

Online Univariate Outlier Detection in Final Test: A Robust Rolling Horizon Approach

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Abstract—We present an online outlier detection method that is applicable to Final Test. Test limits are constructed based on previous measurements and robust statistics are used to ensure a stable start to the method. We analyze our method using real-world data. Furthermore, we identified some cases which can result in performance degradation, but most experiments show that our method is robust to outliers and able to detect them in an online setting.

I. INTRODUCTION

In parametric tests of integrated circuits, measurements usually need to be within certain specification limits; devices that are not within these limits are rejected. However, these limits are usually quite wide, since they need to cope with lot-to-lot and part-to-part variation [1]. Therefore, outlier detection methods are used in order to detect deviating behavior in the measurements that are within specification limits; the outliers [2]. We specifically focus on *univariate online* outlier detection which is applicable to final test, this in contrast to offline outlier detection (post-processing) possible at wafer test. The online element leads to the requirement that methods should be extremely fast, since additional computations lead to an increase in testing time, which may be expensive. However, after the outlier decision there is some time before arrival of the next device due to handling and testing time. So only the outlier decision needs to be made very rapidly, then there is some time before the next decision has to be taken (dependent on the handling and testing time), which can be used for updating of limits and statistical analysis.

II. METHOD

Our proposed method consists of two parts: Baseline Initialization and Rolling Horizon. The Rolling Horizon Method uses test data from the previous n good devices to establish limits for the next device, this idea is based on [3]. To start the Rolling Horizon, we first need to obtain an outlier-free baseline of n devices. However, we want to start online outlier detection during this initialization phase. For both purposes we use robust statistics such as the median and MAD (median absolute deviation). First, we apply offline outlier detection to the first m ($m < n$) measurements. Then we apply (robust) online outlier detection until the baseline consists of n good devices, after which the Rolling Horizon Method starts, using mean and standard deviation to construct limits. The required computations are limited by using recursive update formulas.

III. RESULTS

Experiments show that our method is robust and is able to detect outliers, even if these outliers occur in the baseline. Furthermore, we compared the results of our method to an offline outlier detection method: robust PAT [4]. Our method usually detects more outliers, since PAT only detects global deviations, whereas our method detects deviations from the previous n measurements. We also investigated the boundaries of our method. Since our method uses the mean (or possibly median) as location statistic, it is evident that our method is not designed to deal with multimodal distributions. Furthermore, sharp trends or sudden shifts in the measurements are potential threats, since mean and standard deviation are based on previous n measurements, and hence will only gradually adapt to new situations. Finally, highly skewed (asymmetric) distributions might cause problems, since our method used symmetric limits. However, this can be easily changed, and asymmetric distributions can be detected by (offline) calculating the skewness.

IV. CONCLUSIONS

We have developed a new method to deal with univariate online outlier detection and devoted specific attention to the initialization phase. Initial experiments show that our method is robust and is able to detect outliers. The effectiveness of the method depends on the test data distribution. Therefore, further research is required to identify conditions under which our rolling horizon method is most effective. This can also give more insight into favorable parameter settings and to which tests outlier detection should be applied.

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