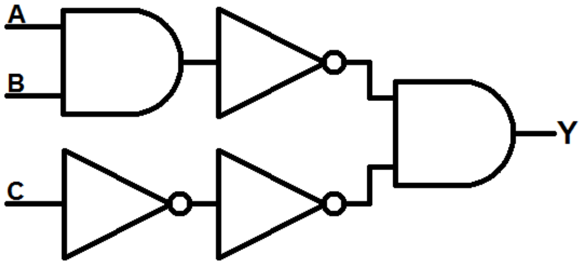
ROBUSTNESS OF SEQUENTIAL CIRCUITS

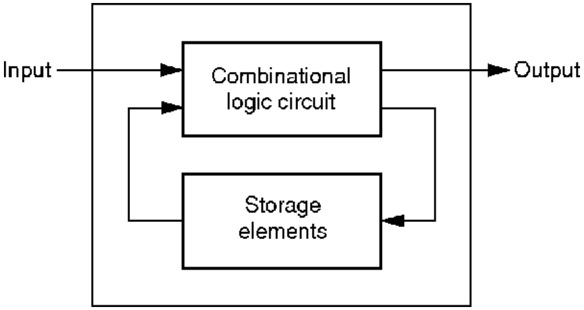
PRESENTATION BY
SRIKRUPA RAGHURAMAN

SYNOPSIS

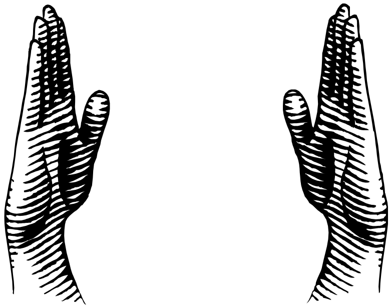
INTRODUCTION



COMBINATORIAL CIRCUITS



SEQUENTIAL CIRCUITS

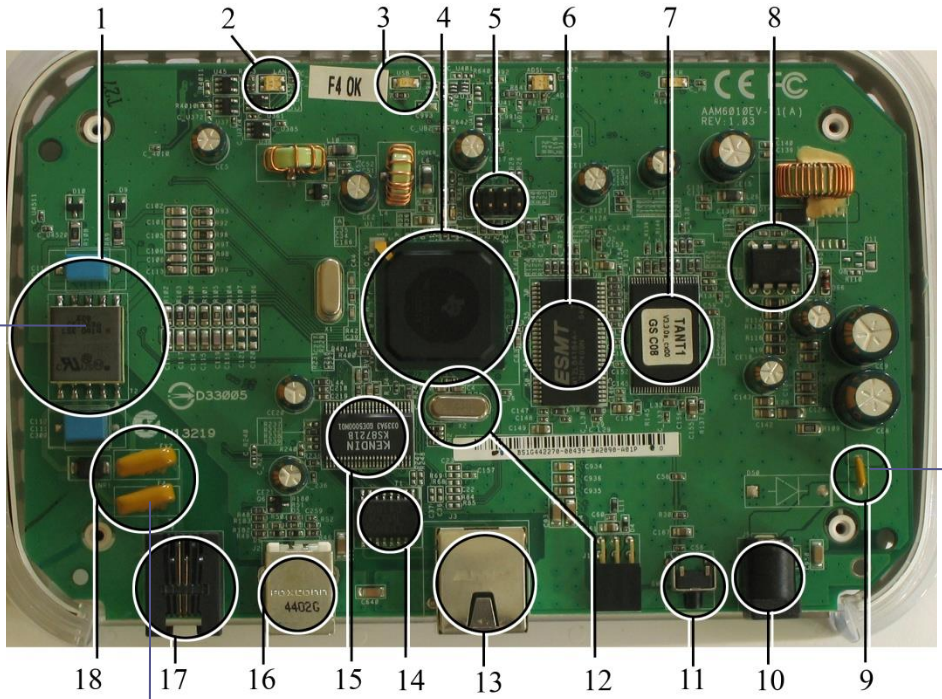


