Analog Neural Network Hardware For Colour Classification

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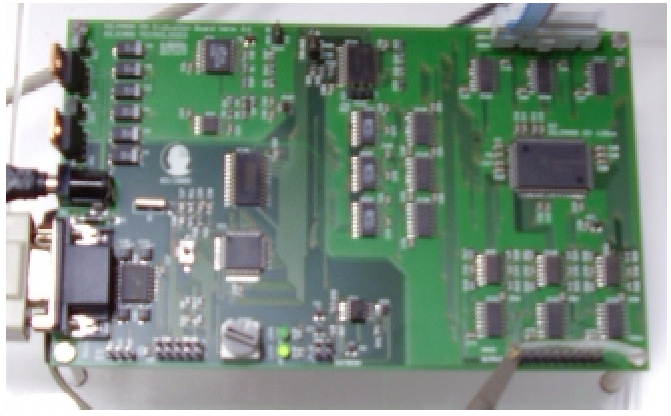
Neurocomputing Project

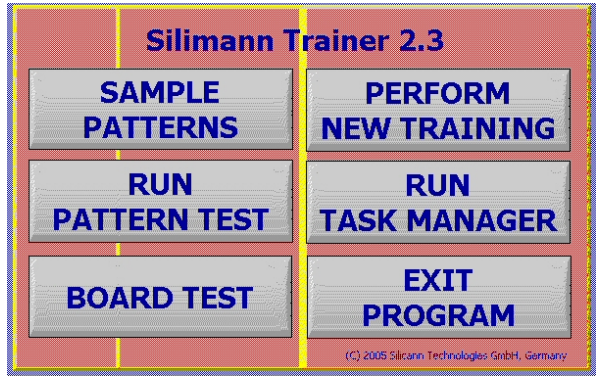
Case study : pill detection

True Colour Sensor



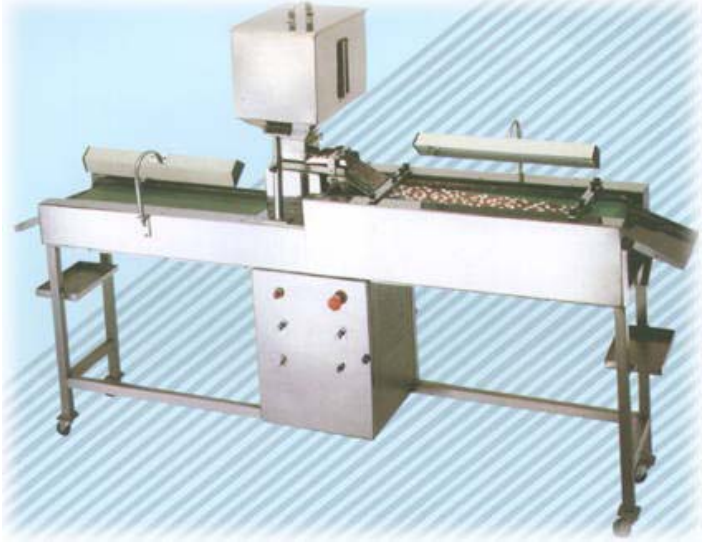
Silimann Trainer Software

Evaluation Board



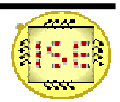
Industrial Problem

Nowadays machines replace people. Every work can be done by a machine instead of a human. People just need to **control** them. After the task is finished, we use detectors to check if there is any mistake.



Industrial Problem

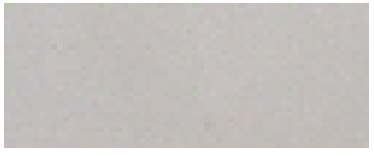
One of the problems that we handle out is about pill detection. After the machine puts all the pills in a tablet, we need to check if all the pills are in the tablet or if there are any empty slots.



Basic Problem

Problem

Is there a pill or not?



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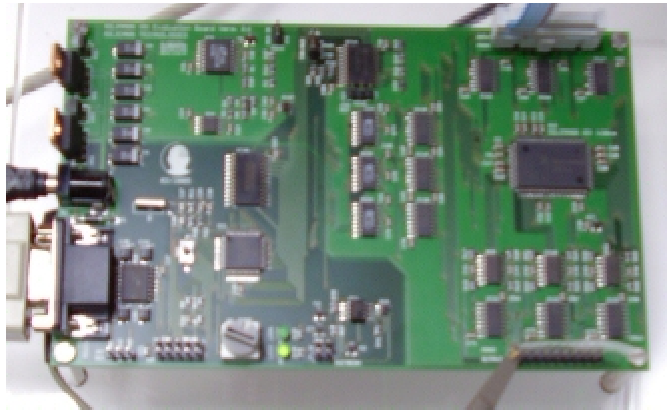
Evaluation Board

True Colour Sensor



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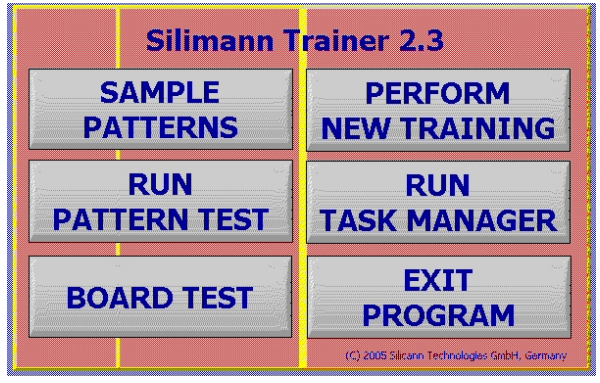
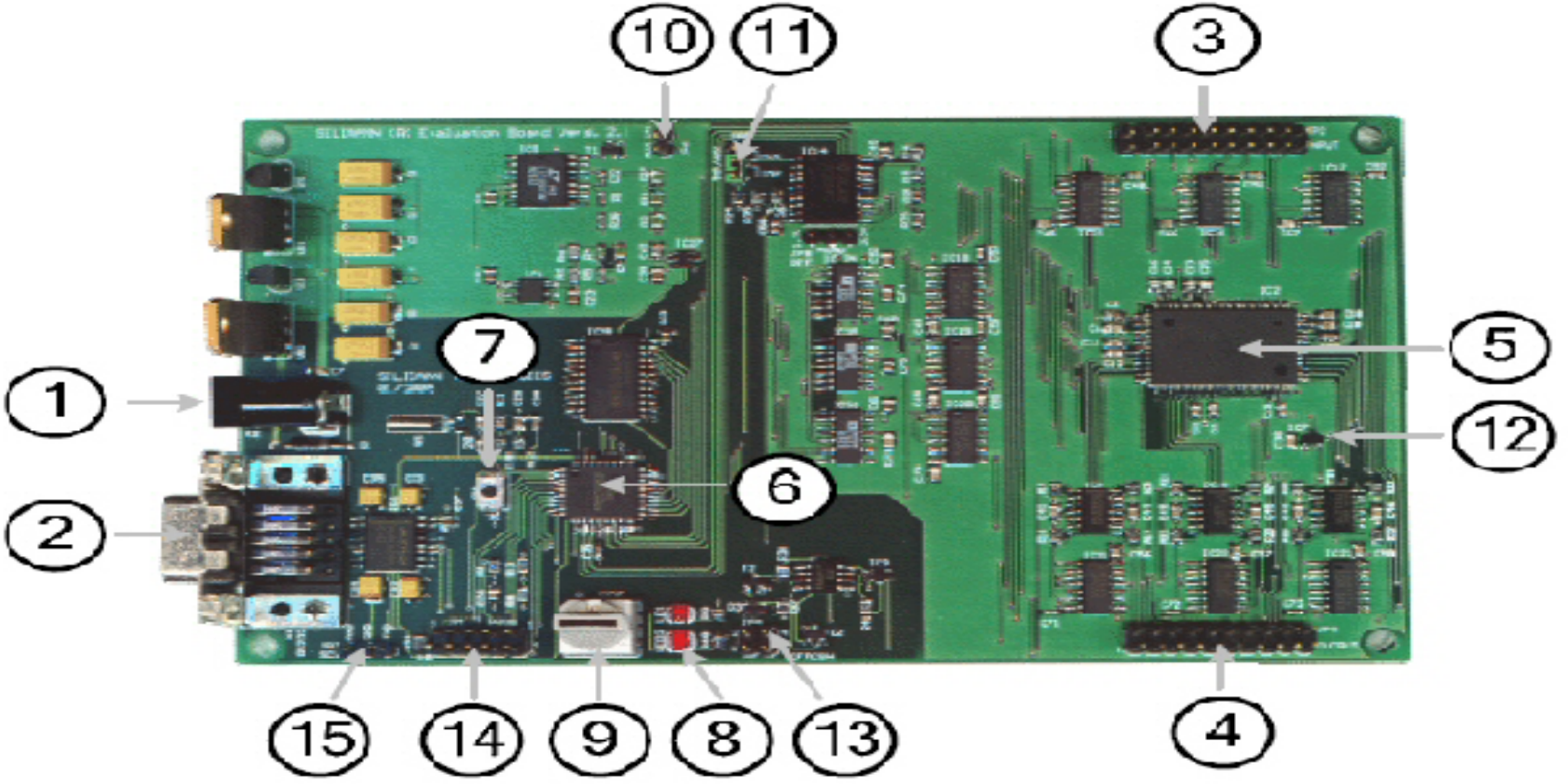
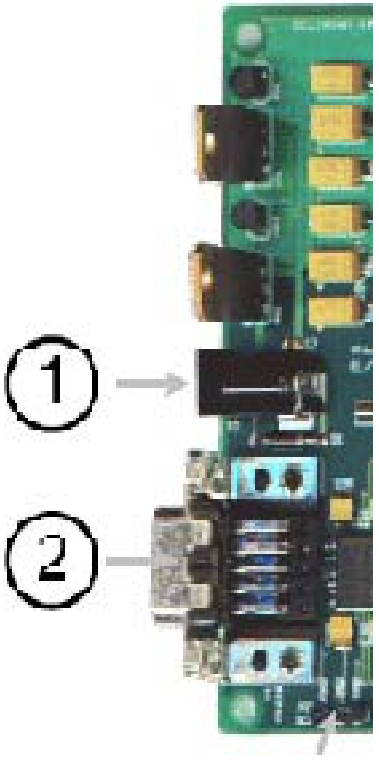
Evaluation Board



