Experimental Chicken Harvester Vehicle

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Abstract

Human interaction with chicken can be traced back to prehistorical period. These interactions range from hunting to domestication for consumption. With high demand in the present time, indoor chicken farming is the most common method to domesticate chicken. However, this method requires large amount of labor to harvest large quantity of chicken. Health hazard, disease transmission, and chicken injury are commonly found within the working area due to crowded capacity, poor ventilation, and direct human interaction with animal. A prototype chicken harvester was developed to serve as a solution. It is an electric powered harvesting platform that can be driven and controlled using only one operator. The prototype is able to harvest chicken with labor reduction and not being harmful with the subject. The results are beneficial for animal and operator welfare. Poultry farm are expected to achieve a safer and more effective working method with less cost than conventional farming system. Test result proved that the prototype can harvest test subjects effectively and can be a possible industrial solution toward farmers.

Keywords: Poultry, Harvester Machine, Labor Reduction, Industrial Solution, Cost Reduction

1. Introduction

Since human practiced animal domestication and agriculture, poultry domestication is one of the main sources of food for humans. Chicken is a well-known poultry to human with different type of species. Brothwell (1998) had investigated that meat Chicken domestication had a history of over 4000 years old. In modern time mass meat chicken domestication are common due to growing food demand. Statistic from Thai-land Department of Livestock Development (2017) recorded over 420 Million chicken are domesticated. The most common method of mass meat chicken farming is indoor farming.

Meat chicken are raised within enclosed space and fed within the area. Automatic feeding system are available for many facilities due to labor reduction and convenience. However, the process of catching chicken for meat processing must be done by manual labor. With manual labor, large amount of worker must work within crowded space with poor ventilation.

Within poultry industries, high concern of health hazards were investigated within conventional poultry facilities. Quandt (2003) evaluated that Latino chicken catchers are subject to dangerous working conditions. Although with a fast pace of work, work-related injury are common including cases such as trauma or respiratory damage. Rimac (2010) investigated the exposure of dust mites and mold within poultry. It was concluded that hazardous amount of molds and endotoxins are determined within poultry houses. Various researchers evaluated chicken catcher worker's health hazard and most result displayed high risk of work injury, respiratory problems, and poor physical health. Golbabaei (2000) conduct exposure measurement of endotoxin and dust within poultry workers in Iran. Results showed high concentration of hazardous substances. With more advanced system such as cage house poultry farm or floor housed poultry farm, higher concentration of bioaerosols are detected. Just (2011) sampled bacteria, dust, and bioaerosols within poultry worker and detected more concentration on floor house poultry system which are commonly found. Other than respiratory hazards, physical hazards were investigated by Rossiter (1997) that poultry mites are commonly infected by workers.

Due to hazards present toward poultry workers, monitoring system or labor reduction solutions were developed. Nur Amir (2016) developed a chicken farm monitoring system to detect various qualities within the poultry farm system. Corkery (2013) had made further research towards business solution to help poultry producer meet financial targets by improving production performance. However, the methods proposed does not directly relate to the segregation of human and chicken. Several mechanical chicken harvest system was marketed and evaluated by researchers such as the Anglia Autoflow system. PLC collection system or a mechanical chicken catching system were proposed by Ramasamy (2004) and Muttha (2012). The practical system such as the Anglia Autoflow system however, are large and cannot be adapted to most of existing farming facilities especially due to extremely high cost. Therefore, the prototype chicken harvesting machine will serve the purpose of chicken harvester by using only one operator. Simple design will retain both cost effectiveness, practicality and easy reproduction to adapt within each different farming facility. This prototype poultry collection machine will act as a solution towards poultry business management as well as enhancing business decisions in the future for small and medium sized business by reducing production cost and reducing workplace related injuries.

