



A Primer on Robotic Milking Systems

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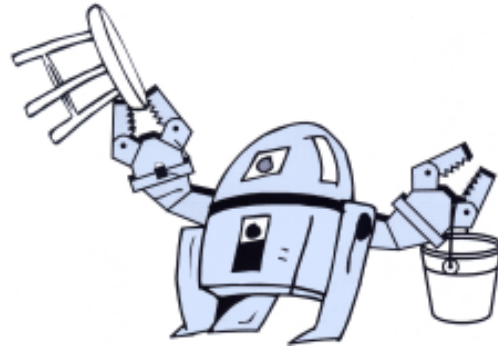
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The purpose of this fact sheet is to review the basic parts, components and functions of a robotic or automatic milking system (RMS, AMS, AM-system). By design an AMS reduces the regular intensive milking labor that is required on traditional dairy farms. With automatic milking, cows are free to move around the barn and enter the automatic milking (AM) unit at anytime without human supervision or intervention. Computer controlled automatic equipment identifies the cow, controls cow movement, preps the udder and attaches and detaches the milking unit. These systems were developed in Europe with the intention of allowing a family farming unit to milk more cows without additional labor. One robot or AM unit is reported to handle 40 ñ 70 cows.

The following steps are involved in harvesting milk:

- ◆ Identify cow requiring milking
- ◆ Move cow to milking location
- ◆ Restrain cow
- ◆ Prepare udder
- ◆ Determine milk quality ñ keep or discard
- ◆ Attach teat cups (and reattach if necessary)
- ◆ Monitor milking process
- ◆ Remove teat cups
- ◆ Post milking treatment of udder
- ◆ Release cow and return to pasture or barn
- ◆ Transfer milk to storage and cool

A successful automatic milking system must accomplish all these steps without regular human intervention. A trained cow and computer system are critical to successful automatic milking . A variety of sensors, mechanical manipulators, pipes, hoses, and the milking machine complete the system. An AMS does not just substitute a robot for a human operator to milk the cow. It is a complete coordinated system that impacts cow housing, feeding, milking and over all management methods.



Manager Responsibilities

The AMS requires oversight by a manager who must understand how to use the automated milking system and carefully monitor the performance of both the system and the cows. Cows that do not voluntarily visit the AM unit must be fetched and directed to the milking box on a regular basis. An AMS removes the routine, intensive and time sensitive milking activities from managing a milking herd.