Evaluation Board



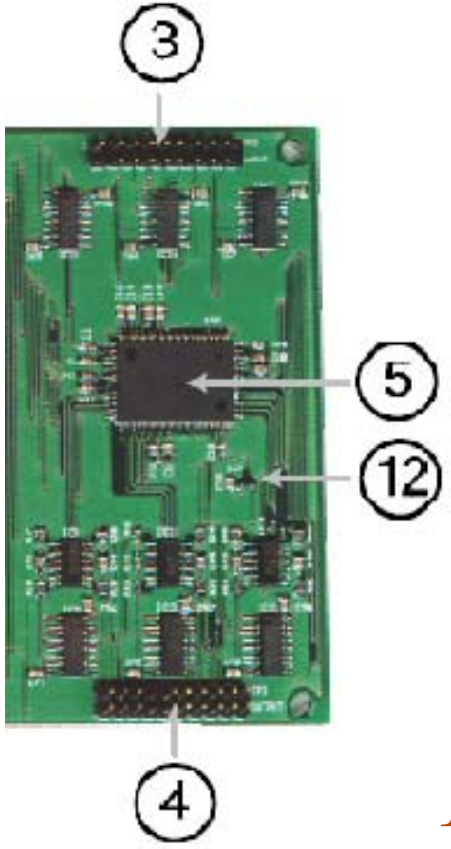
Elements of Evaluation Board



1. Power plug
2. RS232 connector :

A RS232-USB converter is provided with the evaluation board and thus the board can be connected to any computer providing a USB plug

Elements of Evaluation Board



3. Analog input signals connector

with sensor we enter the values

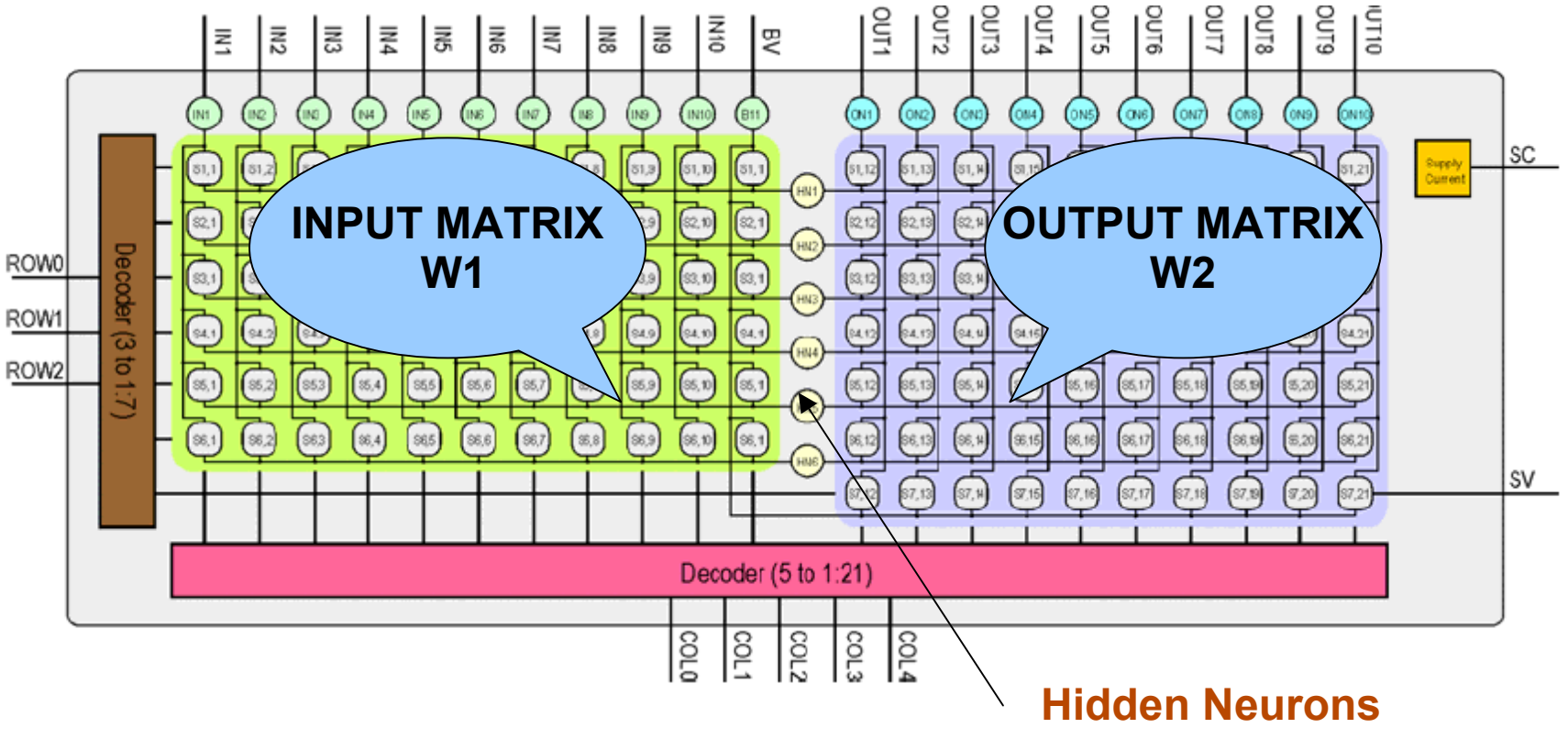
4. Analog output signal connector

with Oscilloscope we measure the response

5. Silimann 120cx LSI

12. Onboard temperature sensor

Silimann LSI logical block diagram



W1 & W2

Weight matrix W1 (hidden synapses).

