DIY computer calculates like quanta

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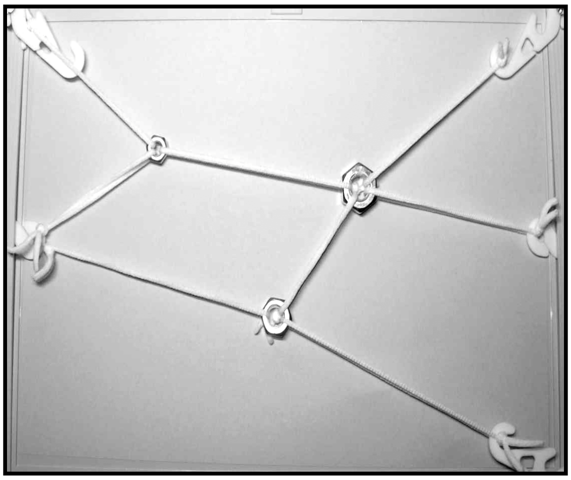
The quantum mechanics appropriates the superposition and entanglement. However, both phenomena also work in classical physics. Following this insight, a $2 DIY computer is built that calculates the optimum of n-dimensional systems in a single microsecond step. This can be used to compute a large class of complex scientific problems. The examples show network optimization and the 3-body problem.

1. Introduction



In a network of similar rubber bands and nuts, forces "superpose" and form an "entangled" overall system in which all forces compensate each other.

This simple system can calculate complex things.

The three nuts of different weights are pulled into the lower left corner and released. After a short settling time, the system finds the force-free optimum.

This rubber band computer is realized and applied as an electronic analog.

Note: Cutting a rubber causes the "spooky action at a distance" on all nuts.

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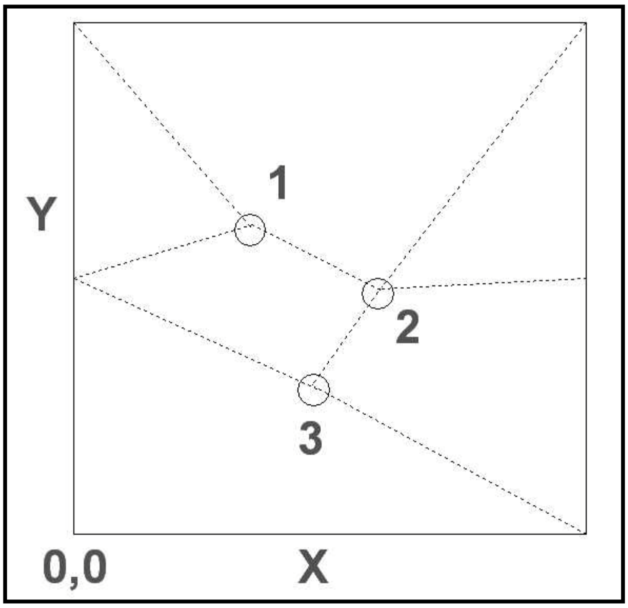
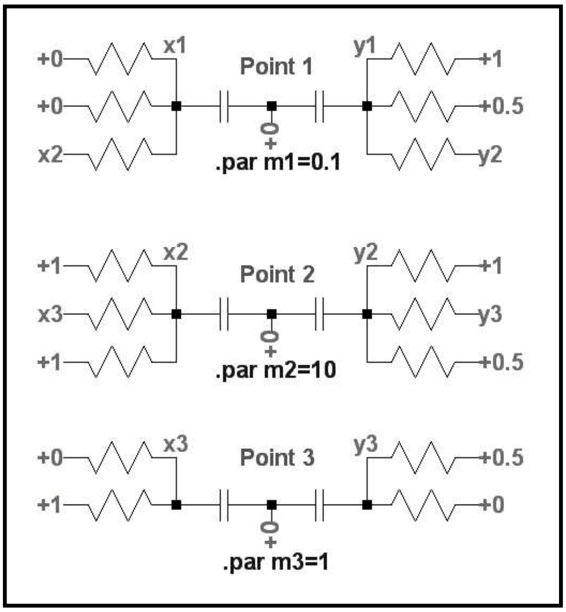
2. DIY computer is built and programmed

The length and force of a rubber band are just as proportional as the voltage and current flow of a resistor. In contrast to the rubber band, resistors can only act one-dimensionally. The eight rubbers are therefore replaced by 16 equal 100k resistors. The different masses of the nuts can be represented by capacitors (m=1 corresponds to 1µF). Since each dimension is calculated individually, 6 capacitors are needed.