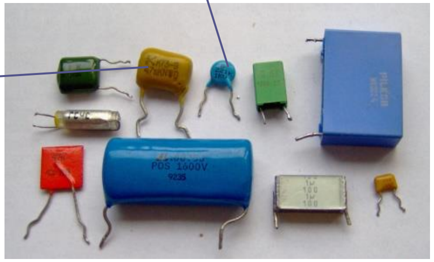
THE TYPES OF DISTANCES - METRICS

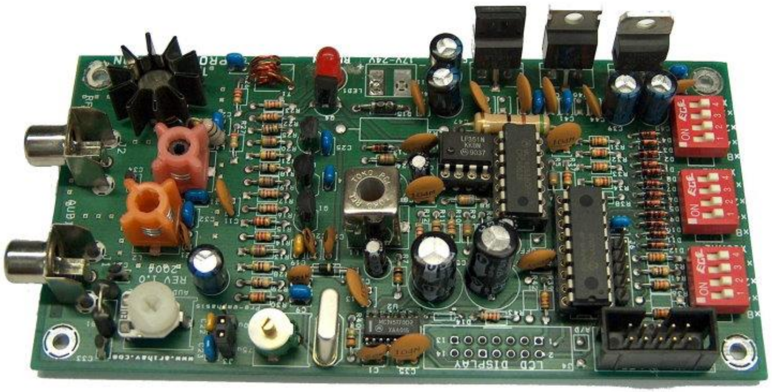
ROBUSTNESS OF SEQUENTIAL CIRCUITS

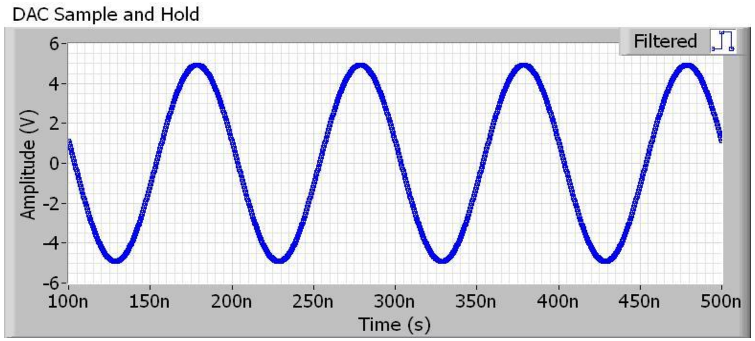
CONCLUSION

EMBEDDED SYSTEMS









EMBEDDED SYSTEMS

MAIN CHALLENGE

EXTERNAL PERTURBATIONS