Output matrix W2 (output synapses).

Not used synapses are filled up with zeros.

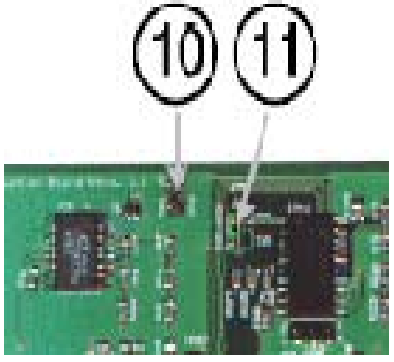
These weight values will be loaded into the Silimann LSI.

W1 & W2 & INPUT & OUTPUT

$$O = [I^T . W_1^T] . W_2^T$$

Elements of Evaluation Board

10.External reference signal output (2- Pin Connector JP6)



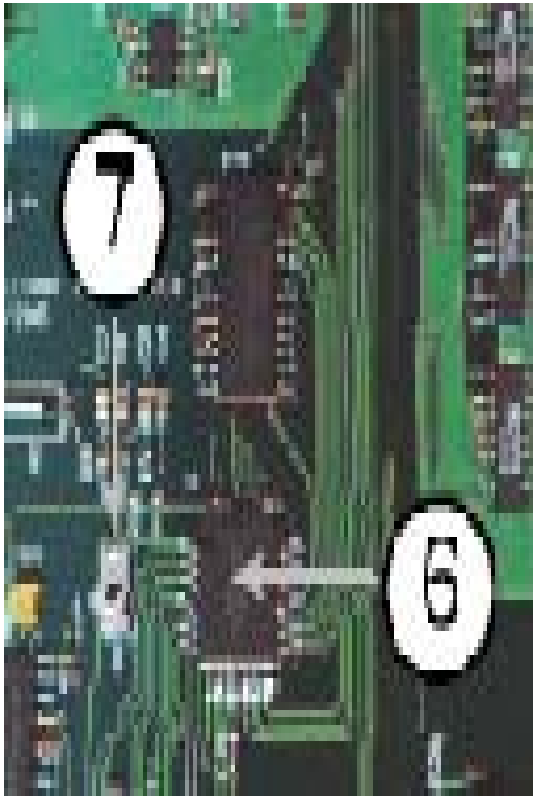
Pin1 is reference analogue signal input
Pin2 is AGND (Virtual Ground)

11. Jumper 5 ***JP5***

JUMPER	*SIGNAL*
1-2	Onboard temp. sensor
3-4	External ref. Signal

3-pin onboard temperature sensor / external reference signal. If pin 1-2 are closed, onboard temperature sensor is used. If pin 3-4 are closed, external ref. Signal is used.

Elements of Evaluation Board

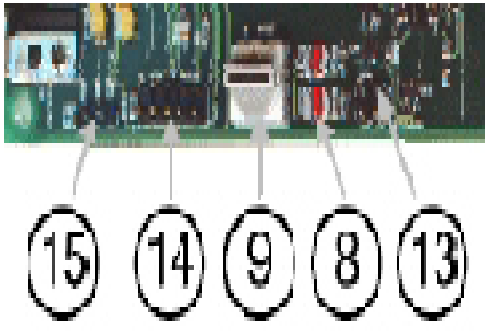


6. *Microcontroller MC68HC908 GP32CFB*

The microcontroller provides the evaluation board's RS232 interface and Flash memory for weight sets.

7. Reset Button

Elements of Evaluation Board



8. Status LED1 and LED2

LED	SIGNAL
1	Refresh mode activated
2	Refresh operation

9. Weight Set Switch

Switch S1 “Mode” is located between connector JP1 and the status LEDs 1 and 2 and is used to switch between weight sets from Task ID 1 to Task ID 15.

Elements of Evaluation Board

13. ***Jumper JP4 (4-pin refresh)***

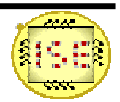
When this jumper is set (pin 1-2 are closed), the refresh is shut off. If pins 1-2 are open, the refresh can be controlled via software commands. If the refresh is turned on, pin 3 signals the status of the refresh cycle: the pin 3 is active during a running refresh.

14. ***Microcontroller MC68HC908 Programming and Debugging I/F***

(10-pin connector JP1)

15. ***Microcontroller MC68HC908 serial I/F***

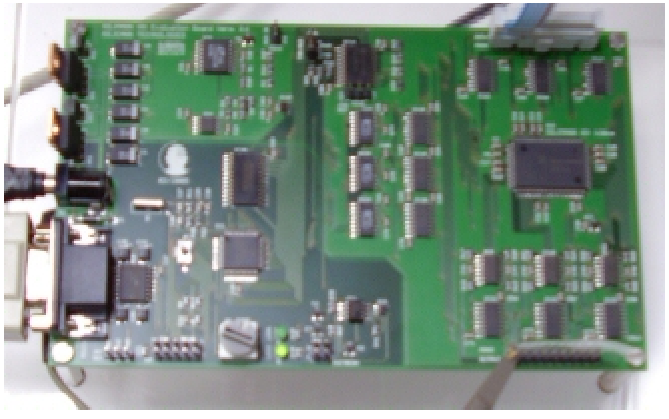
(3-pin connector JP7)



Neurocomputing Project

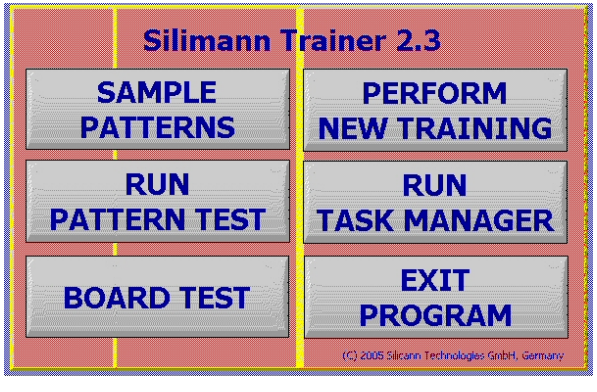
True Colour Sensor

True Colour Sensor



Silimann Trainer Software

Evaluation Board



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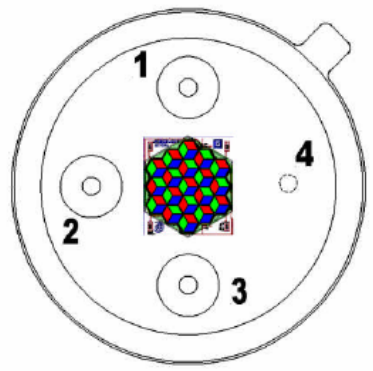


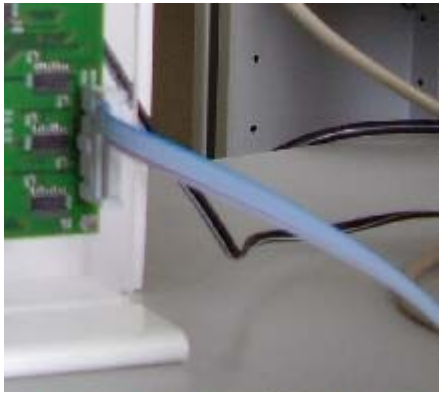
TO39-package

True Colour Sensor ICs are specifically designed for sensitivity to yield a significantly improved performance where colour deviations have ***to be resolved.*** It has three anodes and one common cathode.

