Format (.art)	rw-none doc-none test-none	experimental
Bitmap Cache Embroidery Format (.bmc)	r-basic w-none doc-none test-none	1
Bits and Volts Embroidery Format (.bro)	rw-none doc-none test-none	0
Melco Embroidery Format (.cnd)	rw-none doc-none test-none	experimental
Embroidery Thread Color Format (.col)	rw-basic doc-none test-none	experimental
Singer Embroidery Format (.csd)	rw-none doc-none test-none	experimental
Comma Separated Values (.csv)	rw-none doc-none test-none	experimental
Barudan Embroidery Format (.dat)	rw-none doc-none test-none	experimental
Melco Embroidery Format (.dem)	rw-none doc-none test-none	experimental
Barudan Embroidery Format (.dsb)	rw-none doc-none test-none	experimental
Tajima Embroidery Format (.dst)	rw-none doc-none test-none	experimental
ZSK USA Embroidery Format (.dsz)	rw-none doc-none test-none	experimental
Drawing Exchange Format (.dxf)	rw-none doc-none test-none	experimental
Embird Embroidery Format (.edr)	rw-none doc-none test-none	experimental
Elna Embroidery Format (.emd)	rw-none doc-none test-none	experimental
Melco Embroidery Format (.exp)	rw-none doc-none test-none	experimental
Eltac Embroidery Format (.exy)	rw-none doc-none test-none	experimental
Sierra Expanded Embroidery Format (.eys)	rw-none doc-none test-none	experimental

Format	Ratings	Score
Fortron Embroidery Format (.fxy)	rw-none doc-none test-none	experimental
Smoothie G-Code Embroidery Format (.gc)	rw-none doc-none test-none	experimental
Great Notions Embroidery Format (.gnc)	rw-none doc-none test-none	experimental
Gold Thread Embroidery Format (.gt)	rw-none doc-none test-none	experimental
Husqvarna Viking Embroidery Format (.hus)	rw-none doc-none test-none	experimental
Inbro Embroidery Format (.inb)	rw-none doc-none test-none	experimental
Embroidery Color Format (.inf)	rw-none doc-none test-none	experimental
Janome Embroidery Format (.jef)	rw-none doc-none test-none	experimental
Pfaff Embroidery Format (.ksm)	rw-none doc-none test-none	experimental
Pfaff Embroidery Format (.max)	rw-none doc-none test-none	experimental
Mitsubishi Embroidery Format (.mit)	rw-none doc-none test-none	experimental
Ameco Embroidery Format (.new)	rw-none doc-none test-none	experimental
Melco Embroidery Format (.ofm)	rw-none doc-none test-none	experimental
Pfaff Embroidery Format (.pcd)	rw-none doc-none test-none	experimental
Pfaff Embroidery Format (.pcm)	rw-none doc-none test-none	experimental
Pfaff Embroidery Format (.pcq)	rw-none doc-none test-none	experimental
Pfaff Embroidery Format (.pcs)	rw-none doc-none test-none	experimental
Brother Embroidery Format (.pec)	rw-none doc-none test-none	experimental
Brother Embroidery Format (.pel)	rw-none doc-none test-none	experimental
Brother Embroidery Format (.pem)	rw-none doc-none test-none	experimental
Brother Embroidery Format (.pes)	rw-none doc-none test-none	experimental

Format	Ratings	Score
Brother Embroidery Format (.phb)	rw-none doc-none test-none	experimental
Brother Embroidery Format (.phc)	rw-none doc-none test-none	experimental
AutoCAD Embroidery Format (.plt)	rw-none doc-none test-none	experimental
RGB Embroidery Format (.rgb)	rw-none doc-none test-none	experimental
Janome Embroidery Format (.sew)	rw-none doc-none test-none	experimental
Husqvarna Viking Embroidery Format (.shv)	rw-none doc-none test-none	experimental
Sunstar Embroidery Format (.sst)	rw-none doc-none test-none	experimental
Data Stitch Embroidery Format (.stx)	rw-none doc-none test-none	experimental
Scalable Vector Graphics (.svg)	rw-none doc-none test-none	experimental
Pfaff Embroidery Format (.t01)	rw-none doc-none test-none	experimental
Pfaff Embroidery Format (.t09)	rw-none doc-none test-none	experimental
Happy Embroidery Format (.tap)	rw-none doc-none test-none	experimental
ThredWorks Embroidery Format (.thr)	rw-none doc-none test-none	experimental
Text File (.txt)	rw-none doc-none test-none	experimental
Barudan Embroidery Format (.u00)	rw-none doc-none test-none	experimental
Barudan Embroidery Format (.u01)	rw-none doc-none test-none	experimental
Pfaff Embroidery Format (.vip)	rw-none doc-none test-none	experimental
Pfaff Embroidery Format (.vp3)	rw-none doc-none test-none	experimental
Singer Embroidery Format (.xxx)	rw-none doc-none test-none	experimental
ZSK USA Embroidery Format (.zsk)	rw-none doc-none test-none	experimental