Starting from point 1 (x1/y1), three "rubbers" are programmed with two resistors each:

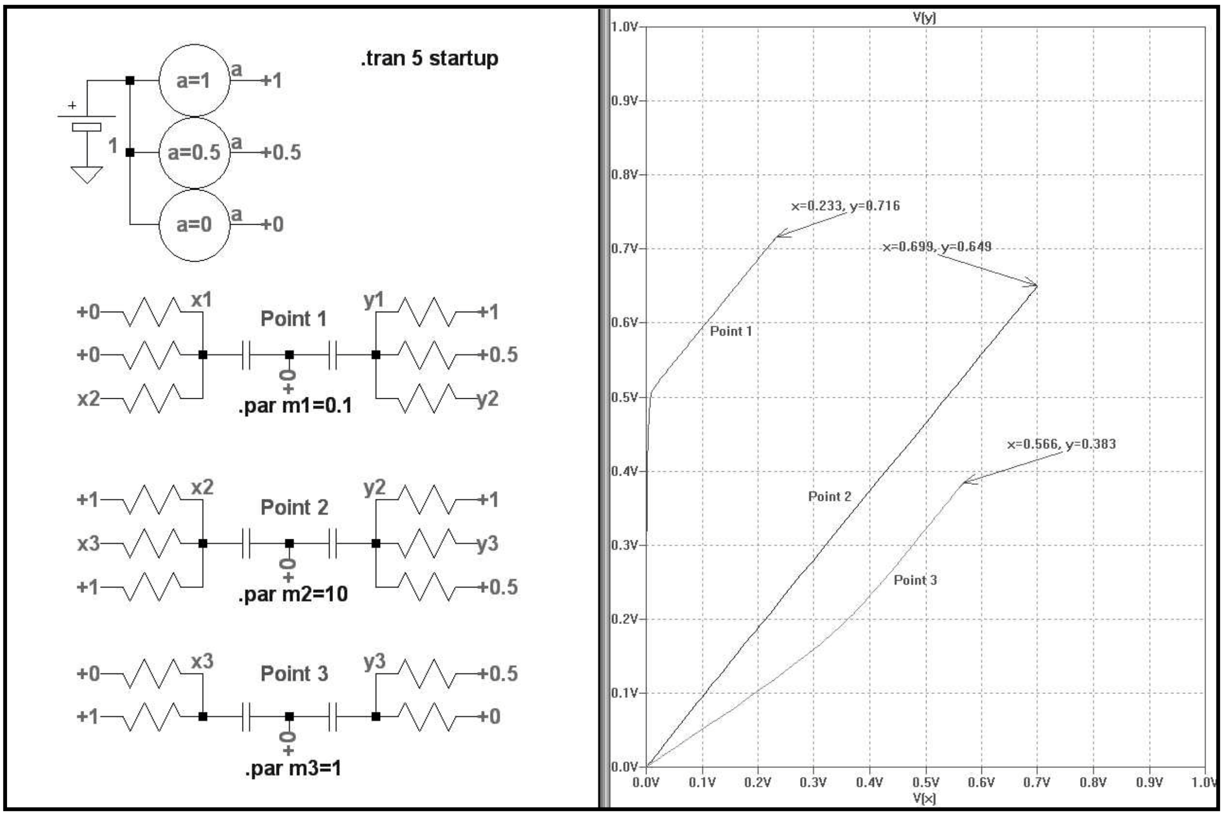
- The top rubber ends at the top left frame position (x=+0, y=+1).
- The next rubber ends at the center left frame (x=+0, y=+0.5).
- And the third rubber ends in point 2.
- With two equal capacitors point 1 starts at the lower left corner (x=+0, y=+0).

Point 2 needs only three more rubbers. The top rubber ends at the frame at x=+1, y=+1. The second rubber ends at point 3. And the third rubber ends at the frame at x=+1, y=+0.5. The mass of point 2 is 100 times greater than the mass of point 1.

Point 3 is programmed accordingly.