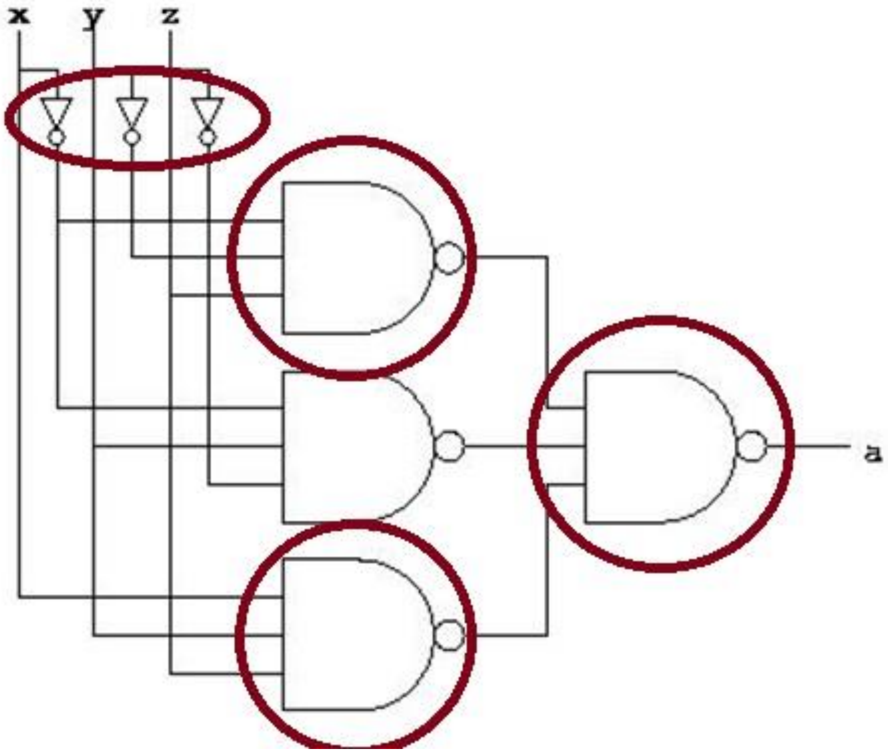
POOR ACCURACY OF SENSORS

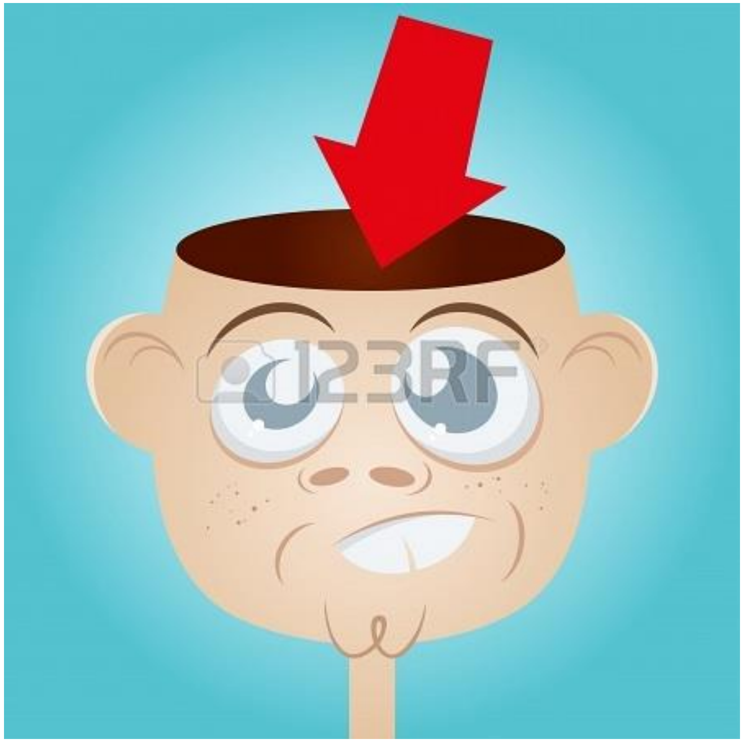
UNCERTAIN INPUTS

UNPREDICTABLE DELAYS

ROBUST BEHAVIOUR

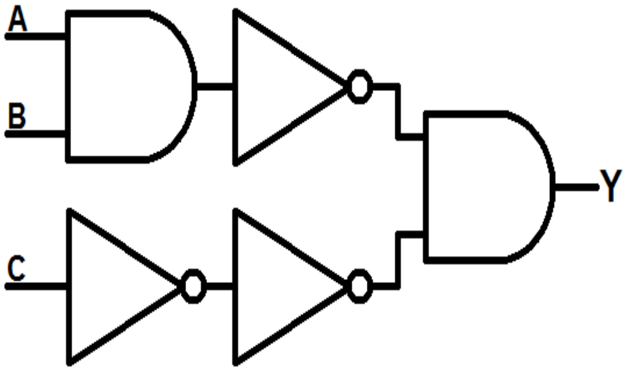
COMBINATORIAL CIRCUITS

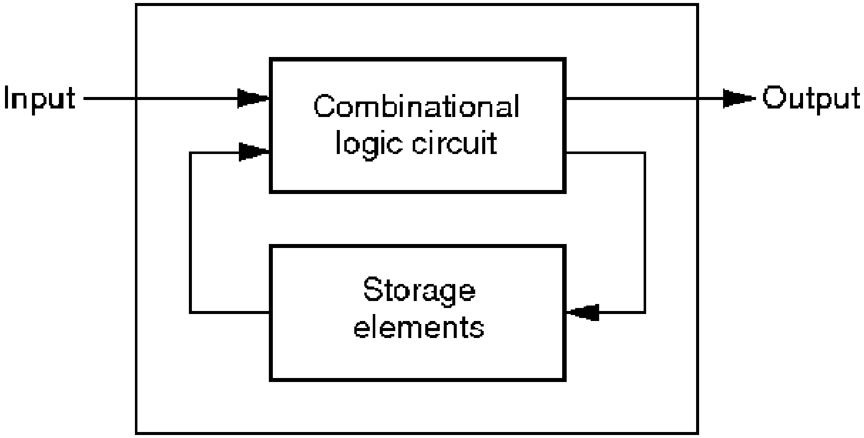




OUPUT AT TIME "T" depends on INPUT AT TIME "T"