Toyota Embroidery Format (.100) The Toyota 100 format is a stitch-only format that uses an external color file.

The stitch encoding is in 4 byte chunks.

Toyota Embroidery Format (.10o) The Toyota 10o format is a stitch-only format that uses an external color file.

The stitch encoding is in 3 byte chunks.

Bernina Embroidery Format (.art) We don't know much about this format. TODO: Find a source.

Bitmap Cache Embroidery Format (.bmc) We don't know much about this format. TODO: Find a source.

Bits and Volts Embroidery Format (.bro) The Bits and Volts bro format is a stitch-only format that uses an external color file.

The header is 256 bytes. There's a series of unknown variables in the header.

The stitch list uses a variable length encoding which is 2 bytes for any stitch

Melco Embroidery Format (.cnd)

The Melco cnd format is a stitch-only format.

We don't know much about this format. TODO: Find a source.

Embroidery Thread Color Format (.col)

An external color file format for formats that do not record their own colors.

It is a human-readable format that has a header that is a single line containing only the number of threads in decimal followed by the windows line break `\r\n`.

Then the rest of the file is a comma seperated value list of all threads with 4 values per line: the index of the thread then the red, green and blue channels of the color in that order.

Example If we had a pattern called "example" with four colors: black, red, magenta and cyan in that order then the file is (with the white space written out):

example.col

4\r\n

0,0,0,0\r\n

1,255,0,0\r\n

2,0,255,0\r\n
3,0,0,255\r\n

Singer Embroidery Format (.csd)

Stitch Only Format

Comma Separated Values (.csv)

Comma Separated Values files aren't a universal system, here we aim to offer a broad support.

Control Symbol	Type	Description
#	COMMENT	
>	VARIABLE	To store records of a pattern's width, height etc. This means that data stored in the header of say a .dst file is preserved.
\\$	THREAD	
*	STITCH	
*	JUMP	
*	COLOR	To change a color: used for trim as well
*	END	To end a pattern.
*	UNKNOWN	For any feature that we can't identify.

Barudan Embroidery Format (.dat)

Stitch Only Format

Melco Embroidery Format (.dem)

Stitch Only Format

Barudan Embroidery Format (.dsb)

- Stitch Only Format.
- ☒ Basic Read Support
- ☐ Basic Write Support
- ☐ Well Tested Read
- ☐ Well Tested Write

Tajima Embroidery Format (.dst)

- Stitch Only Format.
- ☒ Basic Read Support
- ☒ Basic Write Support
- ☐ Well Tested Read
- ☐ Well Tested Write

.DST (Tajima) embroidery file read/write routines Format comments are thanks to tspilman@dalcoathletic.com who's notes appeared at <http://www.wotsit.org> under Tajima Format.

Header

The header seems to contain information about the design. Seems to be ASCII text delimited by 0x0D (carriage returns). This must be in the file for most new software or hardware to consider it a good file! This is much more important than I originally believed. The header is 125 bytes in length and padded out by 0x20 to 512 bytes total. All entries in the header seem to be 2 ASCII characters followed by a colon, then it's value trailed by a carriage return.