2. Research Method

The prototype chicken collection machine is based on a four-wheel electric operated chassis and controlled through a rear steering wheel. A conveyor belt is attached to the front of the machine to collect chicken into storage units. The machine and conveyor system are powered by an electric driving motor with 5 Cell 12 Volt battery connect in series. Figure 1 display the poultry collection machine with all of the components shown. The green component is the electric conveyor belt with the blue component showing chicken storage component.

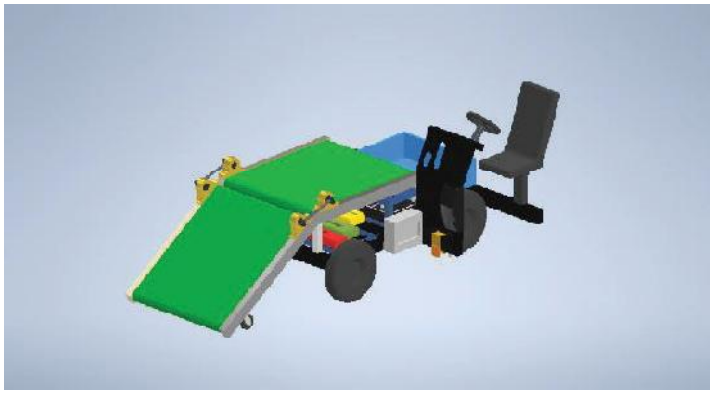

Figure 1 3D Poultry Collection Machine Design

In order to create a simple design and provide easy replication a box frame chassis was selected for this experiment with battery casing mounted for easy replacement and service. High mounted seating position provide comfort for operator with good vision and reduce contact with animal. Figure 2 and 3 display the full chicken harvester. The frame consists of an iron box design with aluminum sub frame to support any other components such as conveyor belt or battery storage. Green plastic frame are installed to protect chicken from falling off the conveyor belt.

Figure 2 Actual Prototype Chicken Harvester (Right)

Figure 3 Actual Prototype Chicken Harvester (Left)

Animal welfare must be considered in the design of the harvester system. A conveyor belt was selected for the prototype machine. A conveyor system is able to pick up chicken subject gently with constant operation. A simple and effective design is displayed in Figure 4 to demonstrate the operation of the conveyor collection system. Chicken will be collected through the first conveyor belt equipped with a rotating wheel. The rotating wheel will allow the chicken harvester to move on unequal terrain. Once the subjects are collected, chicken will drop into the collection box.

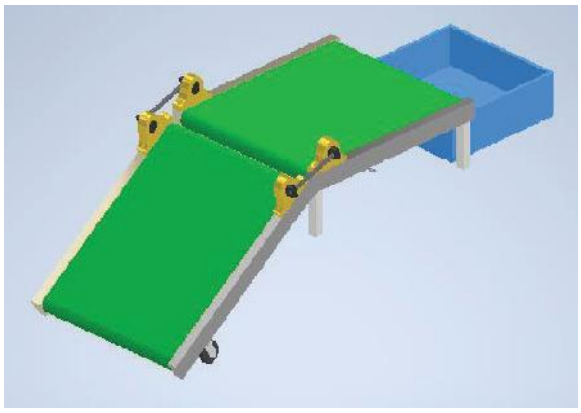

Figure 4 Conveyor Belt and Collection Box

The drive train system comprised of an electrical motor mounted on the wheel hub and battery mounted on the top compartment. Figure 5 display the drivetrain system and electrical flowchart of the poultry collection machine respectively. Battery is charged into the battery series connection. To allow easy maintenance, component are arranged with easy access design from all sides. The conveyor control box can limit the speed of the conveyor independently and are easily accessible from the vehicle.

Figure 5 Conveyor Control Box

To ensure maximum performance and efficiency, a multi-function display provides the important detail to operator. Battery level, speed, and trip meter are located within the blue display. Forward and reverse gear are easily controlled using the switch.

