Introduction to Programmable Logic Controllers Ex9_datahandling

DTU 31343

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Part 1

A binary coded decimal (BCD) representation, takes each individual digit of a decimal number, and converts it to its binary representation which will take up 4 bits per decimal digit. Therefore, the algorithm would first have to make sure the number of digits are the same through the range (e.g. changing 1→01) then splicing the integers into their individual digits and representing them in the binary format using 4 bits per digit. As a result, the BCD representation of the 5 integers (maximally having 12 digits combined) would use up 48 bits of memory.

To minimise the number of bits used, it was first noticed, that it must only be known what the last two digits in the year are, reducing the number of digits in the decimal format to be 10 (12 before). Next, less bits are generally required when a number is simply formulated in the binary format than the BCD representation. Knowing this, the 5 integers can simply be combined, spliced in half and stored as two 16-bit integers, using only 32 bits of memory.

As an example, the largest combined timestamp is converted as follows:

1. The largest timestamp is given by the 5 integers: 2050, 12, 31, 23, 59.
2. As it is known that the year range is only from 2000 to 2050, the year can be reduced to only: 50.
3. The integers are combined to a single number as: 5012312359.
4. This representation is split into two 5 digit integers: 50123 12359.
5. Given that the largest number that can be represented in unsigned integer format is 65535, the timestamp can be stored as two 16-bit integers.

The number of minutes in 51 years is 26805600, meaning that there are that many unique timestamps within the required time frame. The BCD representation uses 6 bytes per timestamp resulting in around 161 MB in total. In comparison, if the 5 integers remained in the 5 integer data-structure, 10 bytes would be required per timestamp as the 16-bit integer would be used for each date specification. Therefore, resulting in around 268 MB after 51 years, which is an increase of 107 MB to what would be found when using the BCD format.

Part 2

When controlling the position of a DC-motor, the measurement that is available should be the position of the motor. This may be delivered by Hall effect sensors or rotary encoders.

As an input to the PLC, the position has to be communicated such that this may be manipulated. As an output, the required velocity to achieve the reference position may be used that is calculated based on the difference with the current position. An example operation would be:

1. The DC-motor must drive the arm to a position that is 10 m away,
2. The controller calculates that the difference between the current and target (i.e. reference) is greater than 3 m so the maximum velocity is applied in that direction,
3. The position is continuously monitored until it reduces below 3 m, where the velocity tapers off such that it stops at the desired position.

Part 3

Knowing the given range, the speed could be saved as a SINT in $\mathrm{cm\,s^{-1}}$, while the position could be saved as an INT in mm. This type is used, because it uses a low amount of bits and conforms to the range being used, while being able to represent each unique value required.

As a result, the total number of bits being used in this format would be 24.