<i>C memory</i>	<i>Description</i>
<code>char LA[16+1];</code>	First is the 'LA' entry, which is the design name with no path or extension information. The blank is 16 characters in total, but the name must not be longer than 8 characters and padded out with spaces (0x20).
<code>char ST[7+1];</code>	Next is the stitch count ST, this is a 7 digit number padded by leading zeros. This is the total stitch count including color changes, jumps, nups, and special records.
<code>char CO[3+1];</code>	Next, is CO or colors, a 3 digit number padded by leading zeros. This is the number of color change records in the file.
<code>char POSX[5+1];</code>	Next is +X or the positive X extent in centimeters, a 5 digit non-decimal number padded by leading zeros.
<code>char NEGX[5+1];</code>	Following is the -X or the negative X extent in millimeters, a 5 digit non-decimal number padded by leading zeros.
<code>char POSY[5+1];</code>	Again, the +Y extents.
<code>char NEGY[5+1];</code>	Again, the -Y extents.

<i>C memory</i>	<i>Description</i>
<code>char AX[6+1]; char AY[6+1];</code>	AX and AY should express the relative coordinates of the last point from the start point in 0.1 mm. If the start and last points are the same, the coordinates are (0,0).
<code>char MX[6+1]; char MY[6+1];</code>	MX and MY should express coordinates of the last point of the previous file for a multi-volume design. A multi-volume design means a design consisted of two or more files. This was used for huge designs that can not be stored in a single paper tape roll. It is not used so much (almost never) nowadays.
<code>char PD[9+1];</code>	PD is also storing some information for multi-volume design.

\end{longtable}

Uses 3 byte per stitch encoding with the format as follows:

The 3 byte encoding for the dxf format.

<i>Bit</i>	<i>7</i>	<i>6</i>	<i>5</i>	<i>4</i>	<i>3</i>	<i>2</i>	<i>1</i>	<i>0</i>
Byte 0	y+1	y-1	y+9	y-9	x-9	x+9	x-1	x+1
Byte 1	y+3	y-3	y+27	y-27	x-27	x+27	x-3	x+3
Byte 2	jump	color change	y+81	y-81	x-81	x+81	set	set

T01 and Tap appear to use Tajima Ternary.

Where the stitch type is determined as:

- Normal Stitch 00000011 0x03
- Jump Stitch 10000011 0x83
- Stop/Change Color 11000011 0xC3
- End Design 11110011 0xF3

Inclusive or'ed with the last byte.

Note that:

1. The max stitch length is the largest sum of 1+3+9+27+81=121 where the unit length is 0.1mm so 12.1mm.
2. The coordinate system is right handed.

ZSK USA Embroidery Format (.dsz)

The ZSK USA dsz format is stitch-only.

Drawing Exchange Format (.dxf)

Graphics format.

Embird Embroidery Format (.edr)

Stitch Only Format

Elna Embroidery Format (.emd)

Stitch Only Format.

Melco Embroidery Format (.exp)

Stitch Only Format.

Eltac Embroidery Format (.exy)

Stitch Only Format.

Sierra Expanded Embroidery Format (.eys)

Stitch Only Format.

Smoothie G-Code Embroidery Format (.fxy)?

Fortron Embroidery Format (.fxy)

Stitch Only Format.

Great Notions Embroidery Format (.gnc)

Stitch Only Format.

Gold Thread Embroidery Format (.gt)

Stitch Only Format.

Husqvarna Viking Embroidery Format (.hus)

Stitch Only Format.

Inbro Embroidery Format (.inb)

Stitch Only Format.

Embroidery Color Format (.inf)

Stitch Only Format.

Janome Embroidery Format (.jef)

Stitch Only Format.

Pfaff professional Design format (.ksm)

Stitch Only Format.

Pfaff Embroidery Format (.max)

Stitch Only Format.

Mitsubishi Embroidery Format (.mit)

Stitch Only Format.

Ameco Embroidery Format (.new)

Stitch Only Format.

Melco Embroidery Format (.ofm)

Stitch Only Format.

Pfaff PCD File Format

Stitch Only Format.

The format uses a signed 3 byte-length number type.

See the description here (5) for the overview of the format.

For an example of the format see (11).

Pfaff Embroidery Format (.pcm)

The Pfaff pcm format is stitch-only.

Pfaff Embroidery Format (.pcq)

The Pfaff pcq format is stitch-only.

Pfaff Embroidery Format (.pcs)

The Pfaff pcs format is stitch-only.

Brother Embroidery Format (.pec)

The Brother pec format is stitch-only.

Brother Embroidery Format (.pel)

The Brother pel format is stitch-only.

