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PROJECT 5: VISIBLE LIGHT-BASED DIGITAL COMMUNICATION

In this Project, while sending the information using bits, one can employ two different encoding methods: On-off signaling and Manchester coding.

In on-off signaling, receiver decides whether the information is 1 or 0 depending on the received signal is high or low. On the other hand, in Manchester coding, 1 is encoded as positive edge, and 0 is encoded as negative edge in the middle of the bit period.

1. On-off signaling

In this part, the detection will be done symbol by symbol, and buffer size will be equal to symbol size.

In on-off signaling, the first arising problem is synchronization. A triggering signal of 1 is employed, and its duration is selected to be 7 bit since the symbol length of the characters is also 7. When the beginning of the triggering signal is detected, the detected index of the buffer will always be the starting position of the received symbols. This position is where a decreasing transition occurs at a magnitude of 45, and for my Arduino, due to unexpected blinking of the LED during loading the code to my Arduino, the 4th sample experiences this transition will be the starting position of the trigger.

After the detection of this index, the part of the buffer with an index higher than this index will be stored. The stored part will be merged with the very first part of the next buffer until the detected index, and the resulting vector will be the binary representation of a character. Then, sweeping through this so-called buffer bit-wise, we will be looking at the mean value of each interval. If this value is lower than a certain threshold, it is 1 and vice versa. This threshold value is determined by doing experiments for 3 different delay values. According to the minimum and maximum values of these signals, a safe region is found to be 68-85, and 70 is selected to be the particular value of this threshold.

Bit period	32 ms	64 ms	100 ms
Max. value of 1	59	55	**68**
Min. value of 0	**85**	115	124

Table I

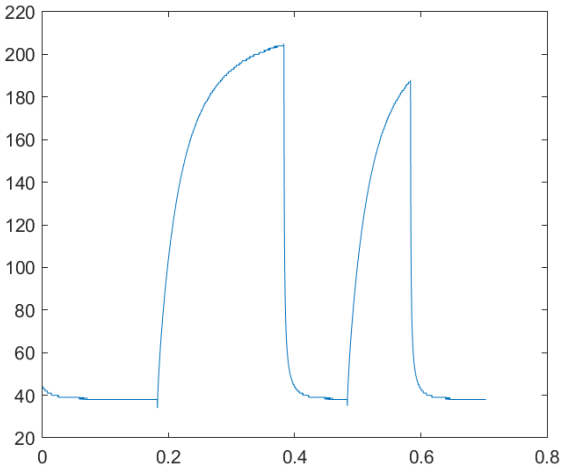

Fig. 1: The received on-off signal of "1100101" which corresponds to "e".

In Fig. 1, one can see the received on-off signal of "1100101" which corresponds to "e".

Max. data rate	30.5 bit/second
Max. freq offset	1%
Max av. Clock delay	5%

Table II

2. Manchester coding

In this part, the detection will also be done symbol by symbol, and buffer size will be equal to symbol size.

The synchronization method is the same with on-off signaling. Also, construction of the symbols are based on the same method resulting from the synchronization method.

In the detection, the author couldn't manage to find a way to employ the method in MATLAB mentioned in [1]. Instead, he calculated the mean of the upper part of the bit symbols, if it

is low, the receiver is designed to be detect 1 and vice versa. In the last experiment, the design managed to do the synchronization and detect correctly up to 7 characters. According to that experiment, other parameters are same with the first signaling, maximum data rate is found to be 3.8 bits/second.

Max. data rate	3.8 bits/second
Max. freq offset	1% with only 3 detected chars.
Max av. Clock delay	NA

Table III

The whole received character signal of "1110001" which corresponds to "q" can be seen in Fig. 2.

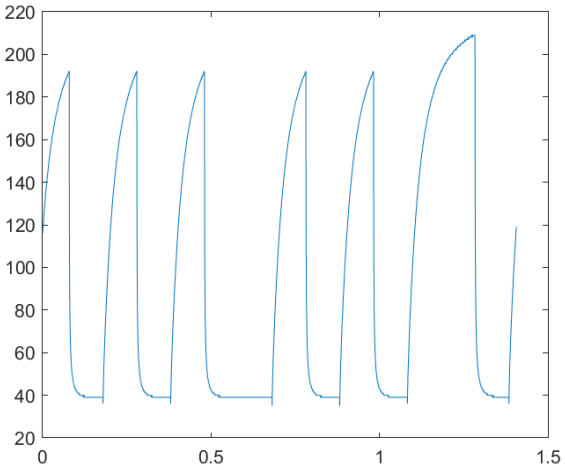

Fig. 2: The whole received character signal of "1110001" which corresponds to "q"

It is not a very reliable generalization but my conclusion, Manchester coding seems to be superior in robustness whereas on-off signaling is higher in data rate. The reason is the frequency of changes is twice of on-off signaling, and in my opinion, this makes high data rates harder in detection.

References

[1] Manchester Coding Basics (microchip.com)