Figure 6 Information Display

Figure 7 displays the electrical flowchart of the machine. Power source is charged from typical 220V source using a conventional socket. Once power is stored within the battery, battery will power three main components. The first component is the conveyor that is controlled using a control box. The second component is the driving motor. Power is directly delivered to the driving wheel through a power distribution box and a motor controller. The last section is the 12V accessories such as indicators, headlamps, and warning lamp. These components are provided from a 12V Stepdown unit. Table 1 display basic specifications of the poultry collection machine.

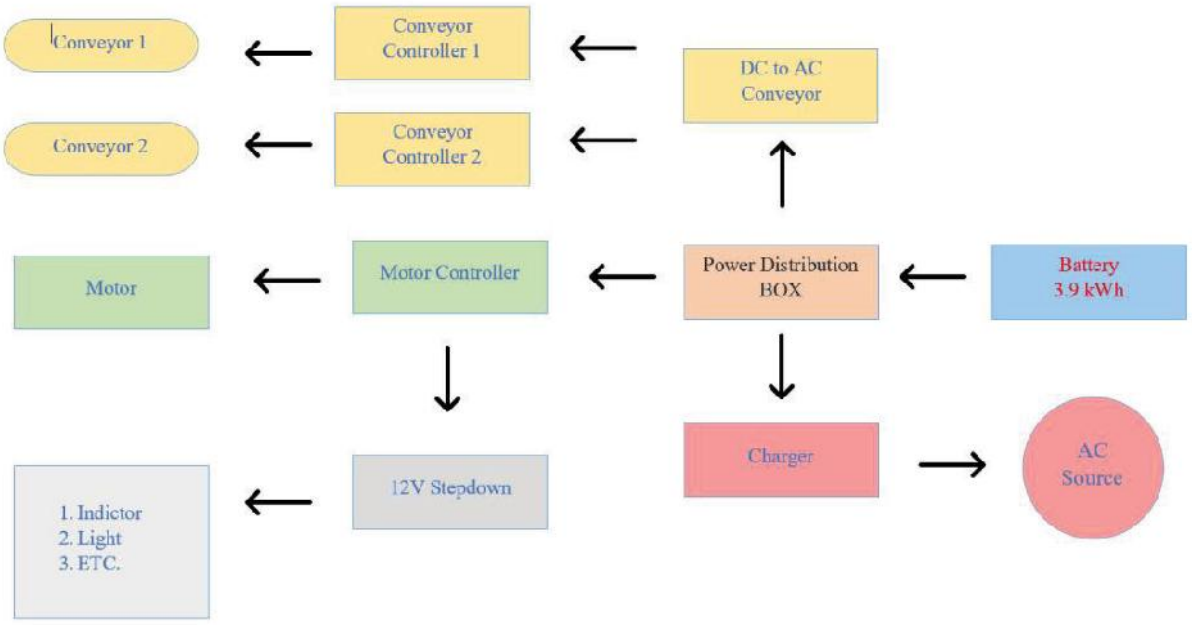

Figure 7 Electrical Flowchart

Table 1 Poultry Collection Machine Specification

Dimension L*W*H	275cm*162cm*145cm
Curb Weight	580 kg
Max power consumption	2.9kwh
Powertrain Motor Consumption	2.1 kWh
Max Conveyor belt system power consumption	0.8 kWh
Nominal Conveyor belt system power consumption	0.3kWh
Battery Capacity	3.9 kWh (60V, 65Ah) 12v 5cell connect in series
Battery type	Lead Acid
Average Range (No Belt Load)	45 km
Top speed	28 km/h
Onboard charging circuit	12A (0.72 kWh)
Charging time	6 Hours from 0% to fully charge
Max payload	350 kg
Estimated Cost Per Full Charge (THB)	17.5 THB
Battery Life	3 Years
Maintenance Cost (Mechanical)	1,000 Thai Baht Per Year
Maintenance Cost (Battery / Tires)	Below 4000 Thai Baht Per Year
Collection Speed (Theoretical)	110 Chicken Per Minute

3. Results Analysis

The poultry collection machine can be operated with and without the belt operating. The nominal current for machine idling is 0.4 ampere and 2.5 ampere with the belt on and vehicle being stationary. Figure 8 and 9 display basic current and power consumption with increasing speed. The scenario is used for application that require driving distance such as moving from facilities or other application. It is clearly seen that the faster the vehicle is moving, the more power consumption is present. A full charge of the chicken harvester is expected to cost 17 Thai Baht.