PIN	description
1	Y (green)
2	Z (blue)
3	X (red)
4	common cathode

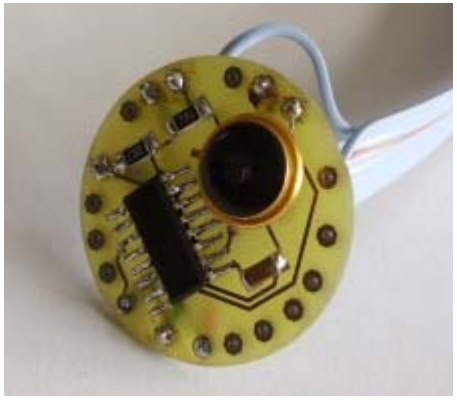
True Colour Sensor

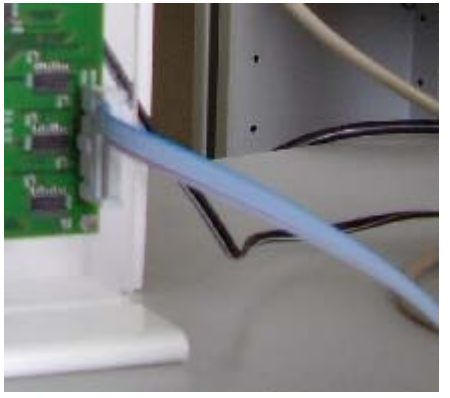
How are we using this sensor in our project?



In evaluation board we have JP2 for our inputs. We connected JP2 with our sensor circuit. We are using sensor for taking samples by our experiment environment.

True Colour Sensor

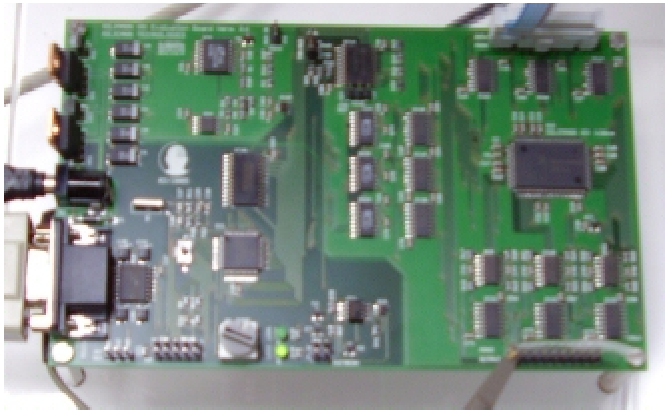




Neurocomputing Project

Silimann Trainer Software

True Colour Sensor



Silimann Trainer Software

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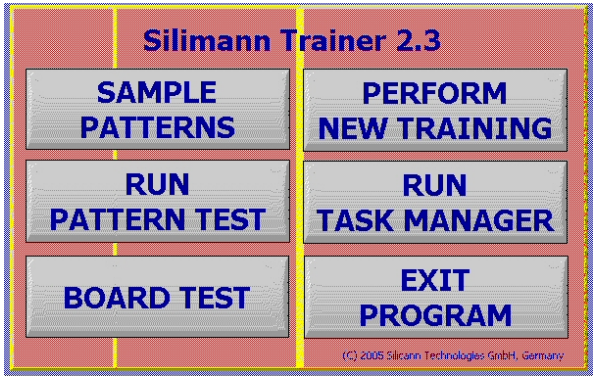
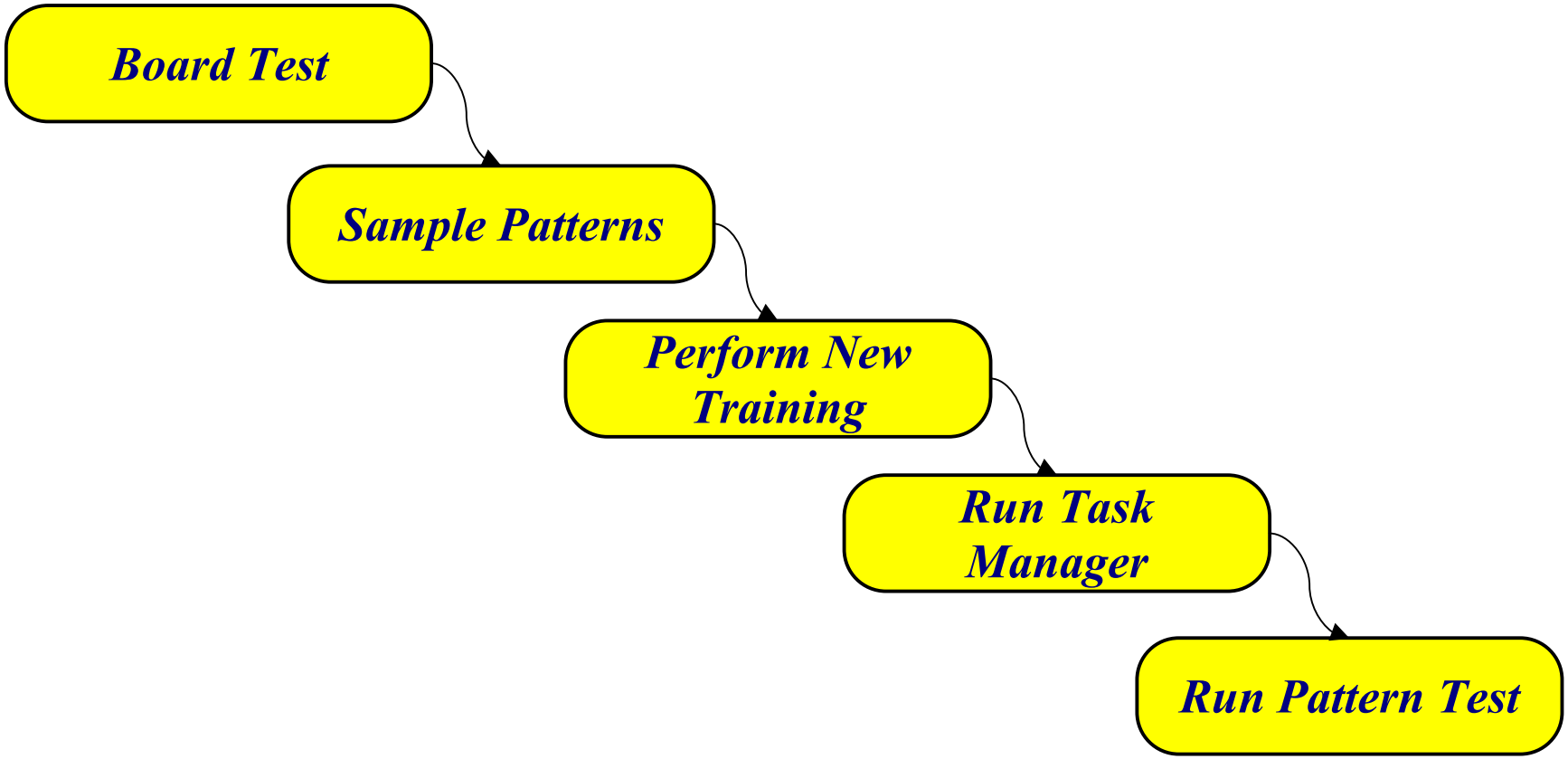


Silimann Training Steps



Board Test

Check if the board is connected and working properly

Important point

Task ID must be zero

Sample Patterns

Sampling analog input signals and creating pattern file (Sample patterns)