SEQUENTIAL CIRCUITS





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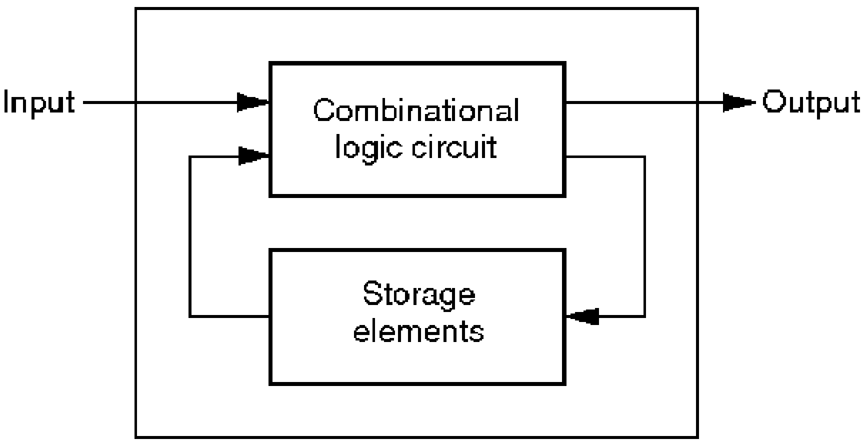
- ✓DELAY = shifts input values by one time step.
- ✓Output Value at time **t>0** = Input Value at time **t – 1**.

CYCLIC CIRCUITS



- ➢CYCLES IN SEQUENTIAL CIRCUITS = ***FEEDBACK LOOPS***
- ➢OUPUT AT TIME T = INPUT AT TIME “T” AND T-1 ***(present and past inputs)***

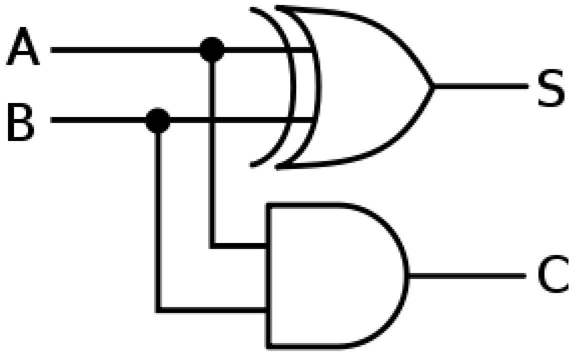
ROBUSTNESS OF SEQUENTIAL CIRCUITS

TO NOTE:

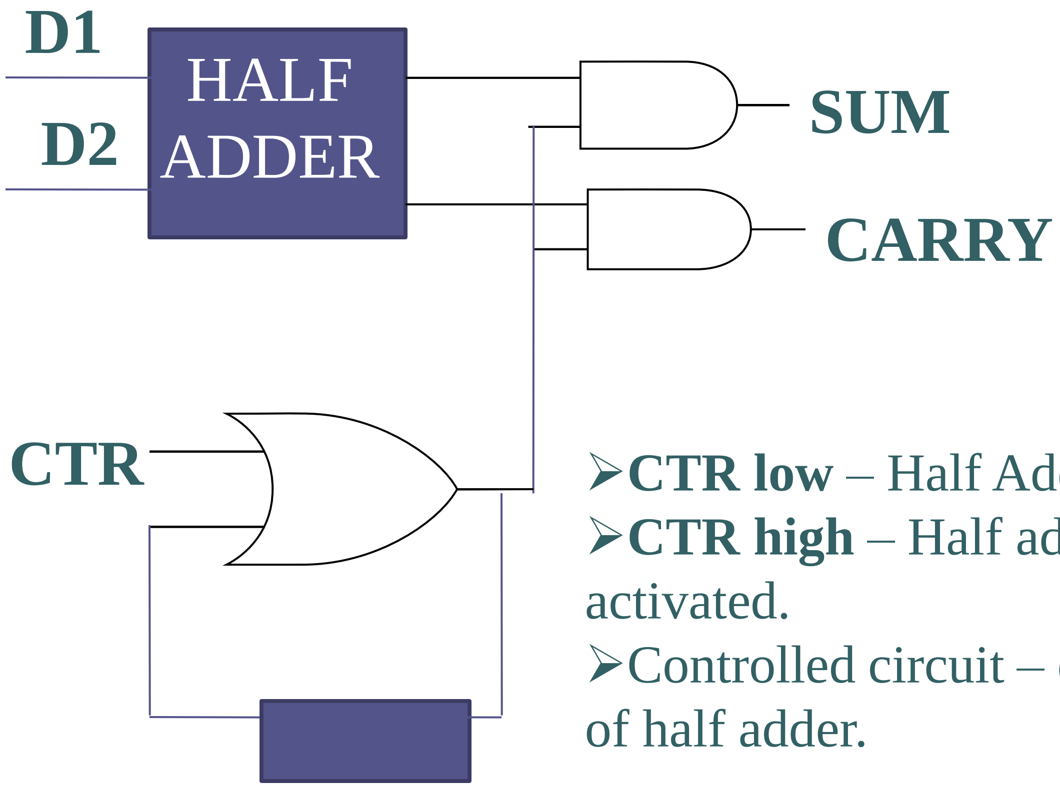
➢**DISTURBANCE VARIABLES** – ENVIRONMENT ACTIONS.

