From a power converter
to a map with 10^{47} border points

Initially, this work has been motivated by a practical application, namely by a model of a DC-AC power converter. Converters of this kind (often called inverters) provide AC power from a DC source and are applied for a broad range of practical purposes including solar panels. Their behavior can be described by ordinary differential equations with a discontinuous right-hand-side leading to low-dimensional non-autonomous piecewise-smooth maps $x_{k+1} = F(x_k, k)$. The dynamics of this map can be investigated using a autonomous stroboscopic map $x_{k+1} = f^m(x_k)$ which corresponds to the mth iterate of $F(x, k)$. The normal operation regime for the considered inverter is the regime of a stable m-cycle of F, i.e., a stable fixed point of f^m. To ensure a good quality of the output signal, i.e. to decrease the amplitude of undesired high-frequency oscillations, it is necessary to use a sufficiently large value of m (for practical purposes, values between 50 and 5 000 are relevant).

The presented approach leads naturally to a specific class of piecewise smooth models which has to our knowledge never been systematically investigated before. In particular, the number of border points of f^m and hence the number of possible border collisions in such systems may be very high, as it grows exponentially with increasing m. This leads to a variety of novel phenomena, for example

- *Transitions to chaos via irregular cascades of border collision bifurcations.* This phenomenon explains partially an unusually complicated and frayed shape of the boundary in parameter space between the domains of regular (desired) and chaotic (undesired) dynamics, which appears not previously to have been investigated.
- *Bifurcation structures inside the stability domain of fixed points.* In strong sense, it is questionable if these transitions should be referred to as bifurcations, since they do not lead to a topological change in the structure of the phase space. However, they are associated with border collisions which do not alter the type of the attractor but only its location with respect to the switching manifolds. Nevertheless, they are important from the applied point of view, as they significantly influence the quality of the output signal of the inverter.

In addition, we discuss several open problems which appear naturally in the considered class of models and are challenging from the mathematical point of view.