Brother Embroidery Format (.pem)

The Brother pem format is stitch-only.

Brother Embroidery Format (.pes)

The Brother pes format is stitch-only.

Brother Embroidery Format (.phb)

The Brother phb format is stitch-only.

Brother Embroidery Format (.phc)

The Brother phc format is stitch-only.

AutoCAD Embroidery Format (.plt)

The AutoCAD plt format is stitch-only.

RGB Embroidery Format (.rgb)

The RGB format is a color-only format to act as an external color file for other formats.

Janome Embroidery Format (.sew)

The Janome sew format is stitch-only.

Husqvarna Viking Embroidery Format (.shv)

The Husqvarna Viking shv format is stitch-only.

Sunstar Embroidery Format (.sst)

The Sunstar sst format is stitch-only.

Data Stitch Embroidery Format (.stx)

The Data Stitch stx format is stitch-only.

Scalable Vector Graphics (.svg)

The scalable vector graphics (SVG) format is a graphics format maintained by
...

Pfaff Embroidery Format (.t01)

The Pfaff t01 format is stitch-only.

\subsection Pfaff Embroidery Format (.t09)

The Pfaff t09 format is stitch-only.

Happy Embroidery Format (.tap)

The Happy tap format is stitch-only.

ThredWorks Embroidery Format (.thr)

The ThreadWorks thr format is stitch-only.

Text File (.txt)

The txt format is stitch-only and isn't associated with a specific company.

Barudan Embroidery Format (.u00)

The Barudan u00 format is stitch-only.

Barudan Embroidery Format (.u01)

The Barudan u01 format is stitch-only.

Pfaff Embroidery Format (.vip)

The Pfaff vip format is stitch-only.

Pfaff Embroidery Format (.vp3)

The Pfaff vp3 format is stitch-only.

Singer Embroidery Format (.xxx)

The Singer xxx format is stitch-only.

ZSK USA Embroidery Format (.zsk)

The ZSK USA zsk format is stitch-only.

On Embedded Systems

The library is designed to support embedded environments, so it can be used in CNC applications.

Compatible Boards

We recommend using an Arduino Mega 2560 or another board with equal or greater specs. That being said, we have had success using an Arduino Uno R3 but this will likely require further optimization and other improvements to ensure continued compatibility with the Uno. See below for more information.

Arduino Considerations

There are two main concerns here: Flash Storage and SRAM.

libembroidery continually outgrows the 32KB of Flash storage on the Arduino Uno and every time this occurs, a decision has to be made as to what capabilities should be included or omitted. While reading files is the main focus on arduino, writing files may also play a bigger role in the future. Long term, it would be most practical to handle the inclusion or omission of any feature via a single configuration header file that the user can modify to suit their needs.

SRAM is in extremely limited supply and it will deplete quickly so any dynamic allocation should occur early during the setup phase of the sketch and sparingly or not at all later in the sketch. To help minimize SRAM consumption on Arduino and ensure libembroidery can be used in any way the sketch creator desires, it is required that any sketch using libembroidery must implement event handlers. See the ino-event source and header files for more information.

There is also an excellent article by Bill Earl on the Adafruit Learning System which covers these topics in more depth: <http://learn.adafruit.com/memories-of-an-arduino?view=all>.

Space

Since a stitch takes 3 bytes of storage and many patterns use more than 10k stitches, we can't assume that the pattern will fit in memory. Therefore we will need to buffer the current pattern on and off storage in small chunks. By the same reasoning, we can't load all of one struct before looping so we will need functions similar to `binaryReadInt16` for each struct.

This means the `EmbArray` approach won't work since we need to load each element and dynamic memory management is unnecessary because the arrays lie in storage.

TODO: Replace `EmbArray` functions with `embPattern` load functions.

Tables

All thread tables and large text blocks are too big to compile directly into the source code. Instead we can package the library with a data packet that is compiled from an assembly program in raw format so the specific padding can be controlled.

In the user section above we will make it clear that this file needs to be loaded on the pattern USB/SD card or the program won't function.

TODO: Start file with a list of offsets to data with a corresponding table to load into with macro constants for each label needed.

Current Pattern Memory Management

It will be simpler to make one file per EmbArray so we keep an EmbFile* and a length, so no malloc call is necessary. So there needs to be a consistent tmpfile naming scheme.

