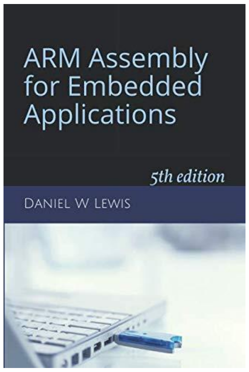


Programming Lab 5D

Automobile Tire Sizes

Topics: Integer arithmetic.

Click to download Lab5D-Main.c

Prerequisite Reading: Chapters 1-5
Revised: June 22, 2021

Background[1]: Automobile tire sizes use a combination of metric and English units and a percentage. For example, a typical tire might be specified as 225/45R17. The first number (225) is the tire's width in *millimeters*. The second number (45) is the tire's aspect ratio; this *percentage* represents the ratio of the sidewall's height to the tire's width. The last number (17) is the diameter of the metal rim in *inches*. The overall diameter of a tire is thus the rim diameter plus twice the sidewall height. I.e., the diameter of a 225/45R17 tire is given by:

$$17 + 2 \times \left(\frac{45}{100} \times \frac{225}{25.4}\right) \text{ inches.}$$

Assignment: Create ARM assembly functions for the diameter and circumference in inches:

```
uint64_t TireDiam(uint32_t W, uint32_t A, uint32_t R) ;
uint64_t TireCirc(uint32_t W, uint32_t A, uint32_t R) ;
```

where W is the tire width in millimeters, A is the aspect ratio (an integer less than 100), and R is the rim diameter in inches. The main program may be compiled and executed without writing any assembly. However, your task is to create faster assembly language replacements for these C functions using the C versions to guide your implementation. The original C functions are defined as "weak", so that the linker will automatically replace them in the executable image by those you create in assembly; you do not need to remove the C versions.

$$Diameter = R + 2 \times \frac{A}{100} \times \frac{W}{25.4} = R + \frac{2 \times A \times W}{2540} = R + \frac{A \times W}{1270}$$

Since you will be using integer arithmetic, you won't be able to return values that have a fractional part. Instead, each function computes two 32-bit values and returns them as a single 64-bit number:

$$\left.\begin{aligned} \boldsymbol{D_{63-32} = R + Quotient\ of\ \frac{A \times W}{1270}} \\ \boldsymbol{D_{31-00} = Remainder\ of\ \frac{A \times W}{1270}} \end{aligned}\right\}$$

The most-significant half of the return value is the integer part of the result; the least-significant half determines the fractional part.

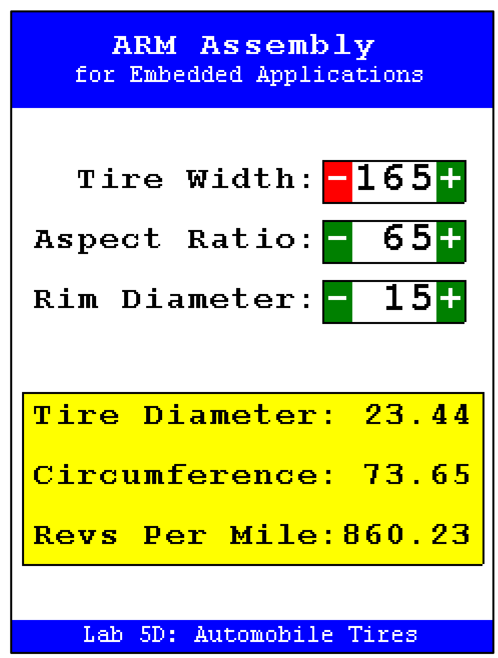
$$Circumference = \pi \times diameter = \pi \times \left(D_{63-32} + \frac{D_{31-00}}{1270}\right)$$

$$= 3.1416 \times \left(\frac{1270 \times D_{63-32} + D_{31-00}}{1270}\right)$$

$$= \frac{4987290 \times D_{63-32} + 3927 \times D_{31-00}}{1587500}$$

$$\boldsymbol{C_{63-32} = Quotient\ of\ \frac{4987290 \times D_{63-32} + 3927 \times D_{31-00}}{1587500}}$$

$$\boldsymbol{C_{31-00} = Remainder\ of\ \frac{4987290 \times D_{63-32} + 3927 \times D_{31-00}}{1587500}}$$



The main program converts these results into real numbers and displays the diameter, circumference and revolutions per mile with two fractional digits. Use the touch screen to see the results for different tire specifications.

[1] https://en.wikipedia.org/wiki/Tire_code