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Automated oyster shucking
Part III. Orientation efficiencies of an oyster orientation and transfer system

Nadine E. Little, Oliver H. Smith, Fred W. Wheaton [1,*], Mark A. Little

Biological Resources Engineering Department, University of Maryland, College Park, Maryland 20742, United States

Abstract

Many oyster handling and processing devices require oysters to enter in a specific orientation. Unfortunately wild caught oysters exhibit great variability in shape and configuration. Thus, orienting them automatically is challenging. Orientation and transfer devices were developed and the efficiency of both orienting single wild caught oysters from the Chesapeake Bay region and transferring them from the orientation device to an exit conveyor were determined.

The computer program, OYSORS, developed to control the orienting device was found to be able to orient only 51% of the oysters within ±0.35 radians when using only the basic program and 68% when using the basic program plus the Adjust modification. The total orientation and transfer system efficiency using the Adjust algorithm was determined for oysters from three oyster bars in the Chesapeake Bay Region: Tangier Sound, Wicomico River, and Potomac River. The total system was found to be able to orient and transfer oysters while holding their orientation within ±0.35 radians for between 50 and 66% of the oysters depending on the origin of the oysters. The transfer system alone was shown to be able to transfer oysters from the orienter to the exit conveyor within an allowable deflection of ±0.17 radians in 75–95% of the oysters depending on the origin of the oysters. It was shown that the transfer system was actually able to correct the orientation of some of the oysters incorrectly oriented by the computer program OYSORS.

Keywords: Oyster shucking; Oyster processing; Oyster orientation; Shellfish processing; Orientation

1. Introduction

The U.S. oyster industry harvests about 38.5 million pounds of oyster meats per year (Fisheries of the US, 2005). Although some of these oysters are sold in the shell, most are sold shucked (the process of removing the meat from the shell). Commercially most oysters are shucked by hand, although there have been efforts to develop automated shucking equipment for over 150 years (Gird, 1977; Wheaton, 1972); even in these machines however, some orientation is required. Today there are two automated machines used in the industry. The steam and shake process cooks the oyster in a retort and then passes them through a perforated tumbler to shake the meats out of the shell. This system produces a cooked oyster for oyster stew or soup but cannot produce a raw shucked oyster as desired in most of the oyster trade. The second system subjects the oysters to very high

* Corresponding author. Tel.: +1 301 405 6511; fax: +1 302 314 9412.
E-mail address: fwheaton@umd.edu (F.W. Wheaton).
[1] Currently Professor, Department of Environmental Science and Technology and Director, Northeastern Regional Aquaculture Center, University of Maryland, College Park, Maryland 20742, United States.

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pressure (approximately 275.8–345 MPa) causing them to release the attachments between the meat and the shell (He et al., 2002; Anon., 1999). This process was designed to pasteurize the oysters and shucking appears to be an additional benefit of the process. Although the high pressure process produces raw shucked meats it has very high capital costs (in the range of US$ 1,400,000 per machine) (Smillie, 2003). All other proposed oyster shucking machines require some method of orienting the oysters-in-the-shell prior to entering the machine.

Gird (1977) developed a method for determining the orientation of oysters lying on one shell valve in their natural resting position. Tojeiro and Wheaton (1991) developed a computer vision system to implement Gird's (1977) method into a research system. Their unit only determined if the computer vision system would accomplish the task and it was proven to be a valid approach. Smith et al. (1992) then developed a method for processing the oyster image to determine which end of the oyster was the hinge. Little et al. (2007a) developed a machine possessing several mechanical components to orient the oyster. Using computer vision as the sensing system, Little et al. (2007b) developed an automated control system to automatically operate the machine and to implement the computer program developed by Smith et al. (1992). This machine took randomly oriented single Eastern oysters, *Crassostrea virginica*, from a feed conveyor, automatically oriented them to the desired orientation, and transferred the oysters to an exit conveyor without losing their orientation. This paper will focus on results of tests designed to determine the orientation efficiency of Little's et al. (2007a,b) orientation and transfer machine.

2. Objectives

1. To evaluate the efficiency of the computer program OYSORS (acronym for oyster orientation system) using the orientation algorithms: the Non-Adjust and the Adjust.
2. To evaluate the orientation efficiency of the total oyster orientation and transfer system for oysters grown in different localities.
3. To evaluate the performance of only the transfer system to maintain oyster orientation during transfer to the exit conveyor for oysters from different localities.

3. Machine operation

Details of the mechanical parts of the orientating and transfer systems are available in Little et al. (2007a).

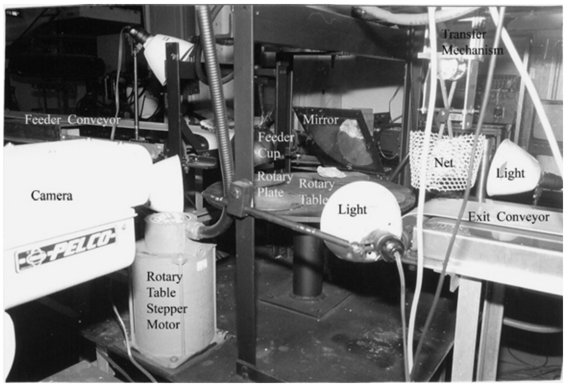

Fig. 1. Oyster orienting and transfer machine.

Details of the automated control system are available in Little et al. (2007b). The basic machine operation is summarized here to assist in understanding both the testing procedure and the machine orienting efficiency.

Fig. 1 shows the configuration of the machine. On the top left of Fig. 1 is the feed conveyor while on the far right is the exit conveyor. At the right hand end of the feed conveyor is the oyster feeder cup. Behind the light in the front center (one of three that provide lighting for the camera) is the rotary table with the four rotary plates on it. The camera in a weather-tight enclosure is shown in the left center of Fig. 1. On the side opposite the rotary plate from the camera is the mirror that provided the top view of the oyster. The transfer mechanism is visible in the right center of Fig. 1 just above the start of the exit conveyor. This transfer mechanism is comprised of three components: the band cylinder which provided the horizontal motion of the mechanism (not shown in photo), the piston which raised and lowered the scissors device, and the gripping scissors device that held the oyster for transfer. The large grey cylinder on the left and below the camera in Fig. 1 is the stepper motor that drives the rotary table. The stepper motor that drives the rotary plate (near the mirror) rotation is under the rotary plate and is not visible in Fig. 1.

The orientation transfer machine operated as described below. Singulated randomly oriented oysters enter the machine on the feed conveyor. The first oyster drops into the oyster feeder cup (a split hemispherical bowl). The cup then opens from the bottom placing the oyster onto the rotary plate located directly below it. The rotary plate then rotates 1.57 radians placing the oyster in front of the mirror. The mirror is tilted 0.78 radians toward the camera so that the camera will see the top and side view of the oyster. Based on the technique developed by Gird (1977) and extended by Tojerio (1987) and Tojeiro and Wheaton (1991) the