TODO: For each pattern generate a random string of hexadecimal and append it to the filenames like `stitchList_A16F.dat`. Need to check for a file which indicates that this string has been used already.

Special Notes

Due to historical reasons and to remain compatible with the Arduino 1.0 IDE, this folder must be called "utility". Refer to the arduino build process for more info: <https://arduino.github.io/arduino-cli/0.19/sketch-build-process/>.

libembroidery relies on the Arduino SD library for reading files. See the ino-file source and header files for more information.

The Assembly Split

One problem to the problem of supporting both systems with abundant memory (such as a 2010s or later desktop) and with scarce memory (such as embedded systems) is that they don't share the same assembly language. To deal with this: there will be two equivalent software which are hand engineered to be similar but one will be in C and the other in the assembly dialects we support.

All assembly will be intended for embedded systems only, since a slightly smaller set of features will be supported. However, we will write a **x86** version since that can be tested.

That way the work that has been done to simplify the C code can be applied to the assembly versions.

Build

To build the documentation run **make**. This should run no problem on a normal Unix-like environment assuming pandoc is available.

- Pandoc creates the content of the page by converting the markdown to html.
- Pandoc also creates the printer-friendly documentation from the same markdown.
- Markdown acts as a go-between because it is easy to alter directly in the GH editor.

This way:

- We write one set of documents for all projects.
- The website can be simple and static, supporting machines that don't run javascript.
- We control the styling of each version independently of our editing (Markdown) version
- The printer-friendly documentation can have nicely rendered fonts and well placed figures.

Features

Bindings

Bindings for libembroidery are maintained for the languages we use internally in the project, for other languages we consider that the responsibility of other teams using the library.

So libembroidery is going to be supported on:

- C (by default)
- C++ (also by default)
- Java (for the Android application MobileViewer)
- Swift (for the iOS application iMobileViewer)

For C# we recommend directly calling the function directly using the DllImport feature:

```
[DllImport("libembroidery.so", EntryPoint="readCsv")]
```

see this [StackOverflow](#) discussion for help.

For Python you can do the same using ctypes.

Other Supported Thread Brands

The thread lists that aren't preprogrammed into formats but are indexed in the data file for the purpose of conversion or fitting to images/graphics.

- Arc Polyester

- Arc Rayon
- Coats and Clark Rayon
- Exquisite Polyester
- Fufu Polyester
- Fufu Rayon
- Hemingworth Polyester
- Isacord Polyester
- Isafil Rayon
- Marathon Polyester
- Marathon Rayon
- Madeira Polyester
- Madeira Rayon
- Metro Polyester
- Pantone
- Robison Anton Polyester
- Robison Anton Rayon
- Sigma Polyester
- Sulky Rayon
- ThreadArt Rayon
- ThreadArt Polyester
- ThreaDelight Polyester
- Z102 Isacord Polyester

Bibliography

1. Rudolf *Technical Info* <http://www.achatina.de/sewing/main/TECHNICAL.HTM> (Accessed 25 November 2021)
2. fineEmbStudio2021
3. Edutech format description (eduTechWikiDST)
4. KDE Liberty Description (libertyTajima)
5. The Sewing Witch *PCD2FMT* <http://www.sewingwitch.com/sewing/bin/pcd2fmt.html> (Accessed November 2021)
6. <http://steve-jansen.github.io/guides/windows-batch-scripting/part-7-functions.html>
7. <https://stackoverflow.com/questions/16286134/imagemagick-how-can-i-work-with-histogram-result>
8. Fritzing <https://github.com/fritzing/fritzing-app>
9. Sahoo, P., Wilkins, C., and Yeager, J., “Threshold selection using Renyi’s entropy”, *Pattern Recognition*, vol. 30, no. 1, pp. 71–84, 1997. doi:10.1016/S0031-3203(96)00065-9.
10. <http://www.fmwconcepts.com/imagemagick/sahoothresh/index.php> (Accessed 12 Dec 2021)
11. FINDME
12. G. van Rossum and B. Warsaw “Python PEP 7” <https://peps.python.org/pep-0007/> (Accessed April 2020)
13. Google et al. “Google Java Style Guide” <https://google.github.io/stylegu>

[ide/javaguide.html](#) (Accessed April 2022)