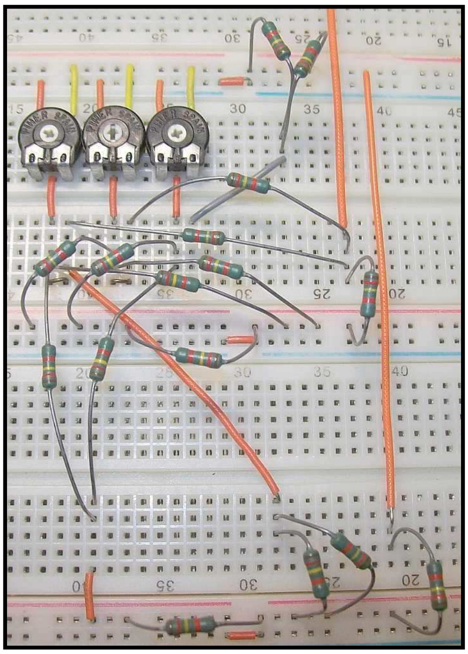
3. *DIY computer calculates*

All capacitors are discharged. One measures at x1, y1, x2, y2, x3 and y3 each 0 volts, which means that all 3 nuts are in the lower left corner of the XY frame. As soon as you connect the 1V battery, the calculation starts.



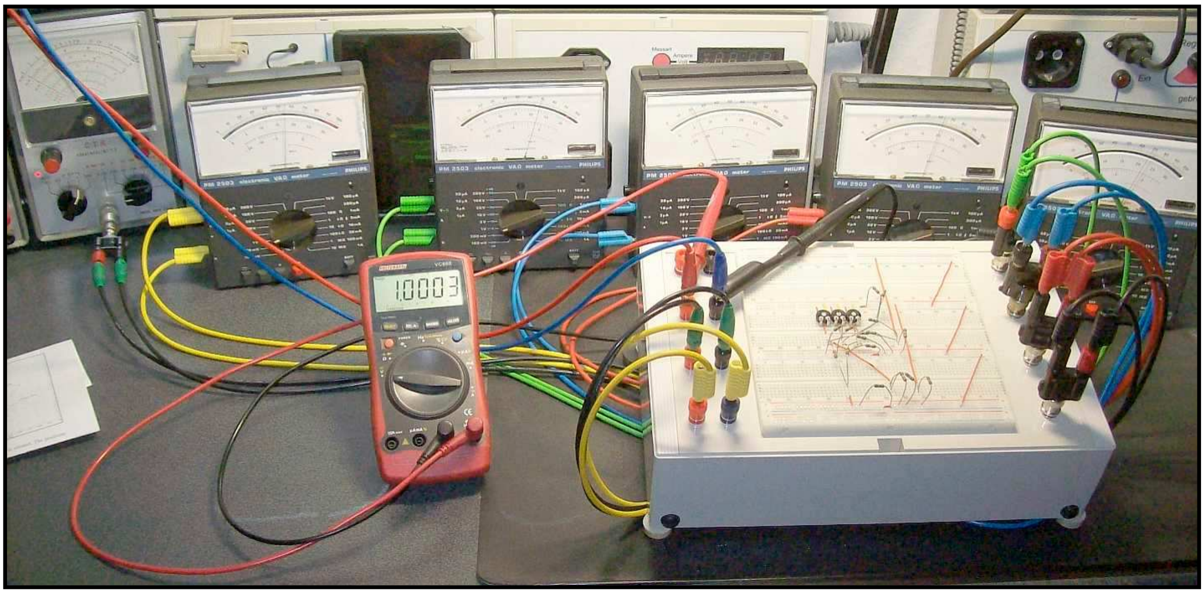
Since the capacitors have a time-delaying effect, a dynamic system is created. The positions of the three points in the course of the calculation are plotted on the right. The three marked end points of the three nuts is the optimal solution of the task.

With small capacitances and low impedance resistors, a computation time of less than one microsecond can be realized. The calculation time is independent of the number of "nuts", the number of "rubber bands" and the number of dimensions calculated in parallel. For many hundreds of thousands of calculations, a small battery is sufficient as a power source.



The $2 setup consists of the voltage source that powers the three 10k trimmers and the 16 resistors. The capacitors were omitted to achieve the maximum computing speed.

The parallel calculation of the six output variables takes less than 1 microsecond. The power consumption during the calculation is around 300 microwatts, 90% of which is due to the three trimmers.



