Micro-power-harvesting of electricity in pot plants with components

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Abstract. Battery electrodes in pot plants are constructed and combined with various electrical components. Capacitors attached to elastic connections distributing wind energy in the lines and the soil provide, alternating current; AC. For AC, Voltage may be increased by e.g. magnetic induction in an IntegratedCircuit. Metal cups collecting from Solar Power and elasticity are tested outdoor, and found to amplify the current with a factor 5.7. The experiments are analysed with differential geometry in terms of isomorphisms and presumed materialisations.

Keywords. Pottery batteries, electric components, alternating current; AC, wind flower beam, dynamic capacitor, photovoltaic, solar power, NPN-diode, amplification, modeling, differential geometry, moisture, load carriers, materialisation

1. Introduction

Devices to produce power together with batteries in pot plants are designed, buildt and tested in various configurations. In addition, expressions derived from calculus of differential forms [1] will be related to electric charges, work for moisture at volume changes and Coloumb-type attraction fields. The analytic framework provides options for how the electric loads and moisture materialise in cylindrical coordinates.

2. Experimental materials

2.1. Pot plants with anode and cathode

Figure 1 shows one pot where magnetic induction pumps up current, above ground, [2].

Figure 1. Plant with cupper anode, iron cathode, coils and magnets

It is observed that the Voltage increases with an amount of water in the soil. Therefore, we assume that the load carriers are connected to a scalar field, similar to that of moisture. Analysis with equations for moisture and load density are given in Section 3. A comparative study without electrodes is not done, but probably, the dynamic process with induction reduces water content (and extra water might be transported into the plant).

Apparently, a state with a time varying voltage and current, occurs and is stable when 3 entities are put together, Figure 2, and also when they are loaded with parallel circuits of smaller reversed type (namely a generalised lamp and a pot with *bog moss*). Therefore, a time dependency is present for the fields in the soil, however, at the faster electric states, the activity is possibly primarily in the lines, above ground.

Figure 2. Battery park with 3 pot plants in serial.

Magnetic induction promotes the activity above ground for one pot, and likely also for the serial coupling.

2.2. Wind Flower pumps, bringing AC to the pot and circuits

To pump electricity, outdoor, flowers as seen in Figure 3 and 4, were constructed.

Figure 3. Wind Flower Beam, WFB. Foil arranged as a capacitor and wrapped around an elastic beam becomes a varying resistor at motion.

Since sensible and durable, the flower provides a varying contact at all wlnds, and also when it moves in rain. When sunny and dull, power might be supplied by a Sun Catcher made by macroscopic element loaded by Sun Heat, e.g. as that below Figure 4.

2.3. Increased Power with meso-scale diods

The Voltage increases with the number of pots; when 3, it reaches 2V, Figure 2, and in one medium size 0.8 V. The maximum measured current was 0.1 mA, AC.

To increase the output of the Plant Kraftwerk, the Voltage can be multiplied by a transformation. Such are present as IC, but often require a higher input current and do not increase the power. Therefore, effort is put to amplify the current. Solar Panels consisting of several cells in a plate are effective collectors, c.f. [3]. This was discussed in [2] in relation with formula language of differential geometry. In the spirit of that form, which tacitly concerns rotations, *Meso scale NPN-junctions* will be proposed.

Theoretically, current, I, is amplified in a NPN-diode, when (part of) the collector current adds to the current in the main line from base to emittor.

The cup, Figure 4, leads in any temperature and the inside foil leads with a time delay, and depending on its density. The wire is pre-strained such that it expands when heated, and then it leads more or at least alternating. Compared with a diode, these devices are the *Base*. Input heat (and other loads that deforms the wire) is the *Collector*. When the output wire achieves contact, all current is gathered into that line which becomes the *Emittor*. At singular use on the largest plant with a flower pump, the current was increased from 10 μA to 57 μA.

Figure 4. For the purpose of increasing power with current, a device (cup with foil, etc) that collects from e.g. Sun, was designed as a *Meso scale NPN-diode*.

2.4. Other types, not yet tested

Another design is twin cups arranged as a balance wave with two equal diods; same as the cup. This has similarities with a Solar Cell since two lines in and two out, however, Solar Cells are often symmetric, i.e. there is no difference between the base and emittor.