➢**CONTROL VARIABLES** – CONTROL ACTIONS

➢ROBUSTNESS STUDIED WITH RESPECT TO ***DISTURBANCE VARIABLES.***



Output at any time "t" depends on Inputs A and B at time "t"



- **CTR low** – Half Adder is inactive.
- **CTR high** – Half adder irreversibly activated.
- Controlled circuit – copies output values of half adder.

HAMMING AND LEVENSHTEIN DISTANCES

- **STANDARD METRICS** – Measures similarities between pairs of sequences.
- **HAMMING DISTANCE**

Example: toned
roses

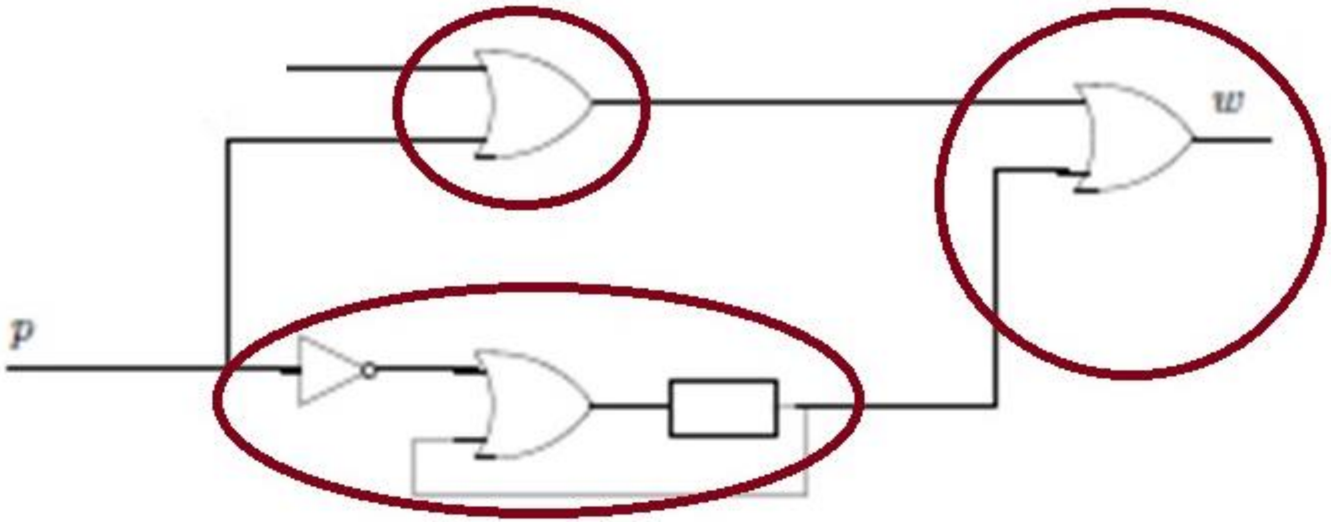
Hamming Distance is 3

1011101
1001001

Hamming Distance is 2

- **LEVENSHTEIN DISTANCE**

- **Example: kitten — sitting** → **The Levenshtein distance is 3**



$$\sigma_1 : \ \overline{\boldsymbol{p}} \cdot p^{2n} \cdot \overline{p} \cdot p^{\omega} \qquad \gamma_1 : \ w \cdot w^{2n} \cdot \underline{\boldsymbol{w}} \cdot w^{\omega}$$

$$\sigma_2 : \ \boldsymbol{p} \cdot p^{2n} \cdot \overline{p} \cdot p^{\omega} \qquad \gamma_2 : \ w \cdot w^{2n} \cdot \underline{\overline{\boldsymbol{w}}} \cdot w^{\omega}$$

p = single disturbance variable
w = output variable

DRAWBACK:

Error Observed at: (2n+2)th position

COMMON SUFFIX DISTANCE

100000111010**0**11111

100000110101**1**11111

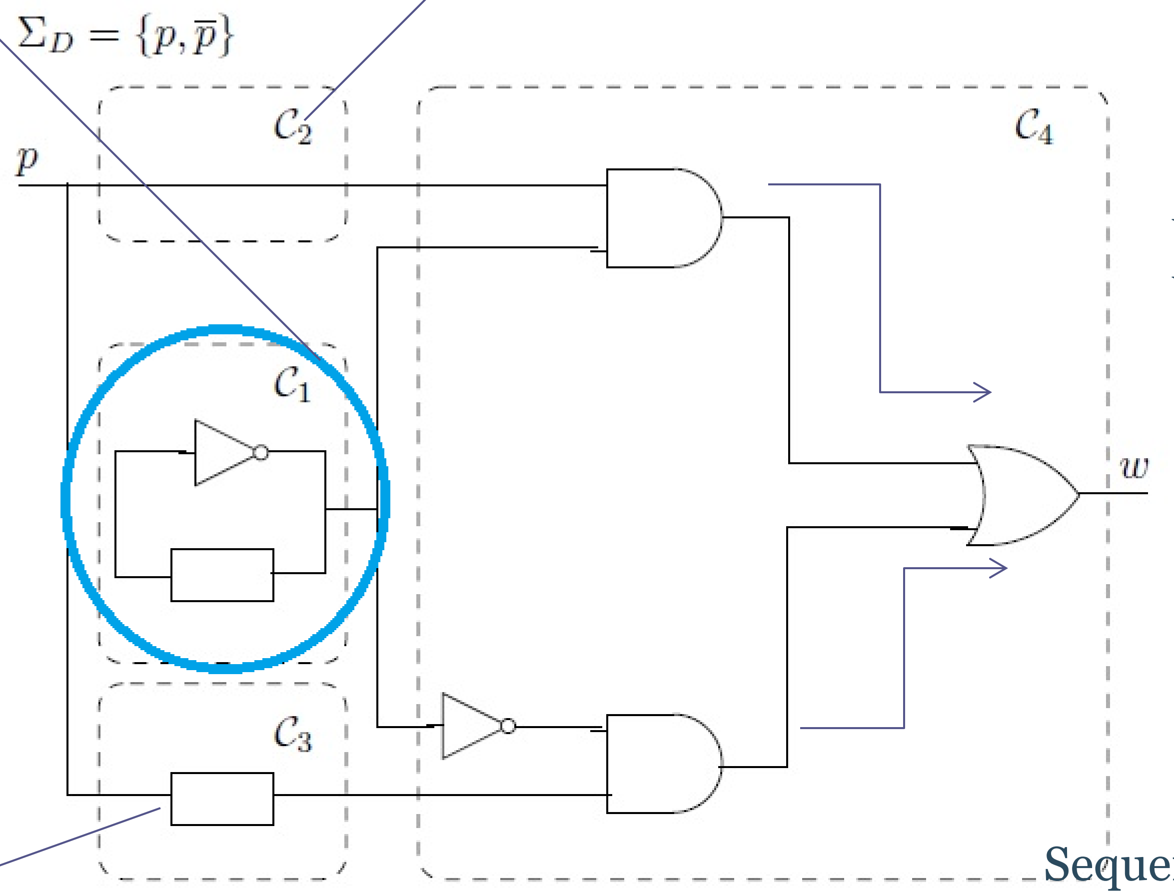
FINITE DISTURBANCE HORIZON

- Bound – b, last mismatching position k
- Last mismatching in output sequence occurs before k+b

Modulo 2 counter using feedback loop. Has no input.