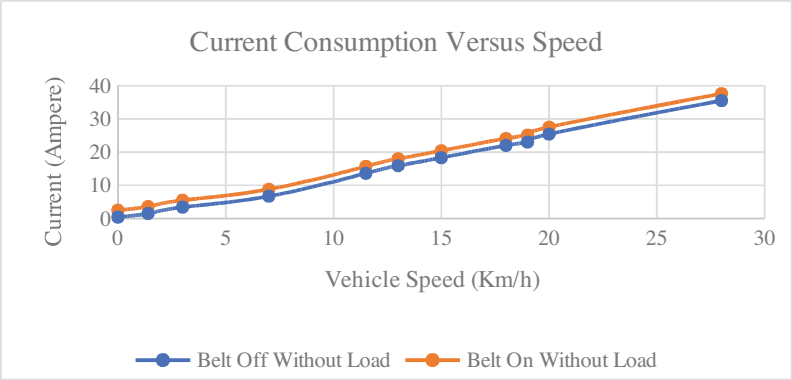

Figure 8 Current Consumption Versus Speed

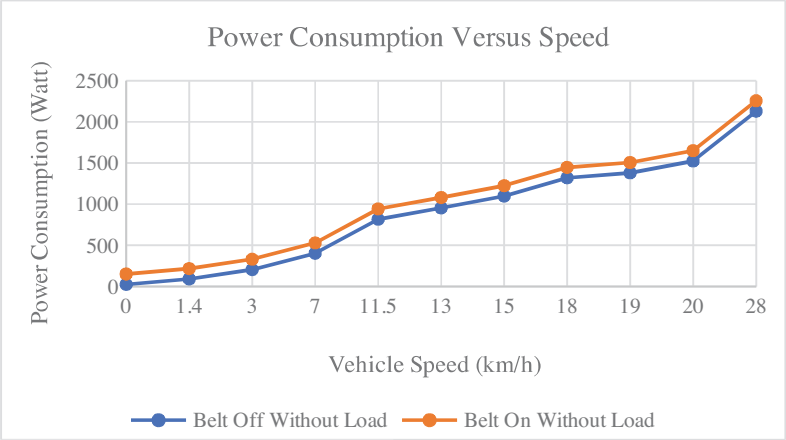

Figure 9 Power Consumption Versus Speed

However, in poultry farm, driving speed is not expected to be high. Figure 10 display the power consumption of the conveyor belt. It is shown that a heavier load will significantly increase power consumption. The nominal power consumption is 150 watt and will constantly increase to 430 watt at 120 kg load.