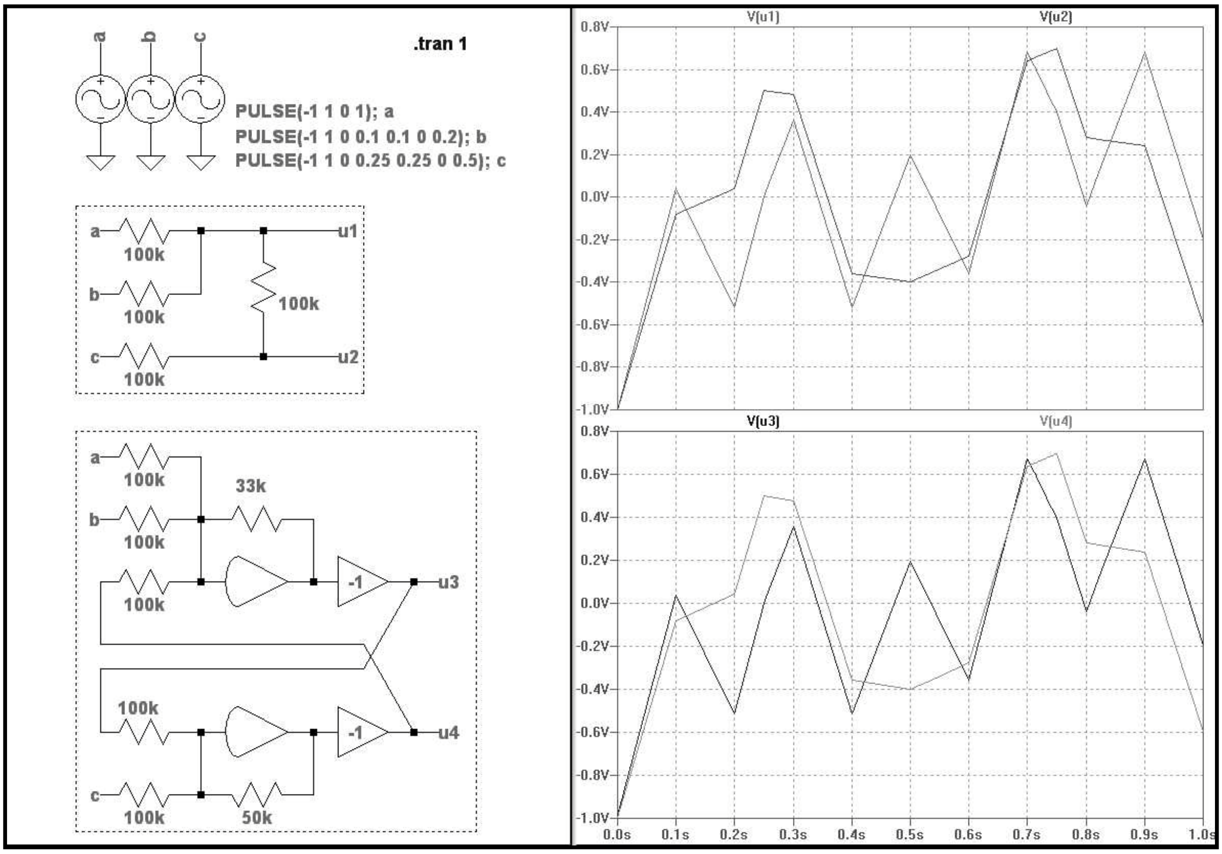
The same six voltage values at x1, y1, x2, y2, x3, y3 as in the simulation are displayed.

In a real environment, the trimmer voltages are replaced by external sensor voltages. Changed sensor voltages disturb the entanglement. The system immediately finds a new optimum and communicates this solution with analog voltages to the connected actuators.

This is not a regulation process since there is no feedback. Perhaps integrating the DIY computer into a regulation loop is another exciting application.

4. Does the DIY computer calculate correctly?

The programming by interconnection resembles electronic analog computers. Here as there, superpositions can be calculated as summation. But in order to calculate entanglements, a **mutual influence** of nodes is necessary - just like in nature. In the DIY computer, a rubber or resistor is simply stretched between the nodes. In an analog computer this is more difficult, which is due to the "unnatural" distinction between inputs and outputs.