A third candidate is a Möbius stripe. If the output is at the twist location, the effective area may get small, which could be beneficial to increase the current. In general, NPN-junctions are more heavy at the base, and possibly, this behaves as a capacitor; getting loaded. In a Möbius strip, some points at the band may serve as the base, and be attached to an output via a foil with time delay and impedans.

2.5. Inflexion point, dividing space into wet and dry

A related component is the arrangement for dry and wet, with fabrics and an aluminum cup in Figure 3. It works by an inflexion point, regardless of electricity. When there is water in the reservoir, the fabric is wet up to the cup, and the other side is dry and moves in the wind. There is some pumping capacity while moving; in the wind (due to the dry side and by itself), or by rain water, since it is clamped with an elastic rubber band at the hinge.

At the hinge, i.e. behind the cup, there is a variable impedans, that couples to the electric circuit with a battery in the pot. The moss was found to stay dry such that the water down in the pot remain, and that is beneficial for a battery function. In order to increase a pump capacity with electricity, a generalised battery will be mounted in the fabric behind the cup. This will be in series with the other as was found to work with the 3 indoor (Figure 2) and perhaps the suction and thus pumping will be enlarged since that device consume moisture.

Organic machine learning. In the long run, a composition where the entire plant with a battery on the surface also profiting on water from suction, could be designed and tuned such that the living plant became part of the machine. That could be accomplished by putting a small plant close to the wet fabric and/or behind the cup.

3. Analysis with Differential Forms

Results in Differential Calculus are derived and related to the Experiments.
First, a differential form from Lovelock and Rund [1] is analysed

In *Exercise 5.7* [1] , a 1-form w is given, and rewritten it reads

$$w=(y-vu_x)dx-(x+vu_y)dy=ydx-xdy-vdu \quad (1)$$

v is a function v=v(x,y) and du is the differential of a function u=u(x,y). It appears that

$$dw=0 \quad (2) \quad \text{iff} \quad (\text{grad } v\times\text{grad } u)= -2\mathbf{e}_z \quad (3)$$

e.g. a necessary requirement of mutual directions and sizes.

3.1. Isomorphisms and materialisations

In [2], the form is related to geometry, physics and engineering. For geometry and materialisations, it is found that if dx and dy have compact support at origin (0,0), parts of the areas in the 1-form xdy-ydx are overlapping, such that there is a double-space, Figure 5.

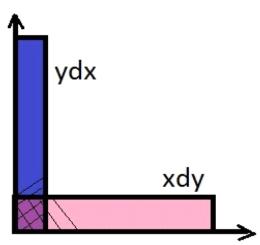

Figure 5. Geometry in Cartesian coordinates.

Two solutions for u and v in cylindrical coordinates, Figure 6, are

$$du=-2\ rdr,\ \ v=\nu \quad (4)$$

$$du=dr,\ v=-2r\nu \quad (5)$$

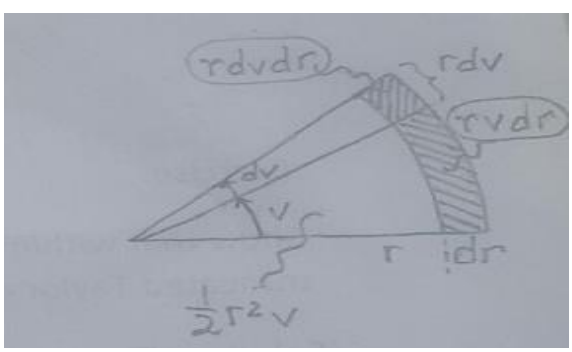

Figure 6. Geometries with differential areas in cylindrical coordinates r, ν

Applications

- Work by e.g. pressure and volume change (vdu), balanced with the 1-form in coordinates x,y and differentials dx, dy
- Fields of moisture [4] and electricity interacting with the 1-form.