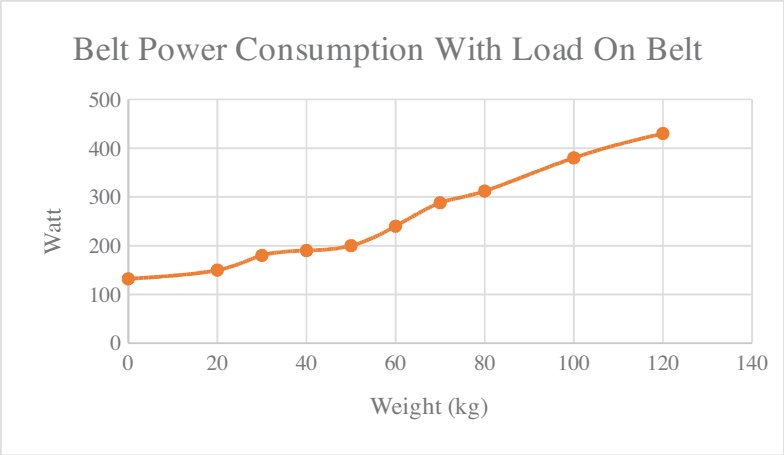

Figure 10 Belt Power Consumption with Load on Belt

With actual application of having the machine to operate at a lower speed, but with high belt load and prolonged period of time as chicken coops are often crowded. With minimal speed and no load, the chicken collecting machine is expected to idle for at least 40 hours. With conveyor belt switched on, the expected time significantly reduce to 3 to 8 hours of operation time depending on driving speed and belt load. Figure 11 and 12 display expected driving distance and expected running time of various scenario.