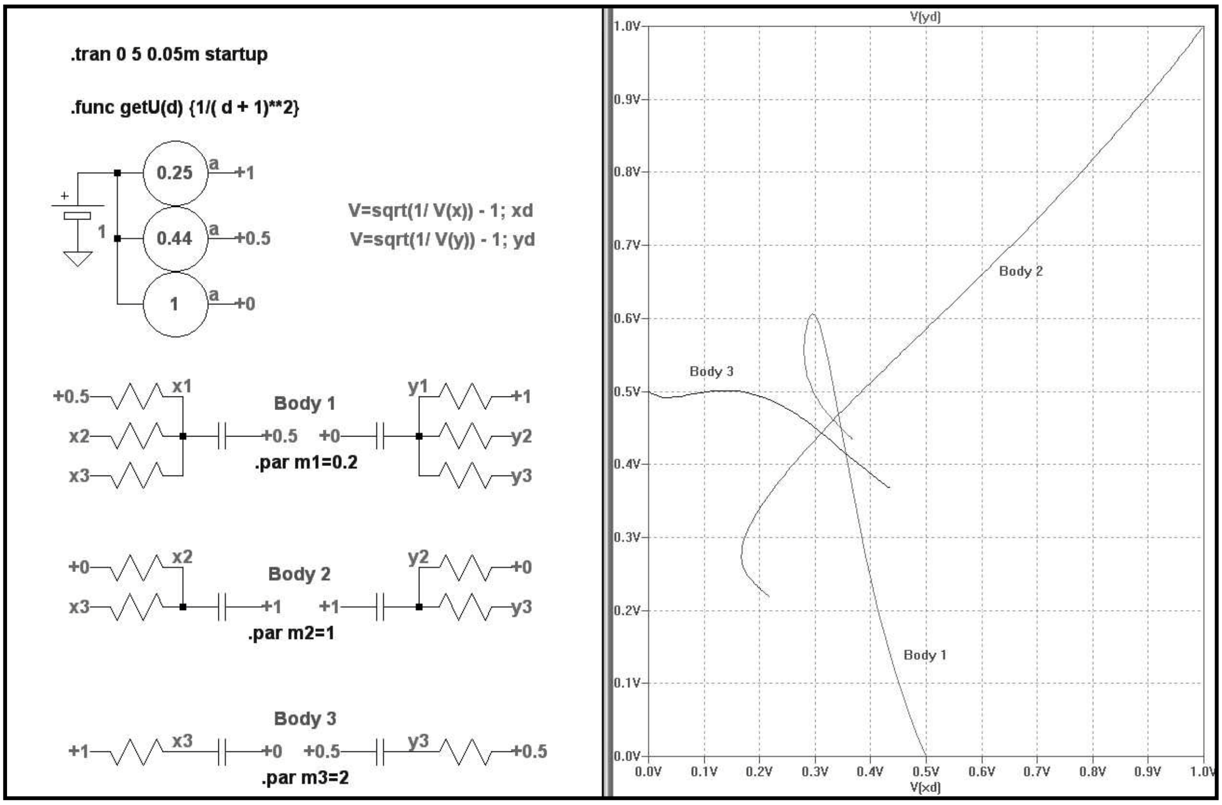
In the small box is a fragment of the DIY computer with the mutually influencing output voltages u1 and u2. Below is the equivalent circuit of an analog computer with outputs u3 and u4. Both circuits are driven with the same input voltages. Top right the plot of the two output voltages of the DIY computer. Below the output voltages of the analog computer. The results are identical.

Whether you use the DIY computer, a "real" analog computer or the free LTSpice used to write this paper is basically irrelevant.

5. DIY computer calculates gravity

Without conversions of the input or output quantities, the DIY computer is suitable for directly solving linear optimizations where the internal voltages and currents correspond to the external quantities (e.g. force and distance). For example, it calculates the arrangement of electronic components on a circuit board where the length of all component connections is minimal. Or it solves the path optimization of the Salesman problem. Or it calculates a supply network with optimal position of the pump stations.

To calculate gravitations, one must convert distances accordingly $U \sim 1/d^2$, and thus adjust the voltages obtained from the battery. Their meaning does not change: x=+0.5 and y=+1 denotes unchanged the upper center. After the calculation is done, the internal voltages are converted back to distances ($d \sim \sqrt{1/U}$) for which a pocket calculator is sufficient in the DIY Computer.