To reflect physics, dimensions need to be added to the format (1), to fit with models for moisture and electric fields. With traditional notations, such are e.g.

a Maxwell equation; div D= ρ (6)

balance for moisture flux q; div q= K $m_{,t}$ (7)

Proposition. With electric field and moisture-flux derived from the scalars u and v in (4)(5), as (grad u) and (grad v), quantities entering in (6)(7), may be derived. These are

div (grad u)=0, div (grad v)=-4 (8)

div (grad u)=-2 ν /r, div (grad v)=1/r (9)

Proof. Integration followed by differentiation of the solutions (4)(5) to evaluate grad and div in cylindrical coordinates.

Remarks. The solutions u and v are interchangeable such that moisture and electricity can materialise in either way: First, the moisture field can be stationary where there is a density of loads, followed by another state where $m_{,t}$ is nonzero and rho=0, corresponding to (8) in (6)(7).

In the solution (9), there is field dependency and the angle ν enters.

In equations for rate of energy, such terms may be balanced by point sources and rate of internal work in a central field.

3.2. A first order nonlinear differential equation.

The differential equation: y^2 + by' =f (10)

can be expressen as a 1-form; y^2 dx + b dy =f dx
To solve a rearranged version, we shall use the anti-symmetry of the wedge product.
Rewriting (10), and multipling with x from left, yield

$$x((f-y^2)/b\ dx)-x\ dy=0 \quad (11)$$

Proposition. Assuming f=f(x), differentiation of (11) gives dx^dy(-1+2xy/b)=0
Hereby y=b/(2x). Insertion in (10) gives f= $-b^2/(4x^2)$ to fulfil the equation.

Proof. Since f=(x), df=f'(x)dx such that df^dx=0. The first term achievs signs from the antisymmetry dx^dy = - dy^dx

Remark. The classical solution reads y=c/x , $f=c(c-b)/x^2$, and c=b/2 is the constraint provided by the wedge product antisymmetri.

Corollary. A similar derivation for the differential equation y^k + by' =f gives that $y=b^{1/(k-1)}/(kx)^{1/(k-1)}$. This is given in Figure 7, for b=1 and some k in the interval [2.5, 9], since the image was frozen in the animation.

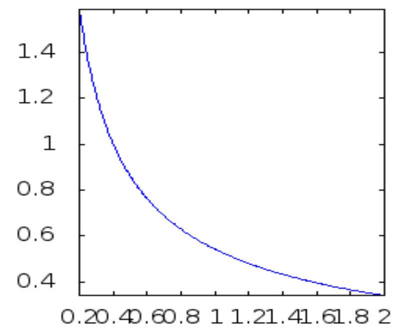

Figure 7. The function $y=b^{1/(k-1)}/(kx)^{1/(k-1)}$, with y on the vertical axis and x on the horisontal axis plotted for b=1 and certain k, with maxima online:
draw(terminal = animated_gif, delay= 40, dimensions = [300,300],
makelist(gr2d(explicit((k*x)^(1/(1-k)),x,0.2,2)), k, 2.5, 9)) $

Application. The equation may be considered as a balance for the force of a central field and a quantity y(x). With y(x) being the velocity of a material point, it is a generalised Bernoulli law with a linear dependence of change in velocity due to e.g. curvature of the stream line. This relates to magnetic induction in curved Cupper wires, Figure 1, 2.

With x=r, the quantities in (9) are solutions to the differential equation (10) and (11).

4. Conclusion

Batteries in pot plants equipped with wind flower beams were constructed.

To obtain a device that develops more inline current, the assumed operation of a Solar Panel was utilized. If the Sun spreads on the Panel, in the same manner as on a water surface at a Sun Breeze, then, the same behaviour may be obtained also for other Sun Catchers, with suitable electronic lines (e.g. Schottky diods) attached. One design in performance was found to give enhancement; >5 times more current, and two other described.

Finally, constructions and experiments were modeled and related to differential calculus, c.f . also [2].

Materialisations of fields were visualised in cylindrical coordinates, Figure 6, within the framework of differential forms. Assuming that these are fields of moisture and electric charges which fulfil linear differential equations; Poisson's equation or static versions of diffusion-like equations, qualitative and quantitative results were obtained; (8)(9). It is seen that *the dependency of angle,* ν, is transported to the differential equation, where it is not related to a space, but instead scaling the magnitude of a central field.

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5. References

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