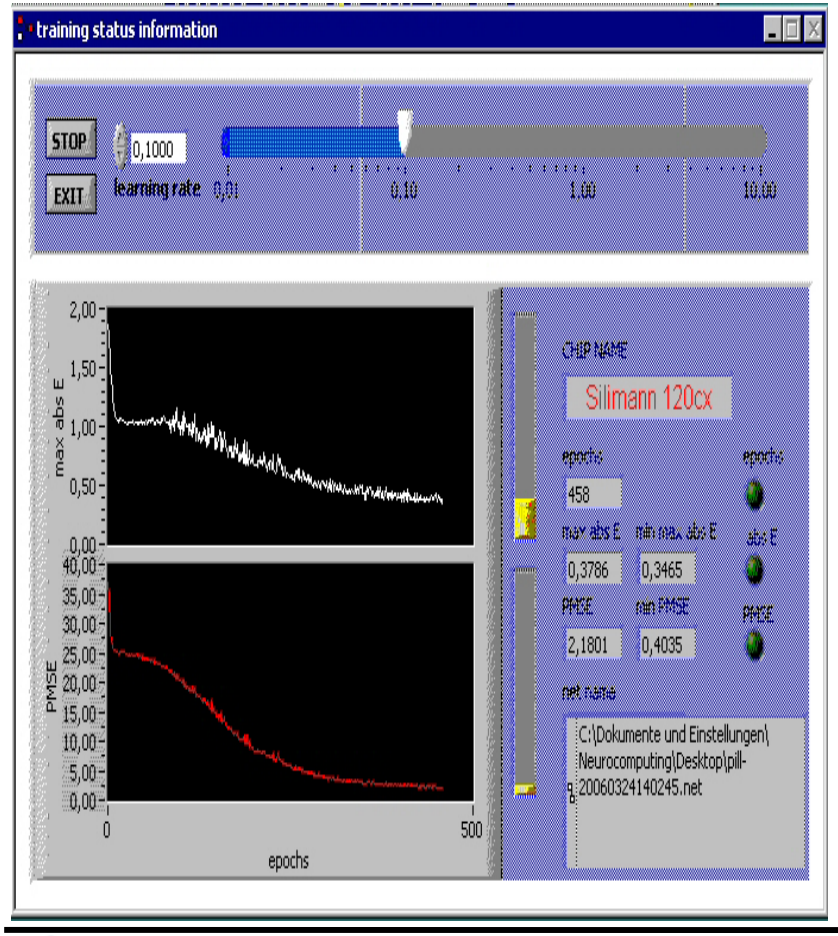
Create a pattern file. Define the number of input and output signals.

Sample input signals and assign the desired output signals.

When assigning the output signals, use the 1 of N coding.

```
TASK_ID
1
INPUT
0.722;0.700;0.999
0.708;0.702;0.992
0.564;0.534;0.898
0.565;0.538;0.890
OUTPUT
1.000;-1.000
1.000;-1.000
-1.000;1.000
-1.000;1.000
```


Perform New Training

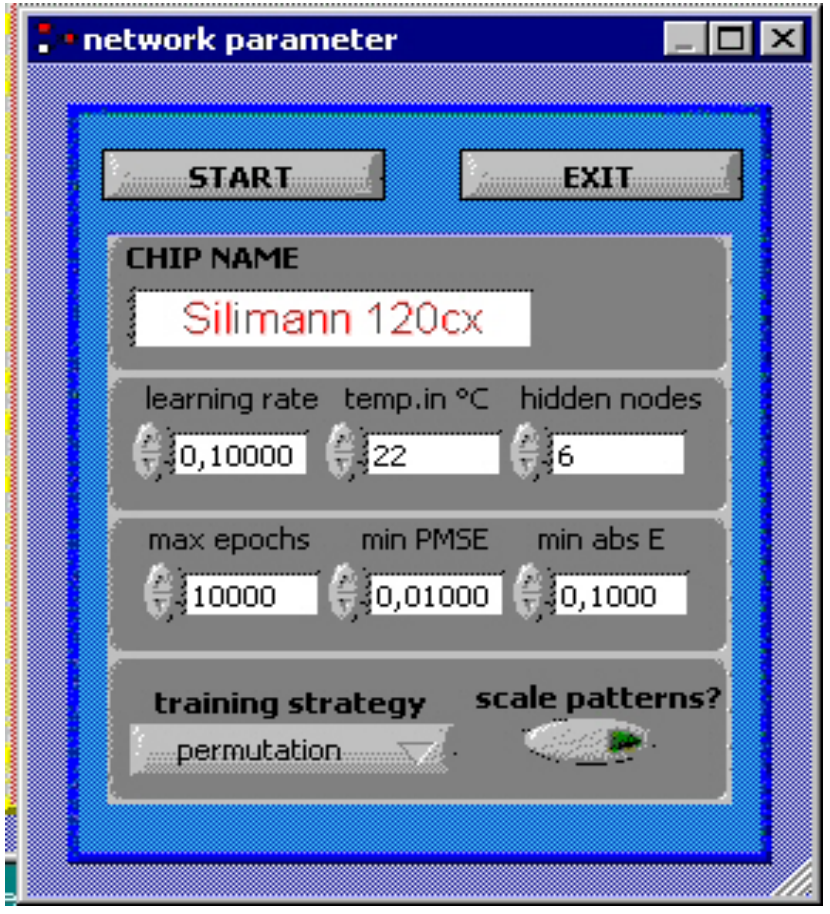


Pattern file based neural network training under user specified parameters. The training procedure creates a weight set, also called as Silimann LSI configuration.

Specify the training conditions and define the training stop criterion.

Perform training for a pattern file. A weight set file will be created

Training Parameters

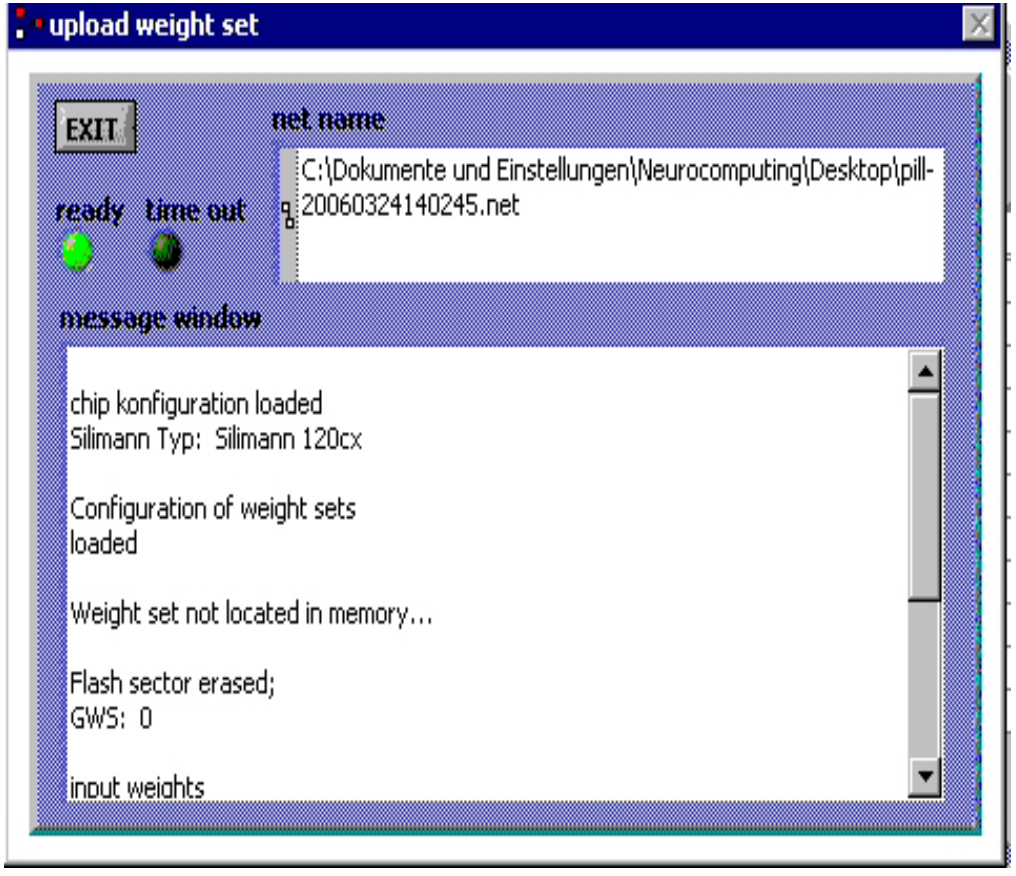


- Task ID
- Temperature
- Learning Rate
- Hidden nodes
- Max. Epochs
- Min. Pmse
- Min Abs. Error
- Training Strategy

