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Milk Heater for Newborn

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Background, Motivation and Objective. In this work, we propose the implementation of a low cost prototype using an open source platform, which performs the heating of the syringe and enteral therapy equipment for newborns. A set of components was used whose main function is to measure the temperature at which the milk is infused. By means of a redundant PID control, it will control the thermoresistive loads with precision and safety. The objective is to automate the process of heating breast milk in hospital admission units, reduce operational errors, increase nutrient conservation, improve comfort during enteral therapy for newborns - born in their recovery.

Methods. During gestation, maternal mechanisms maintain intrauterine temperature. After birth, the newborn's adapted to an adequate response by means of chills [1]. After birth, newborns need a temperature controlled environment. Some children who, for some reason, can not be breastfed by their mothers, such as preterm birth, low birth weight and infection pathology [2]. In many cases, the neonate needs to be reassigned to intensive care units where they use enteral therapy, which in turn is administered by syringe pumps Breast milk is the complete food for the infant, being the only source of vitamin A for fully breastfed infants. And the child's ability to acquire their need depending on concentration and volume consumed [3]. The mother's own milk is the most suitable for prematurity, containing, in the first four weeks, high levels of nitrogen, proteins with immunological functions, total lipids, fatty acids, vitamins A, D and E, calcium and energy [3]. Some children end up needing enteral therapy through syringe pumps that best infuse the nutrients and should be kept horizontal to avoid secondary fat loss and their adsorption in equipment or infusions [4].

We set up a group of studies together with the nursing area to raise the main difficulties found to warm the breast milk, so we describe the steps of the process. Milk should be stored at low temperatures, generating the need to thaw it before use. In the process of thawing the food, the time required is generally high due to the fact that the shaking of the molecules in the ice crystals is much smaller and the energy dissipated is 170 times lower than in liquid water at 25 ° C. the two most commonly used defrost methods are the microwave or the "water bath", and the microwave defrosting process ends up being the most used, considering the delay of the water bath procedure. Thus, the objective of this study is to automate the thawing process and to perform adequate milk temperature control during therapy in order to improve enteral therapy in newborns. Desiring the spread of technology in hospitals with limited financial resources, a prototype was developed with open source platform, providing low cost and easy implementation. This way you can increase the safety and quality of the processes.

Results. Figure 1 shows the steps followed to development of this work. With the data specified, modeled and simulated, then the prototype was designed, developed and tested, according to the flow shown below.

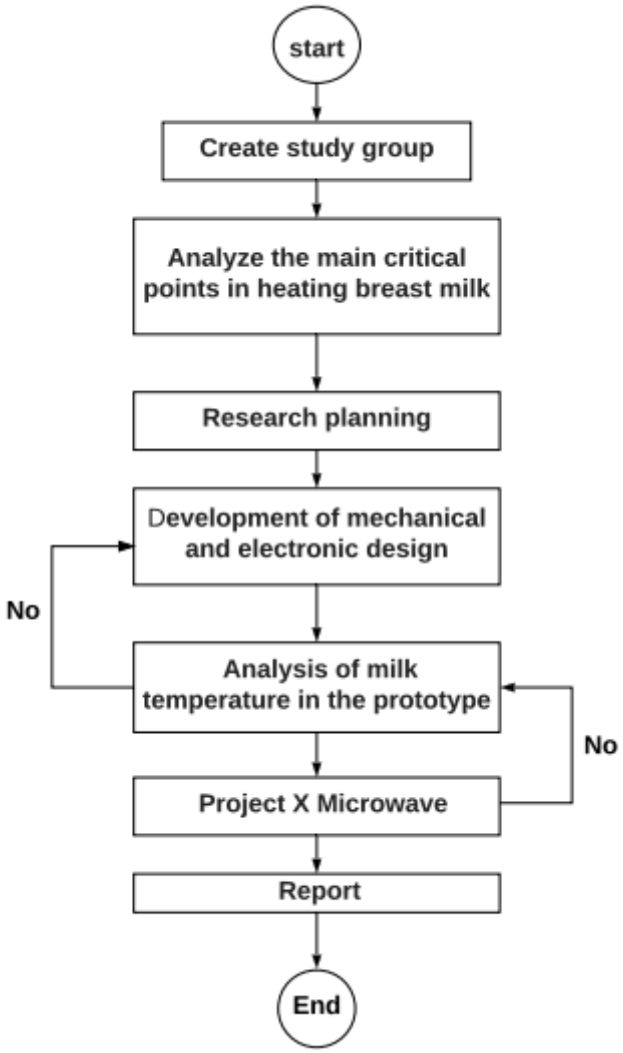

Figura 1: Structure of how the prototype development was carried out

Initially, a study group, composed of nursing professionals and clinical engineering, was organized to evaluate possible solutions for a low-cost prototype for heating breast milk. Several follow-ups were performed at the neonatal intensive care unit, together with the nursing group, to measure the real difficulties of thawing and breast-feeding during enteral therapy. As shown by the flow of Figure 1, the other steps are described below.

Mechanic project: The first stage of the project is the development of an equipment with controlled resistance and control sensors. It is completely insulated to prevent penetration of

liquids. After the developed equipment system, the syringe pump was mounted which will only begin to infuse after the release of the sensors.

Electronic Design: In this stage the programming of the platform PIC, with language C was considered. Based on the sensors and the resistance of the equipment the programming lines were set up. After this step, the stepper motor of the syringe pump was programmed, with all safety mechanisms. The display shows the flow and temperature values.

