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# The EM Field as a Sensor System

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**Abstract**

The presence of the electromagnetic field is ubiquitous and pervasive, yet elusive and not fully explored in its artistic potential, eventually because of its invisible nature. Whereas some forms of 'wave' or 'radio' art have been emerging over the last century, a certain materialism of media art uses waves directly, not just as a carrier of information. This paper, imagining novel possibilities to integrate the electromagnetic field in the design of an interactive piece, reflects on the process of crafting a sensing system and proposes a methodological approach to engineering new media and contemporary art.

**Author Keywords**

Electromagnetism; interaction; antennas; sound; gesture.

**ACM Classification Keywords**

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

**General Terms**

Design, Experimentation, Performance.

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Crafting Interactive Systems: Learning from Digital Art Practice

## **Introduction**

The electromagnetic field is an invisible, yet intuitive<sup>1</sup>, omnipresent, yet mysterious, element of what we perceive as reality, so to say the (external) world. The question of its materiality depends on the micro or macro scale of observation and other theoretical perspectives that are not the subject of this paper. The electromagnetic field can be defined, in its ever-changing, intrinsic dynamism, as form that is alive, pervasive, complementary to the presence of physical objects and entities that constitute solid matter. Similarly, the digital is a domain that can be described as either material or immaterial, according to the specific acceptance of its definition: in fact, if digital objects and entities are perceived as immaterial, there is, yet, a physicality (that of hard-drives, computers, displays and servers) inherent to their existence, a physicality from which we cannot prescind. Designing systems that sense the electromagnetic field for artistic applications [1] means bridging digital and physical through an apparently undistinguished interface – but is this interface really indistinguishable? Interacting with the electromagnetic field unveils its presence, offering our senses the possibility to extend and expand, by technological means, our perceptions. Thus, the question originating this research is: what will we learn about the world by interacting with the waves that surround us?

## **Methodology**

If both science and art try to understand the world, in terms of methodology they show two very different

approaches: on the one hand, scientific experiments are valid if they can be repeated, and their results predicted. On the other hand experimental art, reasoning on a symbolic plane, fulfills itself by genuine serendipity, accepting singularity, chance, accident and uniqueness as its substances. This comparison suggests a differentiation in their heuristics and the phenomenology of their mutations. What science and art have in common is that they can be either applied or theoretical: for example, in a certain sense, theoretical physics is to engineering what philosophy is to design. Fine art, then, is in relation of contrariety with design and complementarity with philosophy, while applied arts will be, instead, complementary to design but in relation of contrariety to philosophy. What happens if we try to define, in similar terms, the field of science? The deductive method will be complementary to theoretical sciences, whereas the inductive method is complementary to empirical sciences. In this logic structure deduction has a parallel place to that of fine art, while induction recalls the techniques of applied arts.

Partially accepting the distinction between traditional and digital art, one of the background assumptions of this research is that artists are to engage with the techniques that inform the substance of their work. The imprint of creation is given by touch. There cannot be art, nor craft, without getting the hands dirty, understanding, at least partially, the paradigm of the piece created.

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<sup>1</sup> During our everyday interactions with technology, it can eventually happen to perceive the presence of the electromagnetic field, for example when dealing with on-air television or radio transmitters and receivers.

## Experiments

The creative potential of the use of antennas and the EM field for gestural and physical expression [2] will be explored through a series of tests and progressive experiments. Starting from very simple sonic devices that use a microwave emitter and a receiver connected to an Arduino or an oscillator (CMOS based micro-circuits), in order to control certain parameters of the sound using the hands, and progressively increasing the complexity of the system, for example adding a number of receivers (so to enlarge the sensing space and control at the same time a wider number of parameters), this research, from the construction of a sound instrument, which will eventually implement meta-materials, will move towards gestural expression in more complex performative settings, where the human body acts as an antenna [3]. The third part of this work will focus on kinetic and interactive art installations, sort of autonomous machines that populate the city space.

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## References

[1] Paradiso, J.A., Gershenfeld, N. Musical Applications of Electric Field Sensing. *Computer Music Journal* 21, 2 (1997), 69-89.

## Conclusion and future

The proposed study, currently at a very early stage, explores the use of antennas and the electromagnetic field for gestural and physical expression in experimental music, contemporary performance and live interactive environments. In order to achieve those results, the author, from a background in classical studies and visual art, will try to partially comprehend the physics and mathematics at the foundation of electromagnetic field theory, and the functioning of sound waves. Only by traversing this threshold, will the art work occur and stand out on its own. From an esthetic perspective, this study aims to design systems which can display some form of complex behavior, an *emergent behavior* that transcends the properties and predicates encoded in each of its elements. Such phenomena will be observed in order to identify and describe an arising aesthetic framework, sort of *technological sublime* in contemporary media art.

[2] Tanaka, A. Musical Performance Practice on Sensor-based Instruments. *Trends in Gestural Control of Music* 13 (2000), 389-405.

[3] Cohn, G., Morris, D., Patel, S. N. and Tan, D. Humantenna: using the body as an antenna for real-time whole-body interaction. *Proc. ACM 2012*, ACM Press (2012), 1901-1910.