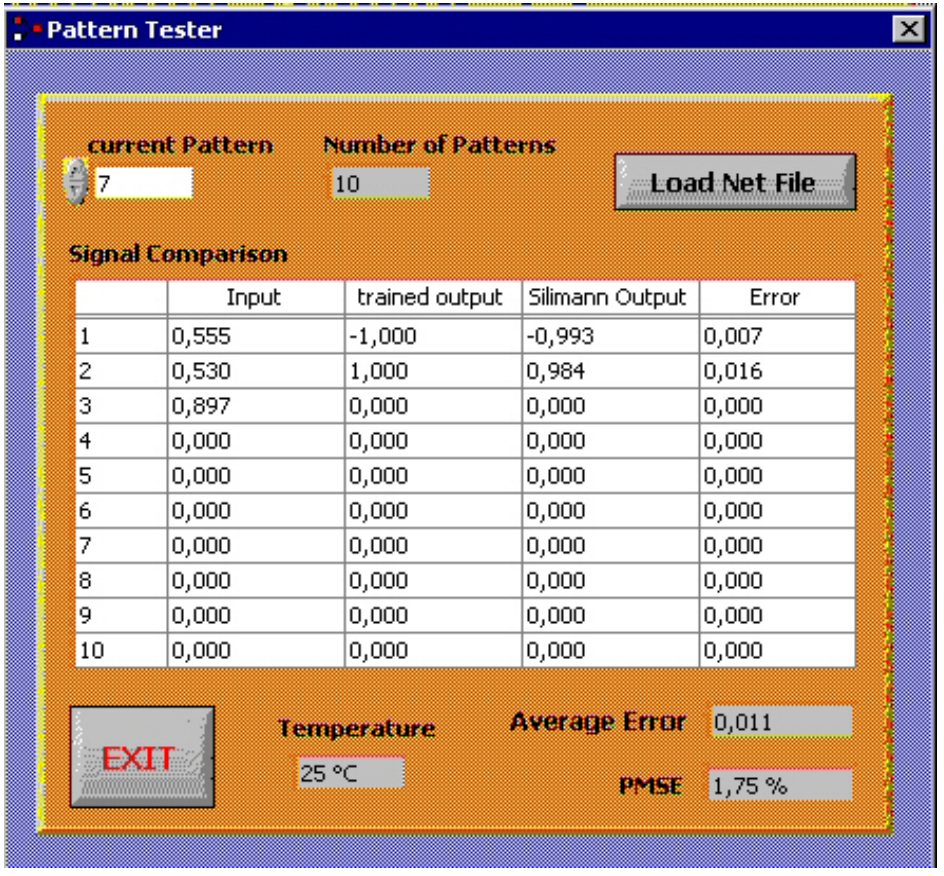
Run Task Manager

Load a previously created weight set file into the evaluation board.

The Manager your weight sets stored in the evaluation board



Run Pattern Test



Test and evaluate a weight set for a given pattern file.

Pattern signals will be set to the Silimann LSI inputs and the actual chip outputs will be read and compared with the desired neural network outputs signals (as specified in the pattern file).

Error will be calculated for evaluating.

Experiment Steps

1- Design the experiment environment

2- Network Configuration

3- Take the samples

4- Training

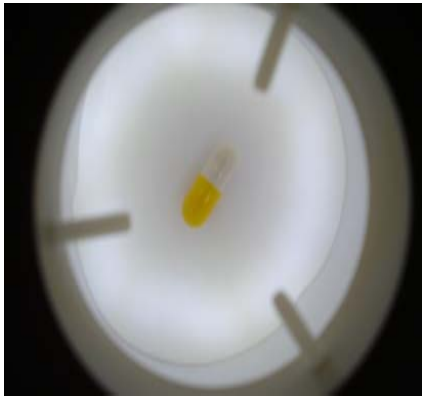
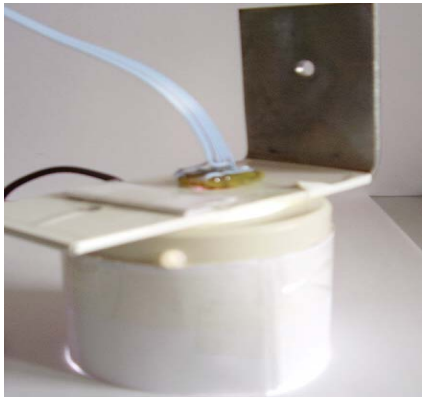
5-Get silimann outputs

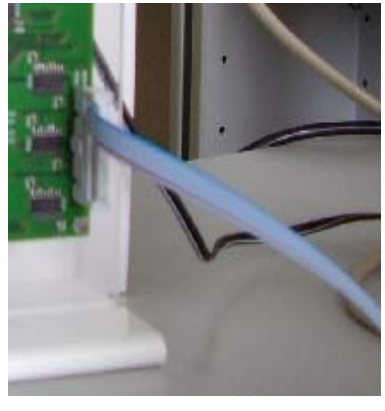
6- Test (recall)