Programming: The programming has basic commands, with monitoring and redundancy of the temperature system. The prototype will have an easy-to-use infusion interface.

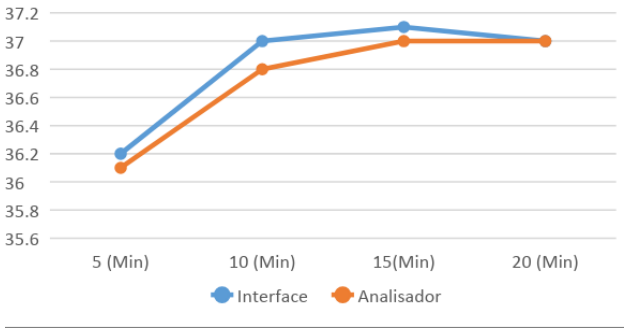

Figure 2: The graph shows the comparison of the prototype with the instrument calibration, the time it takes to reach 37 ° C.

The alarms were set at a temperature above 37.5 ° C and below 35.0 ° C. And also if any anomaly happens with the resistance, if it does not stabilize for 10 minutes the system will trigger the visual and audible alarm. The temperatures will not have manual adjustment. It will be pre-set in the program to reduce human errors.

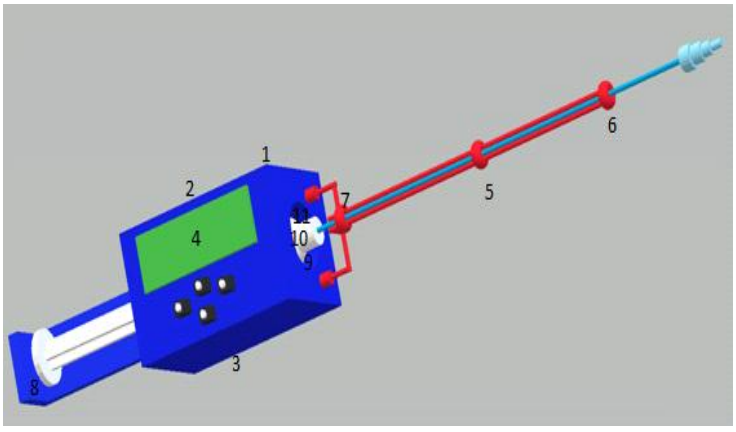

Figure 3: Mechanical prototype.

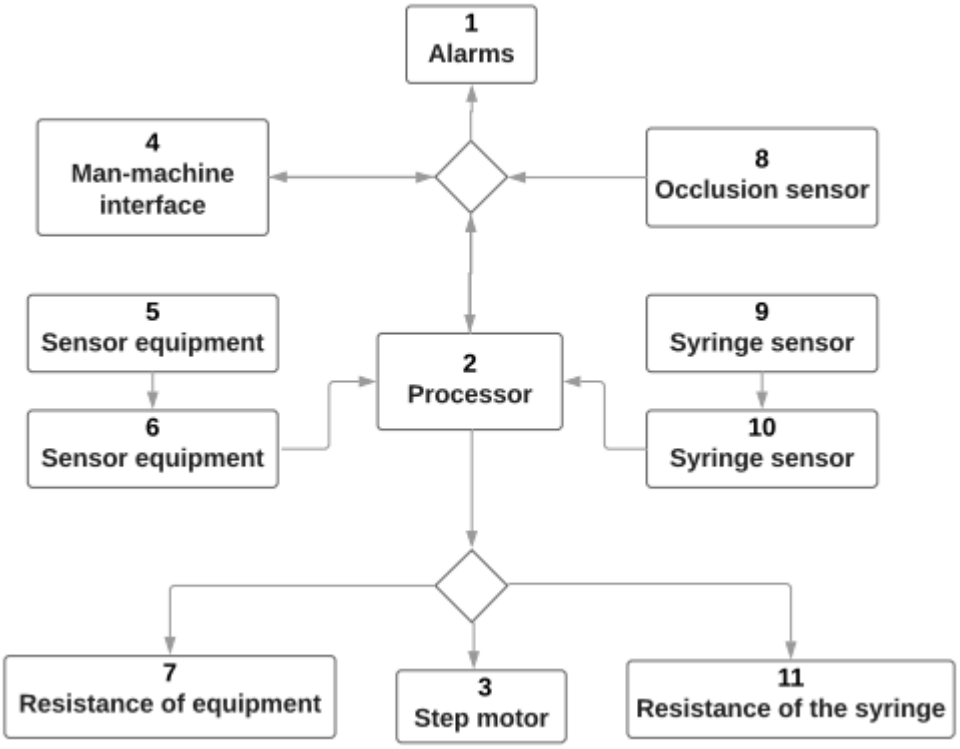

Figure 3: Electronic system flowchart.

Observed in figure 3 and 4 the prototype easy usability, in figure 4 we can see the flow of the electronic system of the project, as shown in the flow we have redundancy in the temperature sensors, we used two resistors one to heat the syringe another to heat the equipment, every system and monitored by the processor.

Discussion and Conclusions. Throughout our research, we realized that this area of medical and hospital equipment is very important for society and often ends up without support due to the costly costs involved. The goal was to design an automation to supply breast milk in hospital admission units, reducing operational errors, increasing nutrient preservation, improving comfort during enteral therapy for newborns and as an aid in recovery. It designs an efficient and safe low-cost system for use in neonatal inpatient centers, contributing to recovery and comfort, adding much to medical care. The project is not complete. We look forward to developing the same.

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Keywords. Automation; Heating; Milk; Arduino; Quality and Safety;

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