SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
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DEPARTMENT OF BIOMEDICAL ENGINEERING

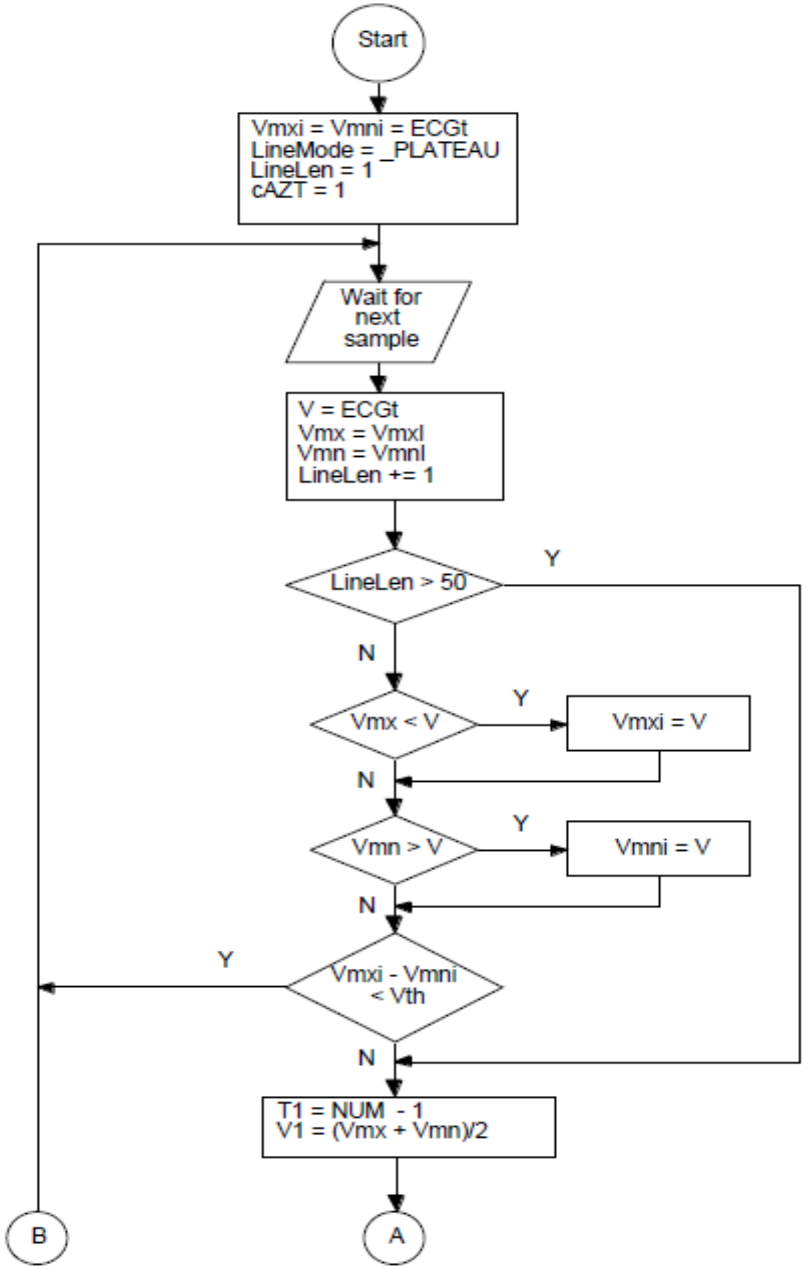
19BMB302 - BIOMEDICAL SIGNAL PROCESSING

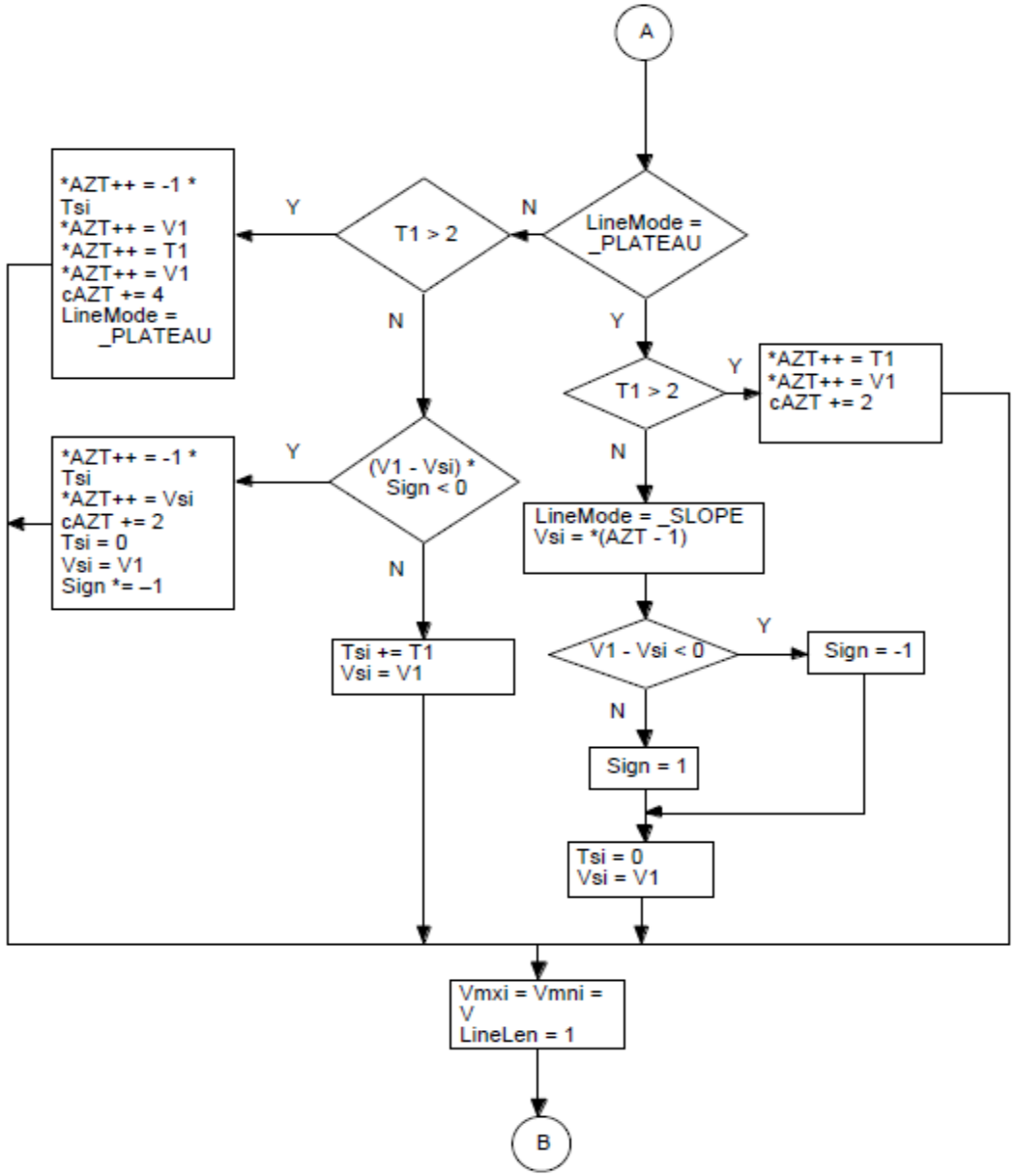
III YEAR/ V SEMESTER

Unit V : DATA REDUCTION TECHNIQUES

- Turning point algorithm
- AZTEC algorithm
- CORTES algorithm
- Fan algorithm
- Huffman algorithm

- Originally developed to preprocess ECGs for rhythm analysis, the AZTEC (Amplitude Zone Time Epoch Coding) data reduction algorithm decomposes raw ECG sample points into plateaus and slopes,
- It provides a sequence of line segments that form a piecewise-linear approximation to the ECG.
- The algorithm consists of two parts—line detection and line processing.
- Figure 1 shows the line detection operation which makes use of zero-order interpolation (ZOI) to produce horizontal lines.
- Two variables *Vmx* and *Vmn* always reflect the highest and lowest elevations of the current line.
- Variable *LineLen* keeps track of the number of samples examined.
- We store a plateau if either the difference between *Vmxi* and *Vmni* is greater than a predetermined threshold *Vth* or if *LineLen* is greater than 50.
- The stored values are the length (*LineLen* – 1) and the average amplitude of the plateau (*Vmx* + *Vmn*)/2.