Design

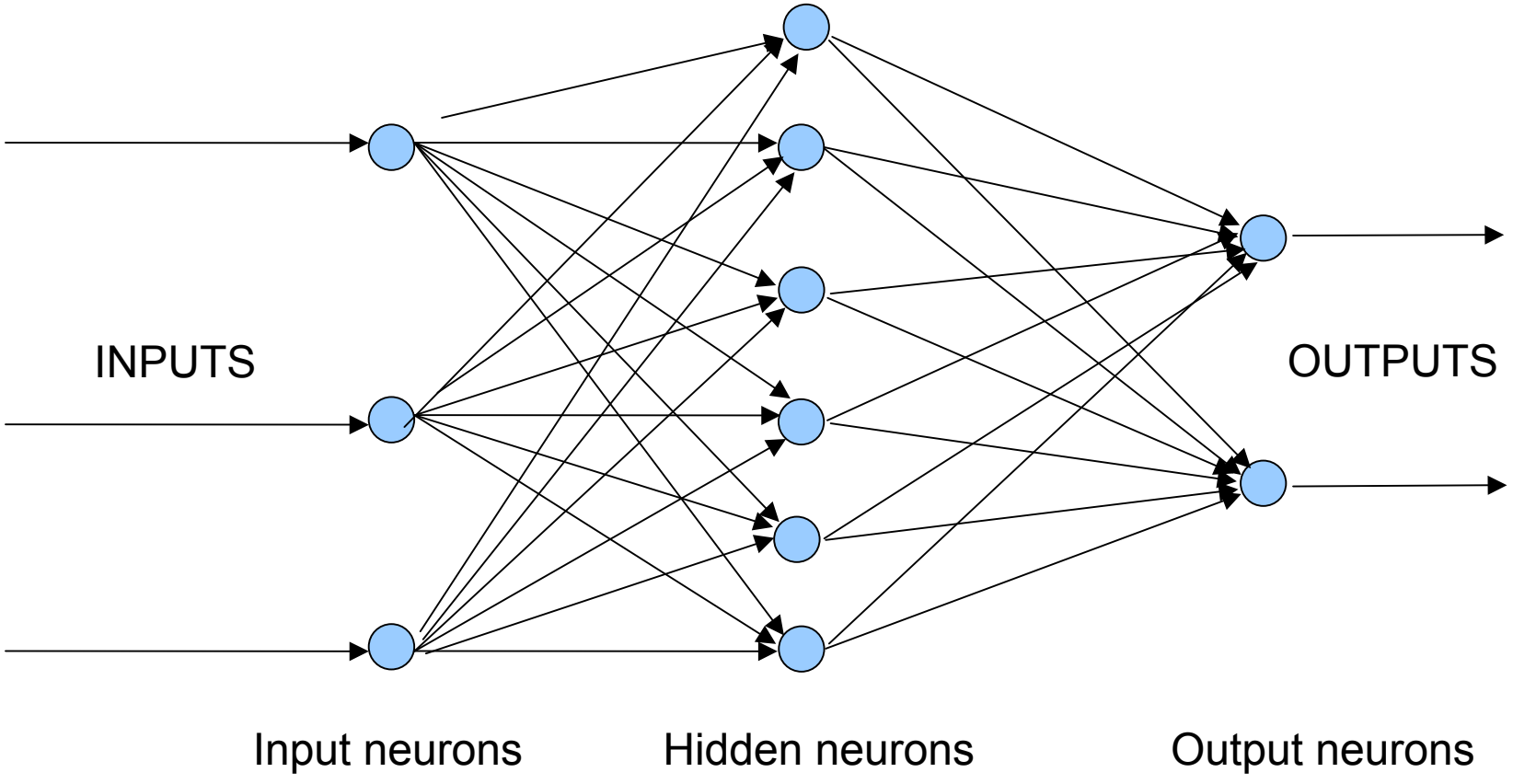






Network Configuration



Take samples

```
TASK_ID
1
INPUT
0.722;0.700;0.999
0.708;0.702;0.992
0.706;0.713;1.000
0.706;0.702;1.000
0.714;0.704;0.995
0.564;0.534;0.898
0.565;0.538;0.890
0.555;0.530;0.897
0.554;0.534;0.906
0.565;0.539;0.897
OUTPUT
1.000;-1.000
1.000;-1.000
1.000;-1.000
1.000;-1.000
1.000;-1.000
-1.000;1.000
-1.000;1.000
-1.000;1.000
-1.000;1.000
-1.000;1.000
```

The sensor is detecting pill by looking at the system.

When there is a pill, the sensor is giving one value. And when there is no pill, it is giving another value.

Then we are labeling the output with 1-of-N coding.

Training

PMSE_TRAIN

0.1507

ABS_E_TRAIN

0.0996

EPOCHS_TRAIN

1545

W1_TRAIN

-0.8534;-0.5754;0.3367;0.7798

-0.4243;-0.3954;-0.2318;-0.1550

0.2911;0.0992;-0.1090;-0.1609

0.8309;0.7371;-0.7868;-0.4400

-0.9991;-0.9991;0.7479;0.6106

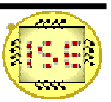
-0.9991;-0.9991;0.4920;0.9990

W2_TRAIN

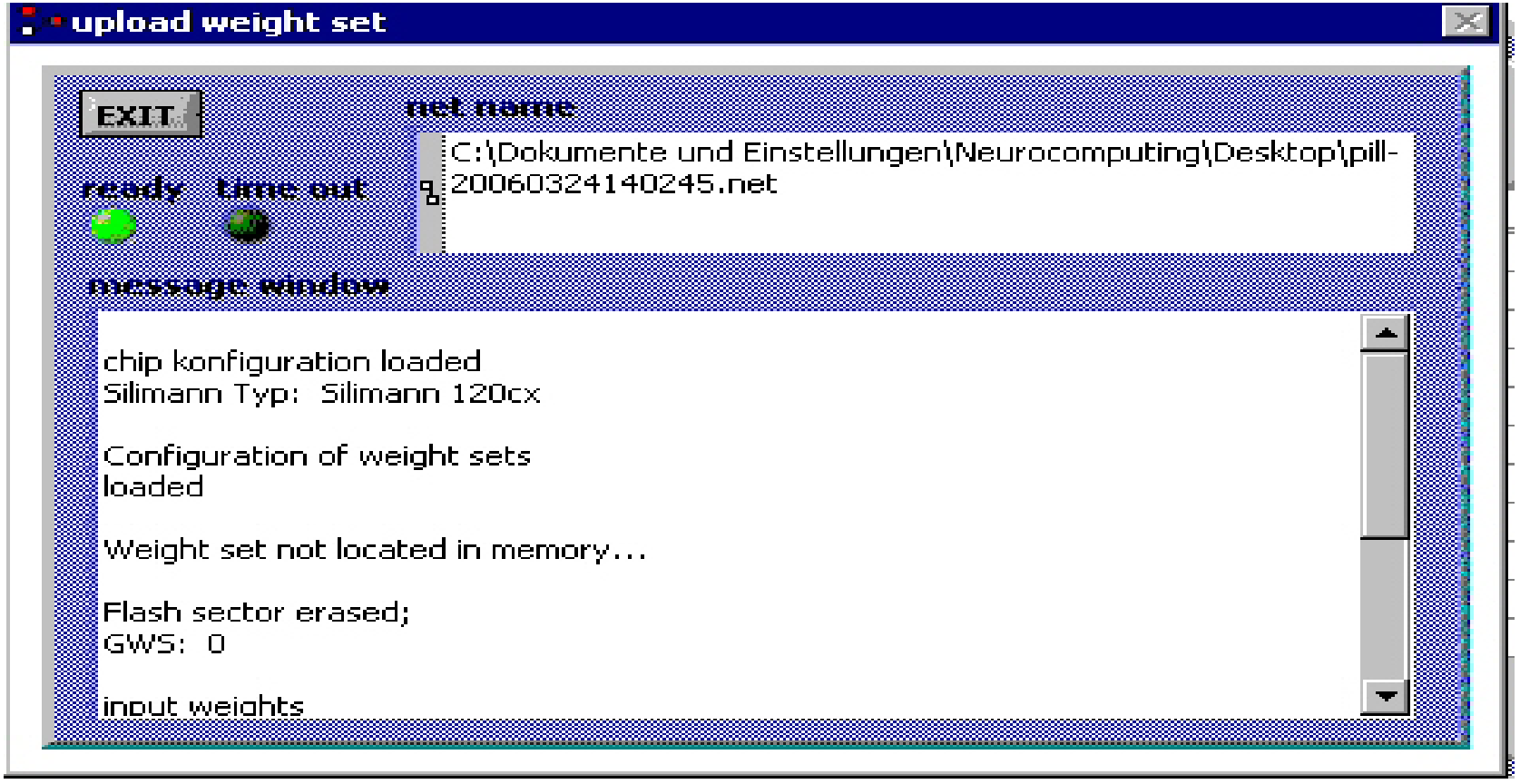
-0.7354;0.2221;-0.0951;0.8223;-1.0000;-1.0000;0.1570

