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Semi-automated double sided livestock (SADSL) mixfeeder

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ABSTRACT

The Semi-Automated Double-Sided Livestock (SADSL) MixFeeder is designed to automatically feed and acts as a mixer for the food ration ingredients of the cattle livestock. The machine helps to reduce the manual work in mixing and feeding the livestock. The software design for the SADSL MixFeeder utilizes custom software written in the language of the Arduino development environment to implement all the functions required to control the feeder using Arduino microcontroller-based system. The prototype for SADSL MixFeeder is designed and implemented successfully. An encrouging result in term of working time taken to mix the food ration and feeding the cattle is shorten as illustrated in the working time for a farm with 20 animals herds, worker had to spend 50 manpower minute/day twice daily using SADSL whereas for manual mixing and feeding working time spend for similar number of animals are around 80 manpower minute/day. This shown a potential time saving in mixing and feeding the food using SADSL.

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1. INTRODUCTION

Livestock are domesticated animals raised in an agricultural setting to produce commodities such as meat food, fiber, and labor. Livestock production globally increases in the demand for livestock products, driven largely by human population growth, income growth and urbanization. [1-6]. However, for cattle farming is not an easy thing but requires a lot of manpower for livestock production. Furthermore, most of the livestock farms in our country are located in rural areas and do not have the sophisticated technology that can help the process of rearing animals running smoothly. In order to ensure productive dairy and beef cattle, the welfare of this livestock need to be taken care properly especially for fully enclosed (indoor) feedlot facility with slatted floors to keep the feed and bedding dry.[7] The problems usually faced by the farmers is during the feeding time. When meals time for the livestock, workers have to carry the weight of food and the food then need to be mix. Mixing manually the cattle food using scoop requires a lot of energy and can gave unhealthy side effect to worker backbone in long term effect. Usually during feeding time for the cattle, the worker will feed the livestock manually. So, this method will requires lot of energy and time. Furthermore, it needs a lot of manpower for large farm. This will cause farmer incur higher costs to pay additional salaries for more manpower. Other than that, the old style "Bunk Feeders" [8-10] have numerous limitations such as over consumption, waste, and exposure to the elements as well as wildlife consumption.

Although, the solution for monitoring and control the cattle farm operation and environmental condition available [11-16] but the existing are still lacking of an automated feeder system. An effient feeding system can produce cattle that are physical and geneticly healthy [17-20]. Nowadays, healthy cattle that are well feed can be monitored using computer vison to gauge further the amount of food taken by each individual cattle [21-25]. Therefore, a Semi-Automated Double Sided Livestock (SADSL) MixFeeder system is proposed and developed to provide the food effectively and to control cattle feeding time. This system provides an efficient solution for sufficient quantity of the food distribution, fixed feeding time and hassle-free automatic feeding to help farmers.

The solution for this problem is to automate the livestock food preparation during their meal time by using SADSL MixFeeder as shown in Figure 1. The SADSL MixFeeder is the most in need of forage. The feeder is programmable that utilizes a power source which can be maintain variously. It will be programmed with adjustable length of run-time. Plus, the volume of the grass-fed will determined and programmed by the number of livestock in the farm. Other than that, the combination of improvisation mixer in the feeder will expedite the food preparation time in production of the food to the livestock. This will helps the worker to feed the livestock faster whereby they just need to load the food into the storage and let the food being mix automatically in some programmable time. Thus, this will lead to reduce the time management of livestock food and could ease the user as well as the farmer in managing their livestock food preparation and production. This project helps to minimize the quantity of manpower at the farm and the cost itself.

Figure 1. The block diagram of the SADSL Mixfeeder

Health and wellbeing of worker also protected by using SADSL Mixfeeder. For an example, this machine will provide mixer process to mix several types of cattle foods and farmer do not need to mix the food manually using scoop. Besides that, cattle also is provided with balanced nutrient, this is because all of food will mix together and cattle will eat that food without choose which one types of food that they want, so with used this machine cattle will be provide with good nutrient daily. Other than that, this project is to restrict the over consumption from food wastage of livestock feeding and to reduce the cost.

The SADSL MixFeeder provide safety for user and animal usage. Firstly, this machine can easily operate for putting the pallet food and secondly, the faulted operation of machine will not give hazardous effect to human, beside that the shape of SADSL MixFeeder have round shape at edge of machine and this shape can protect livestock from obtain any injury or bleeding if hitting this machine.