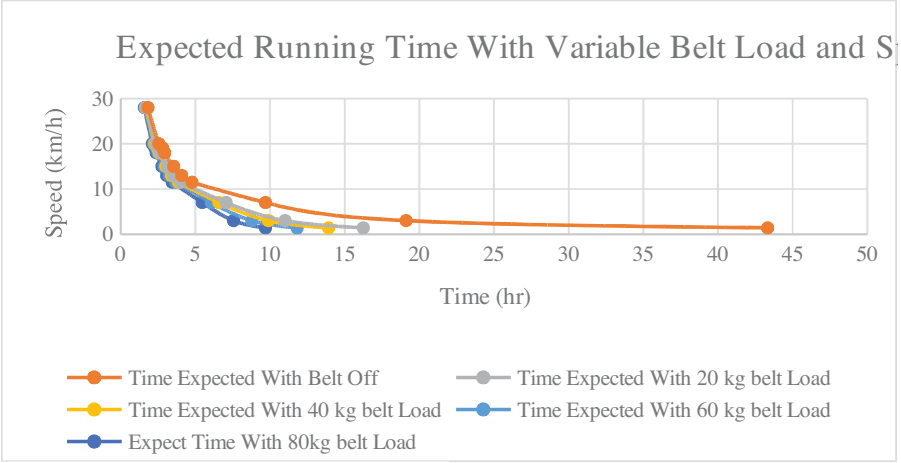

Figure 11 Expected Running Time with Variable Belt Load and Speed

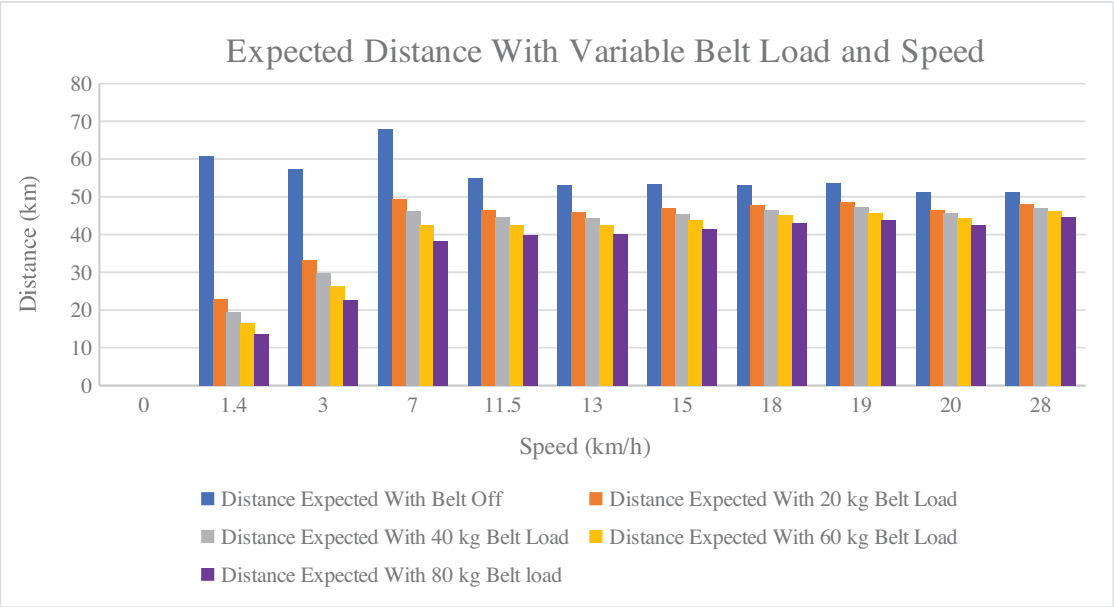

Figure 12 Expected Distance with Variable Belt Load and Speed

The chicken harvesting machine is expected to collect up to 110 chickens per minute assuming subject at a size of 6 x 6 x 6 inch. Actual value can increase or decrease depending on chicken coop crowdness and operation scheme. With a operation cost of 17 Thai Baht per charge, a monthly electricity cost is expected to be under 1,000 Thai Baht per unit assuming two charges per day and operating 30 days per month. The vehicle components are mostly maintenance free and require only chain grease or lubrication estimated at 1000 Thai Baht per year. Battery and Tire cost is expected to average below 4000 Thai Baht per year. Total annually expected cost is approximately 16,000 Thai Baht for 24/7 operation excluding operator cost.

4. Conclusion

The prototype chicken harvesting machine is capable of collecting objects and can maneuver through various terrains such as floor house poultry facility. The conveyor system and driving motor proved feasible power consumption for actual application. Durable component, easy steering, and practical driving distance per charge are obtained from performance test. Therefore, the prototype chicken catcher is an effective solution for human labor reduction and better animal welfare within chicken farm. The ability to adapt to different grow space, the prototype will serve as a guideline for other facilities effectively. The chicken harvester can directly affect business decisions towards chicken farm design and towards cost reduction due to low operation cost and can effectively replace multiple workers reducing production cost, and enhance worker's welfare.

References

Amir, N.S., Abas, A.M., Azmi, N.A., Abidin, Z.Z., and Shafie, A.A. (2016). Chicken Farm Monitoring System. 2016 *International Conference on Computer and Communication Engineering (ICCCE),* 132-137.

Brothwell, P. and Brothwell, D. (1998). *Food in Antiquity: A Survey of the Diet of Early Peoples*, The Johns Hopkins University Press, USA.

Corkery, G., Ward, S., Kenny, C., and Hemmingway, P. (2013). Monitoring environmental parameters in poultry production facilities.

Golbabaei, F. and Islami, F. (2000). Evaluation of workers' exposure to dust, ammonia and endotoxin in poultry industries at the province of Isfahan. *Industrial Health*, 38 1, 41-6.

Muttha, R., N.Deshpande, S., Chaudhari, M.A., and P.Wagh, N. (2012). PLC Based Poultry Automation System.

Just, N.A., Kirychuk, S.P., Gilbert, Y., Létourneau, V., Veillette, M., Singh, B., and Duchaine, C. (2011). Bacterial diversity characterization of bioaerosols from cage-housed and floor-housed poultry operations. *Environmental Research*, 111 4, 492-8.

Livestock Quantity in Thailand, Information and Communication Technology Center (2017). Department of Livestock Development, Thailand.

Quandt, S. (2003). 3-D jobs and health disparities: The health implications of Latino chicken catchers' working conditions, *American Journal of Industrial Medicine*, USA.

Ramasamy, S., Benson, E.R., and Wicklen, G.L. (2004). *Efficiency of a Commercial Mechanical Chicken Catching System*.

Rimac, D., Macan, J., and Varnai, V.M. (2010). Exposure to poultry dust and health effects in poultry workers: impact of mould and mite allergens, *International Archives of Occupational and Environmental Health*, 83, 9-19.

Rossiter, A. (1997). Occupational otitis externa in chicken catchers. *The Journal of Laryngology and Otology*, 111(4), 366-7.