0.6520;-0.0833;-0.3424;-0.7249;1.0000;1.0000;0.0198

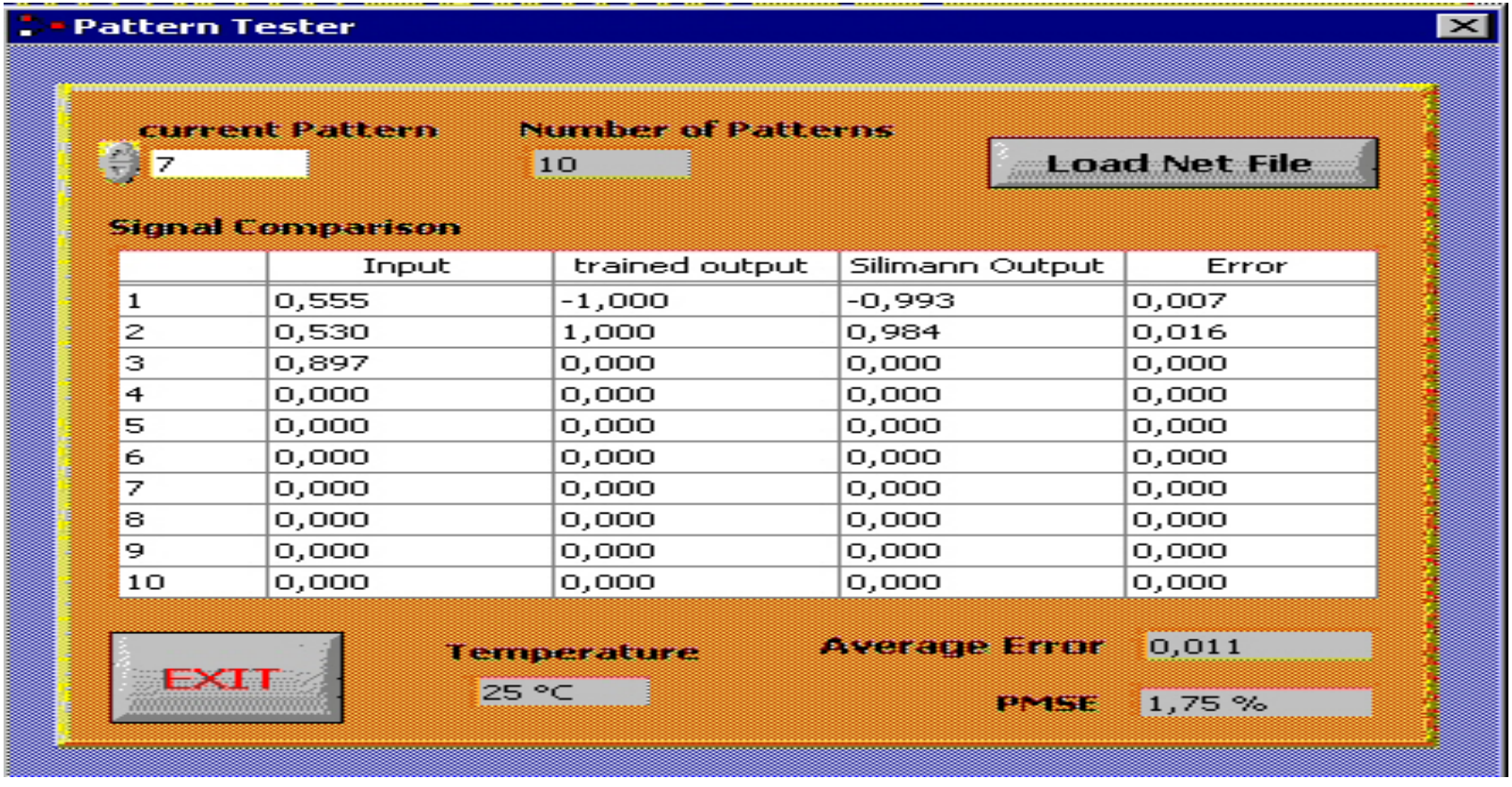
NETWORK-File



Loading Weight Set

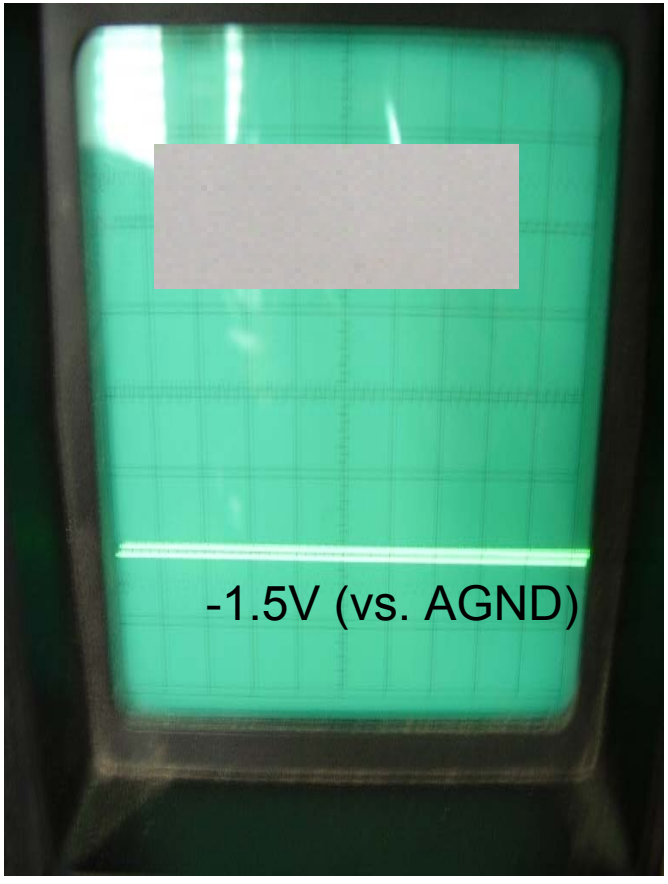


Silimann Outputs



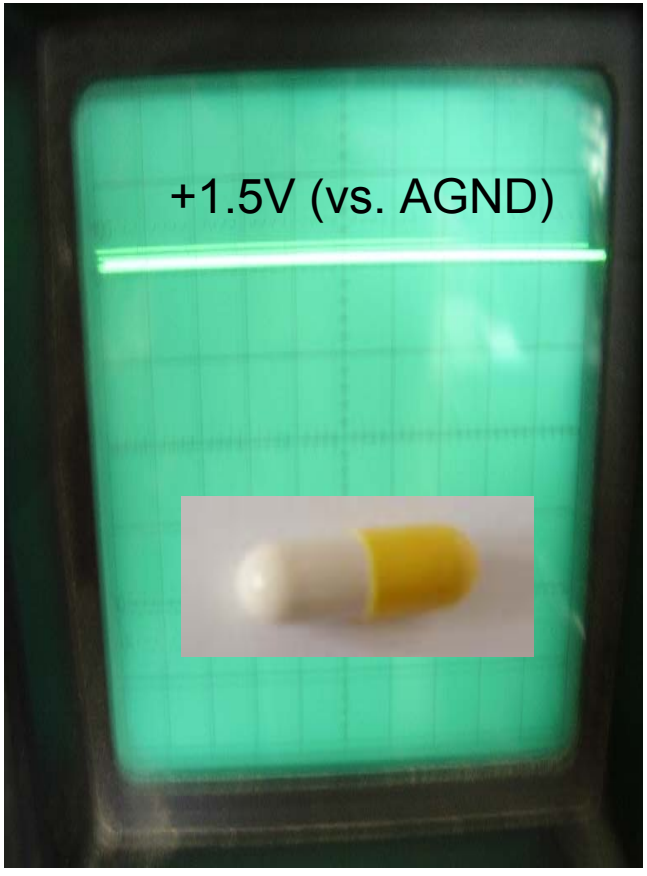
	Input	trained output	Silimann Output	Error
1	0,555	-1,000	-0,993	0,007
2	0,530	1,000	0,984	0,016
3	0,897	0,000	0,000	0,000
4	0,000	0,000	0,000	0,000
5	0,000	0,000	0,000	0,000
6	0,000	0,000	0,000	0,000
7	0,000	0,000	0,000	0,000
8	0,000	0,000	0,000	0,000
9	0,000	0,000	0,000	0,000
10	0,000	0,000	0,000	0,000

Test (Recall)



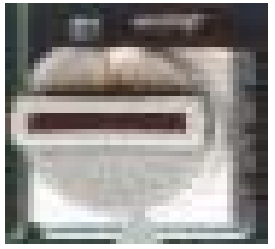
Oscilloscope
at
output neuron 1

There is
OR
there is not



What sort of problem we faced?

1. Limited Software (6 Hidden neurons)
2. Light Effect
3. Temperature Effect



What did we learn?

BackPropagation

Digital Neural Network Hardware

Analog Neural Network Hardware

Neural Network Visualization

Technical Real World Problems

Questions