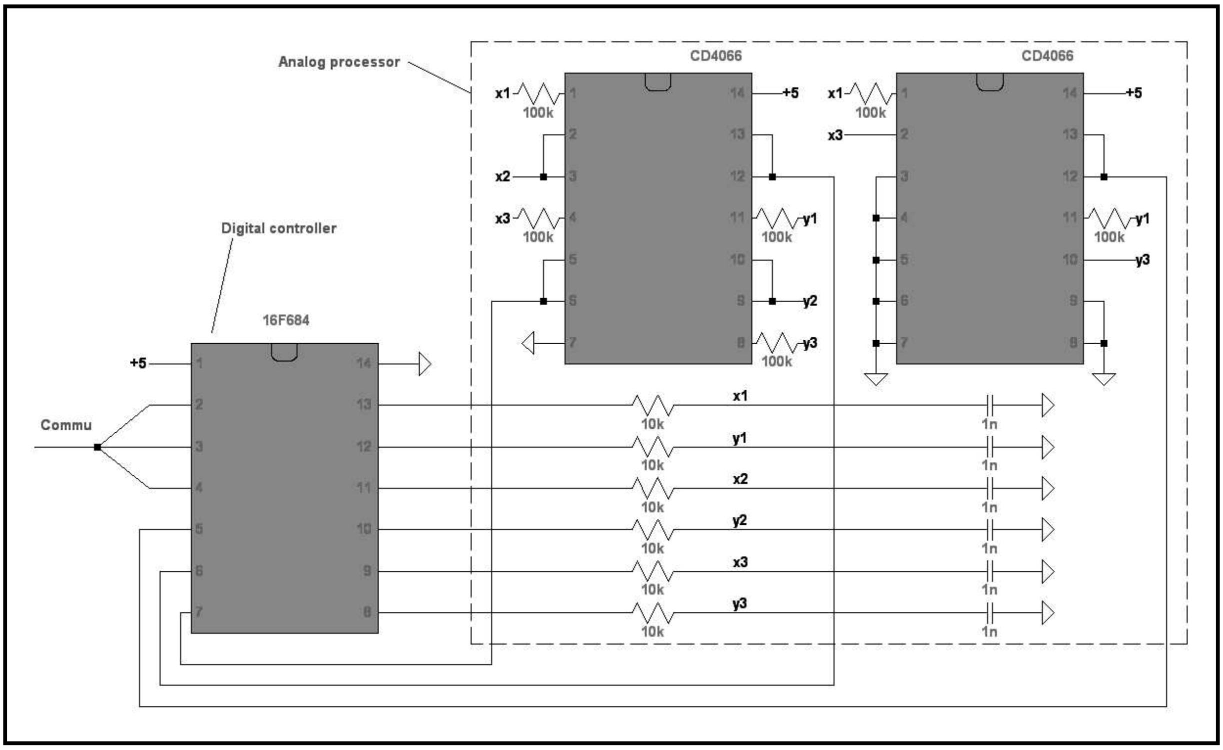
Body 1 wants to fly from x=+0.5, y=+0 to x=+0.5, y=+1. Body 2 from x=+1, y=+1 to x=+0, y=+0. Body 3 from x=+0, y=+0.5 to x=+1, y=+0.5. All three bodies gravitate with each other.

In this way, the DIY computer solves the 3-body problem without the notorious step-size problems associated with numerical iteration calculations.

6. DIY computer becomes hybrid

The dynamics visualized in the paper are based on the charging curves of capacitors and therefore do not give the exact course between the start of the calculation and the result. The calculation results are only correct when the system has settled down. The DIY computer was rather designed to calculate a correct result "abruptly". Capacities have a slowing effect.

On the other hand, capacitors allow the analog values to be stored for a short time. This can be very helpful when coupling with digital systems:



The three trimmers are replaced by six digitally generated voltages that act directly on x1, y1, x2, y2, x3 and y3. The cross-connections are realized with three double-pole analog switches. By PWM-clocking these switches, the effect of the cross-connections can be varied from 0% to 100%.

First, differential digital analysis (DDA instead of PWM) is used to generate the impedance-correct voltages. The cross-connection switches are set and calculation starts. Then the DDA outputs are switched to AD converters and the measured capacitor voltages are converted as required. Communication is serial via three digital lines or via analog voltages.

The system is not very fast but quite flexible.

7. Conclusion

The search for an optimal system state is a major topic in physics, mathematics, industry, chemistry, biology, transportation planning, sociology, economics, AI etc. Numerical optimization methods are slow and complex.

The two principles adopted from QM, superposition and entanglement, find the optimum in one step. But QM computers are not yet practical.

In this respect, the modification of analog computing technology presented here offers a potentially interesting alternative.

Finally, a coupling between DIY computer and digital controller is proposed.

This paper does not explicitly refer to my two predecessor QM papers. But their demystification of QM is what made this paper possible.

- Experiment: Classical fields masquerade as quanta, 2023, https://vixra.org/abs/2302.0109
- Test of Bell/CHSH, 2023, https://vixra.org/abs/2310.0055