This paper presents the development of SADSL MixFeeder has been proposed to build an automatic livestock feeding system with improvisation of built-in mixer machine. The remainder of the paper is organized as follows. Section 2 describes SADSL MixFeeder system development and design approach in term of hardware and software component. Section 3 discussed the development result of the SADSL MixFeeder system. Finally, section 4 draws our conclusions and point out the ideas for future extension of this work.

2. RESEARCH METHOD

The objective of this project is to build an automatic livestock feeding system with improvisation of built-in mixer machine. With the assist of the SADSL MixFeeder, the farmer will easily conduct and schedule the feeding time of the livestock in their farm. Figure 2 shown the overall flow of the SADSL MixFeeder. First, the farmer will load the food and water needed for the livestock in the storage of the machine. Then, a microcontroller will do the part for the scheduling the time needed to open or close the valve of the storage to feed the livestock. The valve will either open or close in seconds to load out the food and mix all the food ingredient for the food production of the livestock. Then, the livestock will be feed automatically by scheduled time and no over consumption or wastage food will happen as the load out of food and water were measured proportionally with the amount needed for per feeding session and the time to pour out the food and water.

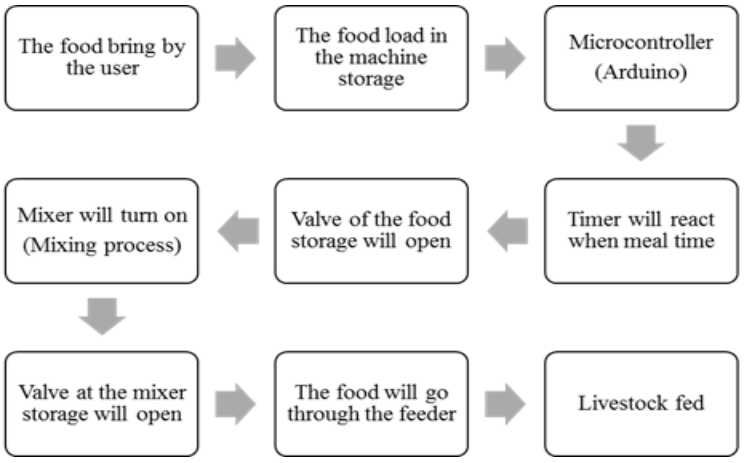

Figure 2. The flow process of the SADSL MixFeeder

The software development flowchart is shown in Figure 3. Firstly, the food ration is placed in food storage container. There are 3 types of foods that need to be mix prior to release to feeder container. Then, Arduino microcontroller is used to schedule the feeding time by opening food storage valves and start the mixing of foods. Once the food is properly mixed through the motorized blade, the food will be release from the mixer container. The releaser valve is active once the motor grinder stops grinding. The releaser valve is open to release the mixed food into flat surface in feeder container.

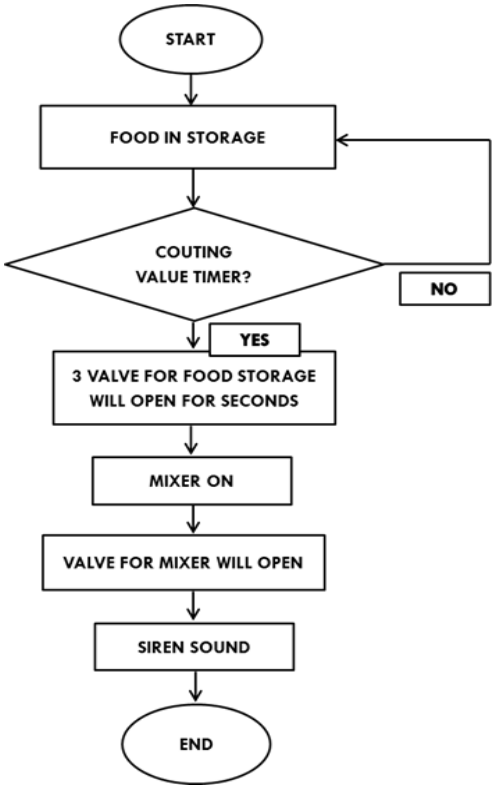

Figure 3. The flowchart of software development

The hardware circuitry is shown in Figure 4. The whole mixing process will be done through a controller (Arduino) which controls the whole two gear motor and a servo motor which are powered by 9V or 12 V.