Dependant on present input

Circuit has finite disturbance memory



$w^t = p^t$ (t is even)

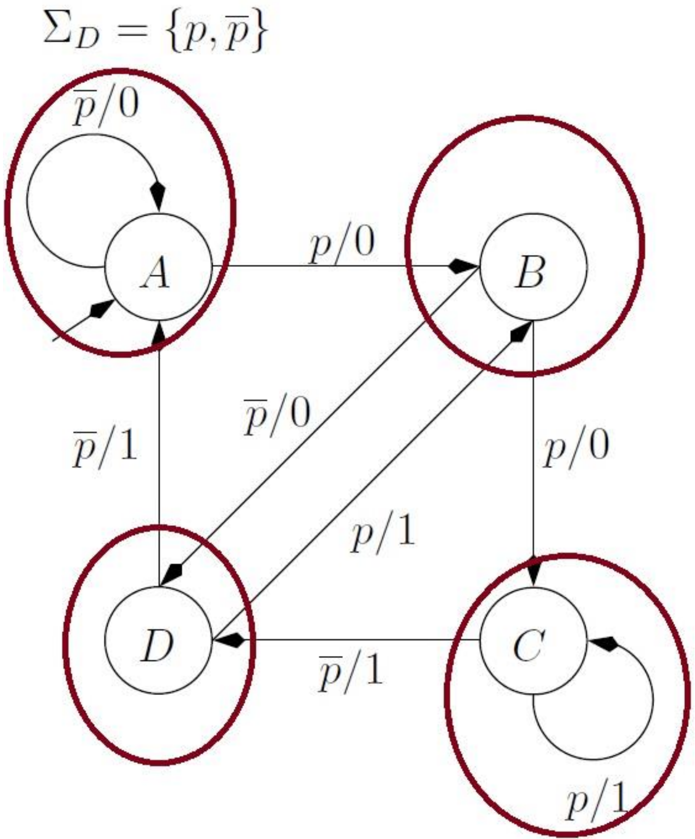
$w^t = p^t-1$ (t is odd)

Dependant on previous time step

Sequential Circuit is ΣD-Robust if and only if it has finite disturbance horizon

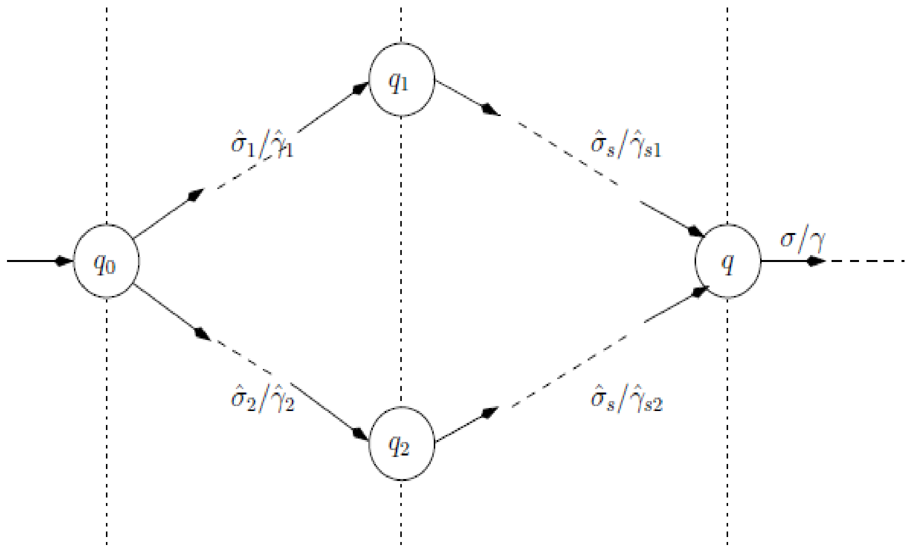
MEALY MACHINES

- Graphical Representation of Sequential circuits



FINITE STATES

TO CHECK ROBUSTNESS FOR SEQUENTIAL CIRCUITS



CRITERIA:

ΣD – SYNCHRONIZED

ALGORITHM:

"When there exists a length β on all input words , then from every pair of states a single (output state) is reached".

TIME COMPLEXITY:

$$O\left(\left(\frac{|Q|^2+Q}{2}\right) \cdot |\Sigma C| \cdot |\Sigma D|^2\right)$$

FUTURE WORK AND CONCLUSION

- Insertion, Suppression of information
- Robustness of Synchronous Circuits
- Two sequential circuits are robust – Which one is better?

LITERATURE

- Laurent Doyen – LSV, ENS Cachan, France
- Thomas A. Henzinger – IST Austria, Austria
- Axel Legay – INRIA – Irisa, France
- Dejan Nickovic – IST Austria, Austria