Start
Vmxi = Vmni = ECGt
LineMode = _PLATEAU
LineLen = 1
cAZT = 1
Wait for next sample
V = ECGt
Vmx = Vmxl
Vmn = Vmnl
LineLen += 1
LineLen > 50
Y
N
Vmx < V
Y
Vmxi = V
N
Vmn > V
Y
Vmni = V
N
Vmxi - Vmni < Vth
Y
N
T1 = NUM - 1
V1 = (Vmx + Vmn)/2
B
A


A
LineMode = _PLATEAU
N
T1 > 2
Y
*AZT++ = -1 * Tsi
*AZT++ = V1
*AZT++ = T1
*AZT++ = V1
cAZT += 4
LineMode = _PLATEAU
N
(V1 - Vsi) * Sign < 0
Y
*AZT++ = -1 * Tsi
*AZT++ = Vsi
cAZT += 2
Tsi = 0
Vsi = V1
Sign *= –1
N
Tsi += T1
Vsi = V1
Y
T1 > 2
Y
*AZT++ = T1
*AZT++ = V1
cAZT += 2
N
LineMode = _SLOPE
Vsi = *(AZT - 1)
V1 - Vsi < 0
Y
Sign = -1
N
Sign = 1
Tsi = 0
Vsi = V1
Vmxi = Vmni = V
LineLen = 1
B

- When we reenter line processing with *LineMode* equal to _SLOPE, we either save or update the slope.
- The slope is saved either when a plateau of more than three samples can be formed or when a change in direction is detected.
- If we detecta new plateau of more than three samples, we store the current slope and the new plateau.
- For the slope, the stored values are its length *Tsi* and its final elevation *V*1.
- Note that *Tsi* is multiplied by –1 to differentiate a slope from a plateau (i.e., the minus sign serves as a flag to indicate a slope).
- We also store the length and the amplitude of the new plateau, then reset all parameters and return to plateau production.
- If a change in direction is detected in the slope, we first save the parameters for the current slope and then reset *sign*, *Vsi*, *Tsi*, *Vmxi*, and *Vmni* to produce a new AZTEC slope.
- Now the algorithm returns to line detection but remains in slope production mode.
- When there is no new plateau or change of direction, we simply update the slope's parameters, *Tsi* and *Vsi*, and return to line detection with *LineMode* remaining set to _SLOPE.
- AZTEC does not produce a constant data reduction ratio.
- The ratio is frequently as great as 10 or more, depending on the nature of the signal and the value of the empirically determined threshold.

Data reconstruction

- The data array produced by the AZTEC algorithm is an alternating sequence of durations and amplitudes. A sample AZTEC-encoded data array is
- {18, 77, 4, 101, –5, –232, –4, 141, 21, 141}
- We reconstruct the AZTEC data by expanding the plateaus and slopes into discrete data points.
- For this particular example, the first two points represent a line 18 sample periods long at an amplitude of 77.
- The second set of two points represents another line segment 4 samples long at an amplitude of 101.
- The first value in the third set of two points is negative. Since this represents the length of a line segment, and we know that length must be positive, we recognize that this minus sign is the flag indicating that this particular set of points represents a line segment with nonzero slope.
- This line is five samples long beginning at the end of the previous line segment (i.e., amplitude of 101) and ending at an amplitude of –235.
- The next set of points is also a line with nonzero slope beginning at an amplitude of –235 and ending 4 sample periods later at an amplitude of 141.
- This reconstruction process produces an ECG signal with steplike quantization, which is not clinically acceptable.
- The AZTEC-encoded signal needs postprocessing with a curve smoothing algorithm or a low-pass filter to remove its jagged appearance and produce more acceptable output.

Thank You!