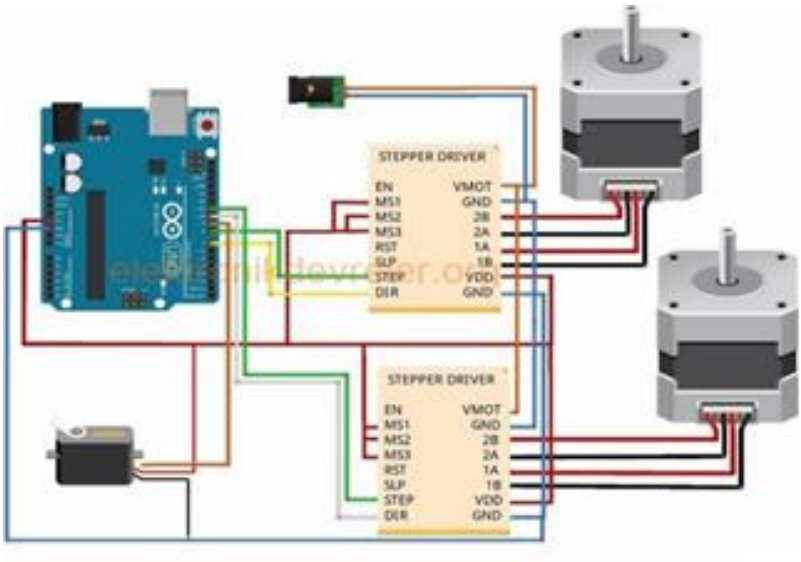

Figure 4. The Hardware and Software implementation architecture

Since motor operates on Pulse Wave Modulation (PWM), most motors will be connected to pins 9, 10 and 11 of Arduino since these pins produced output for PWM. The generated PWM can be adjusted in the coding of the microcontrollers. The servo motor will be used to operate the opening and closing of the valve in which the food will pass through before the mixing process occurs. As for the gear motor, the motor will be controlled through PWM as well. It is estimated the motor will be control through a 12 V with a speed of 3000 to 6000 rpm. Thus, the estimated torque load will be around 1 to 2 kg. The gear motor will be use to propel the mixing blade, for mixing purpose. Since the load of the food ingredients estimated for about 1kg, a high torque load is much preferable.

The SADSL MixFeeder is designed based on user requirement analysis. The design need to be convenient to both user and the livestock. The machine is in rectangular shape. This is to easier the livestock to feed without crowded themselves. The input storage of feed ingredients is designed in partition of four parts. Supposedly, the placement of electrical device will be place beside the machine itself.

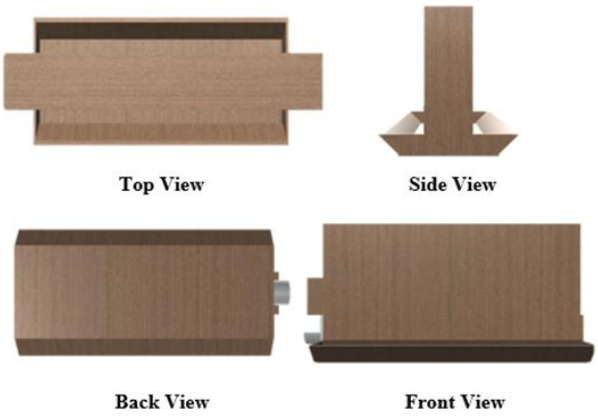

Figure 5. The whole view of the Semi-Automated Double-Sided Livestock (SADSL) MixFeeder

Then, the type of blade will be used is the paddle-blade type. The paddle-blade widely used to general usage of mixing process in agriculture. However, this blade need to be custom-made. For this project, the blade will be made up by using zinc. The whole view of the developed MixFeeder is illustrated in Figure 5. Detail components used for development of this MixFeeder are wooden plank, L-bracket, adapter, power window motor, servo motor, shaft and bearing. Wooden planks is used in this project as a prototype body for

the project. This is because we find that using wooden planks as a project structure will look firmer and tidy. It is also strong and can support heavy weight due to large amount of pallet in the storage area.

L-bracket is an intermediate component for fixing one part to another, usually larger, part. Brackets vary wildly in shape, but a prototypical bracket would be the L-shaped metal piece that attaches a shelf (the smaller component) to a wall (the larger component): its vertical arm is fixed to one (usually large) element, and its horizontal arm protrudes outwards and holds another (usually small) element. For this project L bracket used to hold or strengthen the divider wall between the partitions of palette.

