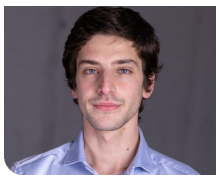
Signal decomposition for sensor signals of a Tree infiltration ditch

Graduate



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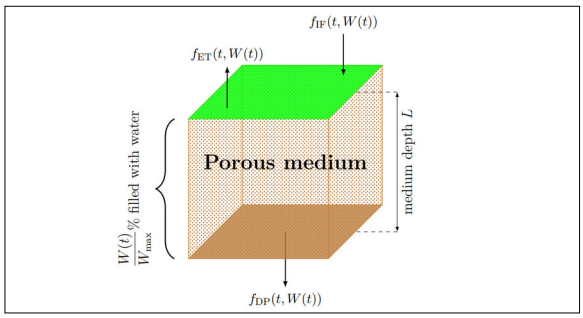
Introduction: This project was conducted in conjunction with the Environmental and Process Engineering Institute (UMTEC) at OST, which developed a tree infiltration ditch. Furthermore, the latter, was equipped with various sensors to measure different environmental variables, including a scale that measures the weight of the whole system.

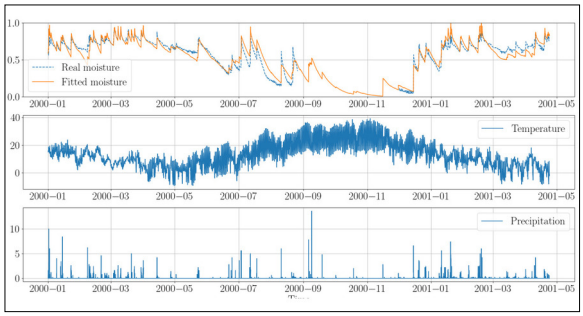
Definition of Task: The goal of this project can be divided into two parts: firstly, a mathematical model was developed to simulate the weight measured by the scale, considering the influence of tree growth and the amount of incoming and outcoming water. The dynamics of these two components were individually modeled testing the results with real data. The second part of this work focused on proposing a signal processing method to decompose the weight signal into the two aforementioned components: weight oscillations and continuous growth.

Approach: When faced with a situation involving the estimation of internal states of a system with known dynamics, and where only a combination of these can be measured, the Kalman filter (KF) is the ideal solution. However, in this particular scenario, a challenge arises due to the non-linear nature of the weight dynamics we aim to model. To address this problem, a linearization process around the Kalman states is performed, a technique known as the Extended Kalman Filter (EKF). This approach has been demonstrated as the most effective method for decomposing the scale signal into the respective weights of the tree and the water.

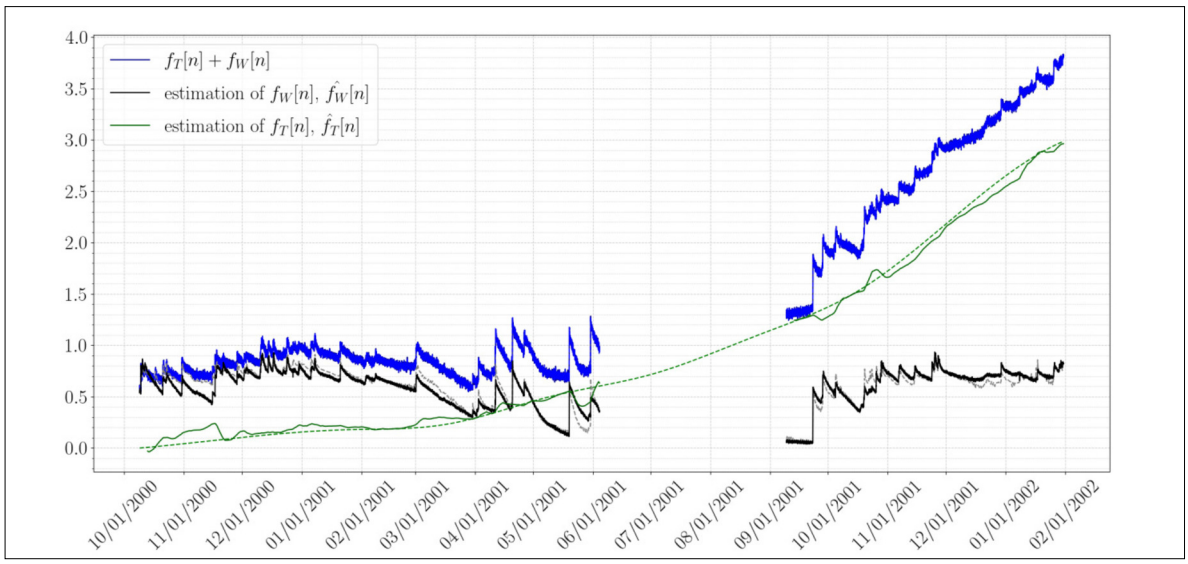
Graphical representation of the soil moisture model used in the simulation.
Own presentment



Soil moisture model results compared with real data.
Own presentment



Extended Kalman filter separation results.
Own presentment



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Electrical Engineering