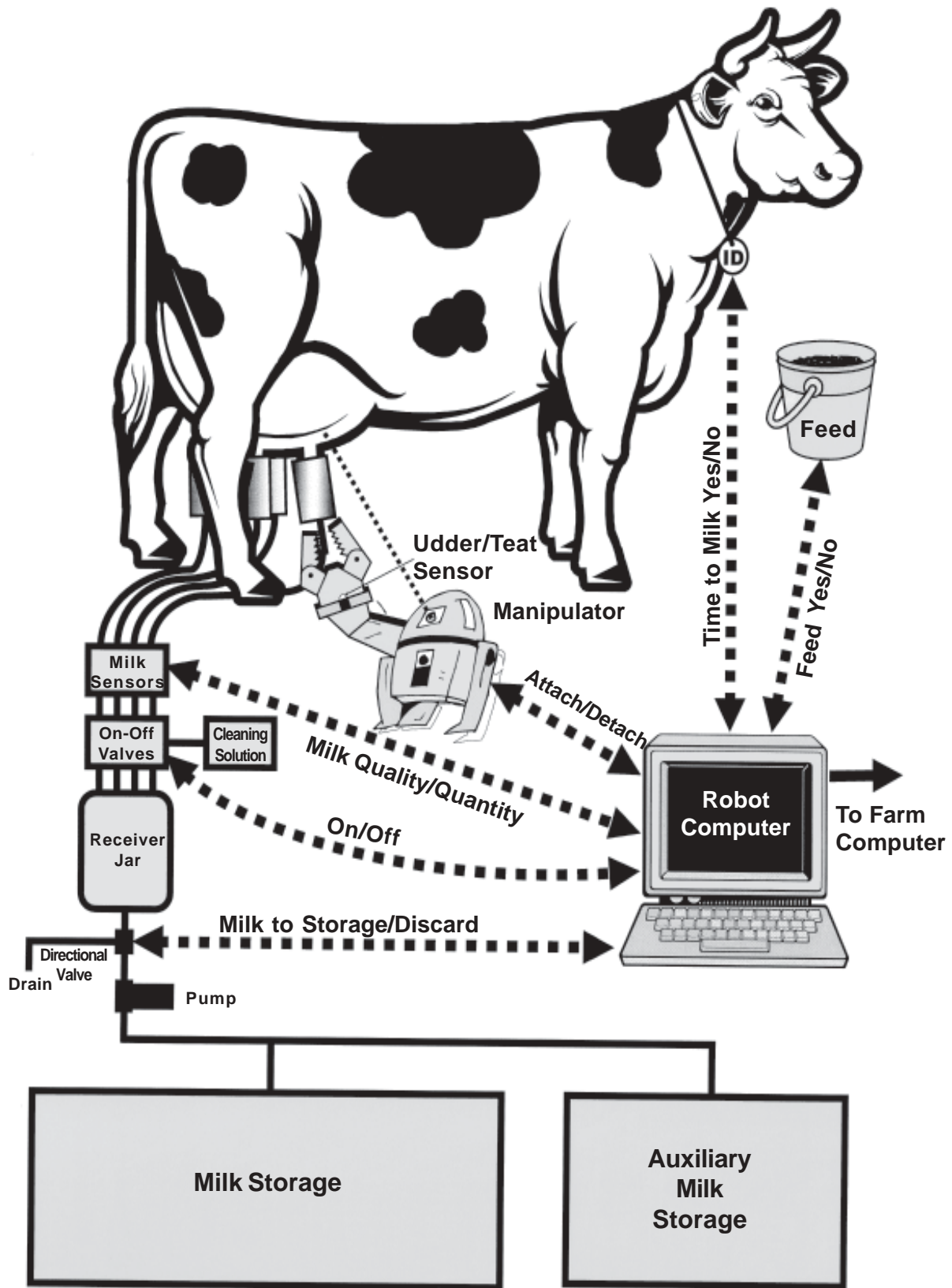
Cow Responsibilities

In a conventional dairy system the cow's responsibilities are to eat and drink, lie around and produce milk, and stand to be milked. In an AMS she also must present herself at the milking box or stall to be milked. She is encouraged to do this by grain feeding in the milking box, barn layout that may force her to walk by the milking box to access feed and water, and training.

Computer Responsibilities

Adequate computing power is essential to operation of automated milking systems. The computer directs the functioning of the various parts of the AM system and alerts the manager to unusual events. It also evaluates data collected by the various sensors, uses information from the sensors and direction provided by the manager, and records information concerning each cow and her milking process.

Components of an Automatic Milking Unit



Components of an AMS

Computer(s)

A computer located at the milking box is integral to a successful AMS. It monitors and controls the milking operation, cow handling and record keeping. This computer is normally linked to a management computer that contains long term records. Either computer can be used to input instructions to the automatic milking unit and review cow information collected by the robot.

Sensors

Cow Identification

All cows must have an electronic identification tag. These tags are read at selection gates and the milking box to determine the status of the cow.

Udder/Teat Location

Laser, ultrasonic or vision camera devices are used to locate the cow's udder and teats. This allows the computer to direct the movement of the manipulator arm as it preps the cow and attaches the teat cups.

Milk Flow

Milk flow sensors measure flow in the milk line from each teat. These sensors function similar to any automatic detacher. The computer uses information from this sensor to determine if there is milk flow coming from the teat. If milk flow does not occur at a set time after teat cup attachment the manipulator is directed to reattach the teat cup. As the cow is milked out and milk flow declines, the computer uses this information to shut off the milking vacuum and the teat cup is removed. The amount of milk removed is recorded for each cow milked.

Milk Conductivity, Color and Temperature

A variety of sensors may be used to determine the quality of the milk. Conductivity, color and temperature are three characteristics presently being measured. The computer uses this information to determine if the cow's milk should be sent to the storage tank or discarded. Information can also be reported to the manager if there are indications of mastitis or other health problems. This is probably the area of AMS that is the least developed and is changing rapidly.

Milking Box or Stall

The milking box or stall provides for restraint and positioning of the cow. It also serves as the mounting location for various accessories including entrance and exit gates, feed dispenser and often the manipulator arm itself.

Power Gates

Power operated gates are required at the entrance and exit points of the milking box to allow cows to enter and exit. Gates before or after the milking box may also be used to divert cows away from the milking box or to special holding pens. One-way gates, operated by gravity or springs, are also used to control cow movement.

Feeding station

All AMS include a grain feeding station in the milking box. The grain provides an incentive for the cow to go to the milking box and may keep her quieter during milking.

Udder Cleaning

Udder cleaning is accomplished by rotating brushes or wash cups with jets of air and water. At present the systems have no way to determine the amount of cleaning necessary so all cows are cleaned the same.

Milking System

AM units employ quarter milking. A separate milk line goes from each teat cup through the milk sensors and valve to a small receiver. The receiver jar is used to accumulate milk from the cow. When the cow is milked out the milk in the receiver is either transferred to the milk cooling and storage system or discarded. Milk is discarded if directed by either information from the manager that was entered into the computer or from the milk quality sensors.

Milk Cooling and Storage

Milk cooling and storage systems used with AMS have some unique requirements. The storage system must be able to receive milk at anytime because cows can access the milking box around the clock. To facilitate milk pickup and subsequent tank cleaning operations it is necessary to have a second tank available. Timely cooling of small milk flows is also necessary. It would take too long for a large tank to accumulate enough milk for milk to cover the cooling plates for proper milk cooling. Therefore the auxiliary tank that is used during milk pickup is usually a small tank that allows for quicker cooling of small quantities

of milk. When the small tank holds enough milk to allow the large tank to properly cool, the milk is transferred to the primary tank. Ice bank tanks and in-line cooling are other methods for providing appropriate cooling.

Cleaning Milk Handling Equipment

Rinsing and cleaning of the teat cups and their milk hoses, the receiver jar, the milk transfer pipeline and bulk tanks is required. Usually the milk hoses and teat cups are back flushed after each cow. If the cow's milk was withheld due to treatment anything that this milk came in contact with must be appropriately cleaned (receiver jar, milk hoses and teat cups). If no cows have visited the unit for a predetermined time, milk that has been lying in the milk transfer line is flushed out and the line is cleaned. At predetermined times (two or three times a day) the entire system is completely washed.

Storage tanks are washed after milk is removed from them. When two tanks are used, interconnected, automatic valves are necessary to assure proper milk flow, equipment cleaning, and separation of saleable milk from cleaning solution. This is another area that is receiving close attention from manufacturers and milk quality regulators.

History

Anyone who has milked very many cows has probably dreamed of a way to get milk without the chore of milking. The history of today's Automatic Milking Systems is considered to have started in the 1970's. Western Europe began intensive development efforts in the 1980's with work going on in the Netherlands, France, the United Kingdom, Germany, Sweden and Denmark. In the early 1990's these systems were being placed on practical farms in Europe. In 1999 there were over 400 robots on farms in Europe and the first robot in Canada began operation. In 2002 there are three farms using milking robots in Pennsylvania.

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