An adapter or adaptor is a device that converts attributes of one electrical device or system to those of an otherwise incompatible device or system. Some modify power or signal attributes, while others merely adapt the physical form of one electrical connector to another. Adapter is used in this project instead of battery because the project need more power and last longer.

Power window motor used in this project is because the powers that can accommodate the high number of weight and since the prototype built in a large size, the power window motor required for rotating the shaft and at the same time as operate as mixture. The function of the servo is to receive a control signal that represents a desired output position of the servo shaft and apply power to its DC motor until its shaft turns to that position. The servo has three wire connection: power, ground, and control.

Servo motor used in this project is to open and closed the valve from the palette container to the mixture part. Shaft is a mechanical component for transmitting torque and rotation, usually used to connect other components of a drive train that cannot be connected directly because of distance or the need to allow for relative movement between them. But in this case shaft have been used to connect to the motor so it can rotate and act as a mixture for this project.

A bearing is a machine element that constrains relative motion to only the desired motion, and reduces friction between moving parts. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may prevent a motion by controlling the vectors of normal forces that bear on the moving parts. Most bearings facilitate the desired motion by minimizing friction. Bearings are classified broadly according to the type of operation, the motions allowed, or to the directions of the loads (forces) applied to the parts. For this project bearing have been used to connect with the shaft so that the rotation will become smooth.

3. RESULTS AND ANALYSIS

The SADSL MixFeeder prototyped has been developed from version to version by adapting the designs from several testing results. Further explanations of prototyped development and experiment will be discussed in the next subsections.

3.1. Prototyped

Preliminary development works include of component testing. One of the most important experiment is to study, plan and prove the movement of the blade will support the mixing process of the ingredients as shown in Figure 6. The working of power window motor as shown in Figure 7. The final development works involve of the assembly of software development and hardware design as shown in Figure 8.

Figure 6. The custom-made paddle blade

Figure 7. The placement of power window used as the open-close of the feeder valve

Figure 8. The final design of the SADSL MixFeeder

3.2. Final Experiment

The experiment is done to test the operation of the SADSL MixFeeder operation in real-world condition. The next experiment is focus on the working time measurement of the SADSL MixFeeder. The recording of working time is done at task element level in the form of direct measurements taken by using timer function on smartphone while observing work on one particular farm in Bukit Mertajam. The working time data using SADSL have been recorded and compare with the working time of a manual mixing and feeding. This include the working time requirement for ration management, daily storage container filling and mixing of the food pallet, daily feeding and feeder table cleaning.

The working time modelling shown for a farm with 20 animals herds had to spend 50 manpower minute/day twice daily using SADSL whereas for manual mixing and feeding working time spend for similar number of animals are around 80 manpower minute/day. This shown a potential time saving in mixing and feeding the food using SADSL as shown in Figure 9 below.

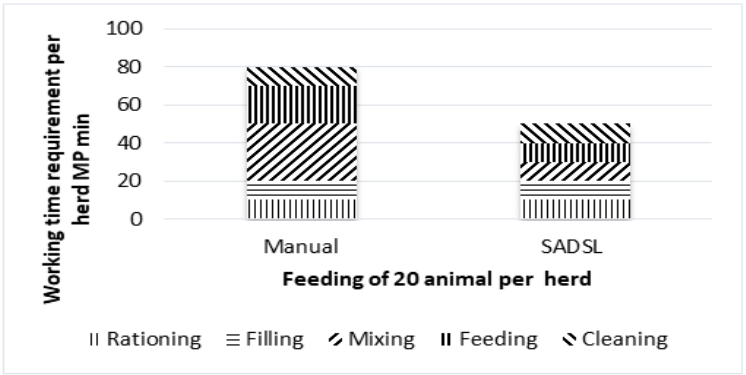

Figure 9. Comparison of daily working time for manual with SADSL MixFeeder for feeding 20 animals

4. CONCLUSION

The SADSL MixFeeder will be an agricultural machinery useful in automation of cattle feeding system that satisfy need of the user to minimize manpower for the farmer itself. This innovation will help the farmer to make their work easier, reduce the labour of manpower and restrict the over consumption from food wastage. The MixFeeder is successfully implemented. In a nutshell, by using SADSL MixFeeder it can help the farmer to make their feeding work more efficient. Further recommendation of future works is implementation of the machine using stronger material such as steel and aluminums structure. The filing of food into container should be fully automated therefore a storage compartment needs to develop on top of the Mixfeeder to fully automated the feeding work.

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