

# Automatic Detection of Clinical Mastitis in Astronaut A3™ Milking Robot

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## Introduction

Clinical mastitis (CM) in dairy industry is a major welfare problem, leads to the poor performance of dairy cattle and reduces the farmers' profit (Halasa *et al.* 2007). Recently, most online CM detection models primarily focused on measuring electrical conductivity (EC) and milk color (Kamphuis *et al.*, 2008; Kohler and Kaufmann, 2003). In practice, most of farmers who use automatic milking system (AMS) look in addition to EC and colors at milk yield and other information when cows visit the AMS. The objective of this study was to combine EC and milk colors from a newly developed Milk Quality Control™ (MQC; Lely Industries N.V., Maassluis, the Netherlands) with dead milking time (DMT) and quarter yield ratio (QYR) and improve the detection of CM in AMS.

## Data Collection

This research was conducted in the Netherlands from May through September of 2009 in 5 commercial farms. A total of 131785 milking were recorded coming from 649 randomly selected lactating cows (Friesian-Holsteins, Montbéliarde and its crossbreeds). There were 10 Lely Astronaut A3™ milking robots equipped MQC™. The MQC™ re-sampled quarter milk yield in 10 equal amounts and recorded the average light transmittance and EC for those periods. The light transmittance through milk was presented by the spectrum colors blue, green, red and near infrared. It also recorded DMT defined as the time from the 'teat cup connected' to the 'milk flow detected' and QYR calculated as the ratio between the quarter milk yield and the total milk yield. In this experiment, farmers were requested to report all treated CM cases. By the time of writing, 26 CM cases were reported to serve as reference. Furthermore, farmers received no feedback from our model and only relied on their own standard operational protocols.

## CM Detecting Model

The CM detection model was built in MATLAB® 2009a (The MathWorks, Inc., US) and developed on a training dataset sampled on the same farms prior to this experiment. For every quarter milking, the inputs (EC, colors, DMT and QYR) were evaluated as CM indicators by standardizing with 10 preceding non-CM milking from the same quarter. For EC or color input, if more than half (20 for the 4 colors and 5 for EC) of the values had standard scores greater than 2, it was indicated positive for CM. For DMT or QYR input, if the standard score was greater than 2, the CM indicator was given positive. In case there was any positive CM indication in the current milking, and all 4 indicators showed positive at least once within 2 preceding milking, it received a CM attention. The CM attentions were compared with the reference reported by farmers. The sensitivity (SN) and specificity (SP) were calculated with a defined time window of 2 days (1 preceding day plus the detecting day).

