

## UTF-8 installations of T<sub>E</sub>X

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### Abstract

In its design T<sub>E</sub>X has the concepts of “internal encoding” and “external encoding”. This fact allows T<sub>E</sub>X to work with any encoding.

We use Unicode as T<sub>E</sub>X’s external encoding. Then we change the necessary parts of T<sub>E</sub>X to use UTF-8 as the input/output encoding.

The resulting implementation passes the `trip` test.

### 1. Initialization

Note: we use the `web2w` [1] implementation of T<sub>E</sub>X, but the ideas described here can be applied to any implementation.

First, we change the data type of characters in text files to `wchar_t` to accommodate Unicode values.

Background: this predefined C type allocates four bytes per character (on most systems). Character constants of this type are written as `L'...'` and string constants as `L"..."`.

(For brevity, in the diffs following, the original code from `web2w`’s `ctex.w` source is preceded with `<` characters, and the new code with `>`. Both are sometimes reformatted for presentation in this article, and for readability we sometimes leave a blank line between the pieces. The actual implementation uses the file `utex.patch` [2].)

```
< @d text_char pascal_char
> @d text_char wchar_t
```

Use values from the basic multilingual plane (BMP) of Unicode.

```
< @d last_text_char 255
> @d last_text_char 65535
```

Then we change the size of the `xord` array [3] to 2<sup>16</sup> bytes.

```
< ASCII_code xord[256];
> ASCII_code xord[65536];
```

Elements in the `xchr` array [3] are overridden using the file `mapping.w`.

```
@i mapping.w
```

This file specifies the character(s) required for a particular installation of T<sub>E</sub>X, for example:

```
xchr[0xf1] = L'ë';
```

A complete example of `mapping.w` is here:

<https://github.com/igor-liferenko/cweb>

In `tex.web` the type `char` is able to contain the same characters as in text files (see §19 in [3]). Text characters are now in Unicode.

```
< pascal_char TEX_format_default[]=" TeX...
> wchar_t TEX_format_default[]=L" TeXfor...
```

```
< pascal_char months[]=" JANFEBMARAPR MAY...
> wchar_t months[]=L" JANFEBMARAPR MAYJUN...
```

File names must be in UTF-8.

```
< pascal_char name_of_file0
< [file_name_size+1],
< *const name_of_file = name_of_file0-1;
< /* on some systems this may be a
< \&{record} variable */
```

```
> char name_of_file0
> [file_name_size+1],
> *const name_of_file = name_of_file0-1;
```

It remains to set the `LC_CTYPE` locale category, on which depends the behavior of the C library functions used below

```
setlocale(LC_CTYPE, "C.UTF-8");
```

and to add the necessary headers.

```
#include <wchar.h>
#include <locale.h>
```

### 2. Input

For automatic conversion from UTF-8 to Unicode, text files (including the terminal) must be read with the C library function `fgetwc` [4].

In `ctex.w` the macro `get` is used for reading text files, as well as font metric and format files.

Text files are read in the functions `a_open.in` and `input.ln`. In `a_open.in` we replace the macro `reset` with its expansion and then in both functions we change `'get(*f)'` to `'f->d=fgetwc(f->f)'`.

### 3. Output

Printed strings can be specified directly in UTF-8. And as they are already in ASCII (which is part of UTF-8) we need no special treatment for them, except that `%c` is changed to `%lc`.

```
< wlog("%c",months[k]);
> wlog("%lc",months[k]);
```

```
< wterm("%c",xchr[s]);
> wterm("%lc",xchr[s]);
```

```
< wlog("%c",xchr[s]);
> wlog("%lc",xchr[s]);
```

```
< write(write_file[selector], "%c", xchr[s]);
> write(write_file[selector], "%lc", xchr[s]);
```

#### 4. The file name buffer

The name of the file to be opened, which is stored in the *name\_of\_file* buffer, must be encoded in UTF-8. Therefore, each character passed to *append\_to\_name*, before being added to *name\_of\_file*, must be converted to UTF-8. This is done using the C library function *wctomb* [4].

In the *append\_to\_name* macro, the variable *k* is used as the index into the *name\_of\_file* buffer where the last byte was stored. Originally, *k* was always increased and provisions were made that characters will not be written beyond the end of buffer (which has the index *file\_name\_size*); *name\_length* was then set to the minimal value between *k* and *file\_name\_size*.

We cannot do the same in our implementation, because we may reach the end of the buffer in the midst of a multibyte character. Instead, if the next multibyte character does not fit into the buffer, we prevent *k* from being increased by negating its value:

```
< @d append_to_name(X) { c=X;incr(k);
<   if (k <= file_name_size)
<     name_of_file[k]=xchr[c]; }

> @d append_to_name(X) { c=X;
>   if (k >= 0) { /* try to append? */
>     char mb[MB_CUR_MAX];
>     int len = wctomb(mb, xchr[c]);
>     if (k+len <= file_name_size)
>       for (int i = 0; i < len; i++)
>         name_of_file[++k] = mb[i];
>     else
>       k = -k; /* freeze k */ } }
```

In *pack\_file\_name* and *pack\_buffered\_name* (the functions that call *append\_to\_name*), we have to “un-freeze” its value if it was “frozen”.

```
if (k < 0) k = -k;
```

In *make\_name\_string*, each (multibyte) character from *name\_of\_file* must be converted from UTF-8 to Unicode, before being converted to T<sub>E</sub>X’s internal encoding. This is done using the C library function *mbtowl* [4].

```
< append_char(xord[name_of_file[k]]);

> { wchar_t wc;
>   k += mbtowl(&wc, name_of_file+k,
>             MB_CUR_MAX) - 1;
>   append_char(xord[wc]); }
```

In the code checking *format\_default\_length* for consistency, we use the C library function *wcstombs* [4] to count the number of bytes in the UTF-8 representation of *TEX\_format\_default*.

```
< if (format_default_length >
<     file_name_size)

> if (wcstombs(NULL,
>     TEX_format_default+1,0) >
>     file_name_size)
```

In the function *pack\_buffered\_name*, the code that drops excess characters assumes that each character is one byte:

```
if (n+b-a+1+format_ext_length >
    file_name_size)
    b=a+file_name_size-n-1-format_ext_length;
```

But the number of bytes used to represent a character in UTF-8 may be more than one. Therefore, we use an equivalent method to drop excess characters, the one which will work with multibyte characters: After appending the contents of *buffer[a .. b]* to *name\_of\_file*, we roll back in it character by character until the format extension fits in it. We use the C library function *mblen* [4] to determine the start of the next (multibyte) character to be discarded.

```
while (k+wcstombs(NULL,TEX_format_default+
    format_default_length-
    format_ext_length+1,0) >
    file_name_size) {
    k--;
    while (mblen(name_of_file+k+1,MB_CUR_MAX)
        ==-1)
        k--;
}
```

#### References

- [1] Ruckert, Martin. WEB to cweb.  
[https://w3-o.cs.hm.edu/users/ruckert/public\\_html/web2w/](https://w3-o.cs.hm.edu/users/ruckert/public_html/web2w/)
- [2] Source of the present implementation.  
<https://github.com/igor-liferenko/tex>
- [3] Knuth, Donald E. *T<sub>E</sub>X: The Program*, 1986. ISBN 0201134373.
- [4] Single Unix Specification. Introduction to ISO C Amendment 1 (Multibyte Support Environment).  
[http://unix.org/version2/whatsnew/login\\_mse.html](http://unix.org/version2/whatsnew/login_mse.html)

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