An Enhanced Logic-gate Based Automatic Water Drinking System for Chicks

M. J. Saidu
Department of Agricultural and Bio-Environmental Engineering Technology. College of Agriculture Jalingo, Taraba
msjauro2020@gmail.com

A. M. Kauji
Department of Agric Engineering Technology, Ramat Polytechnic Maiduguri

Y. M. Abdullahi
Electrical Engineering Department, Umaru Ali Shinkafi Polytechnic, Sokoto

A. Mohammed
Department of Physics, Kaduna State University, Kaduna-Nigeria

M. J. Musa
Communications Engineering Department, Ahmadu Bello University, Zaria. Nigeria
mjmusa@abu.edu.ng

ABSTRACT—*Water is a resource that need to be conserved. Large volume of water is wasted due to the manual way of water supplied to chick from the batten houses to the chicken grown up cages. This traditional water drinking practice of placing a container of water for chicks to drink does not only waste the water, but it also leads to high mortality when a chick mistakenly falls into the water full container. Similarly, when the chicks pour away the water in the container or drink all the water at night, they will remain stave till the owner noticed and refilled again. This paper proposed an automatic water drinking system using the three not-or (NOR) gates of CD4001 as the heart of the design. Two probes were used as water sensors, which are fixed at different level in the water container to enable completed the logic circuit and triggered a 12 V relay. The relay acted as a switched that energizes and de-energizes a mini water pump, which on/off the water supplied respectively to the container through a complex logic strategy. The chicks water drinking system provided an efficiency of about 79% as compared to the traditional practice of manual refilling of the water container with the same number of chicks*.

KEYWORDS: chick, control, refilling, drinking water.

INTRODUCTION

Chicks usually drink water from any available source for survival, sometimes they do drink the water even when they do not need it to an extend that it become harm to the chicks [1-3]. Occasionally chick die as a result of falling into the water way pan. Research has been conducted ad is ongoing in this area of interest to enable provide an automatic way of water supply to the chicks. In this paper, an automatic chick drinking water was proposed, which used logic gates and solid-state components.

Section II of this paper describes the design of the circuitry and the mathematical analysis of the proposed design based on the components used. Testing results are shown in section III with respect to the traditional practice of drinking water. Section IV concludes on the presented results.

IV. DESIGN OF AN AUTOMATIC CHICK DRINKING SYSTEM

Water is essential in life, but the amount of drinking water needs to be regulated to in such a way that the water will only be available to a safe level when needed by the chicks. Hence the control of water flow to the chicks drinking pan is necessary. The proposed drinking system was controlled as shown in Figure I, which only allows water flow when needed and cased when not.

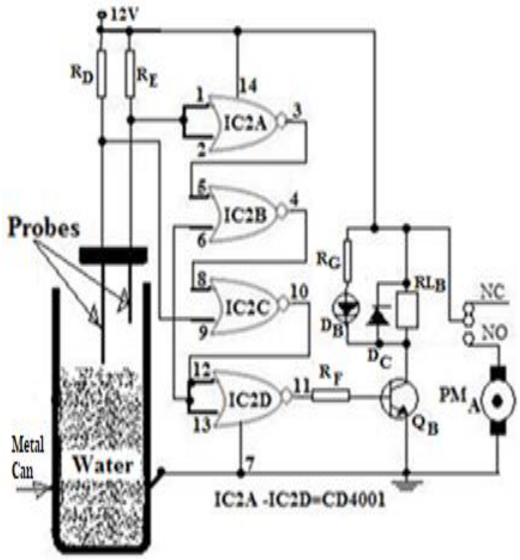


Figure I. Water Refilling Control Diagram

This water refilling circuit is designed and constructed using quad 2 - input NOR gate CMOS IC1 (CD 4001) as the active component that generates the oscillation. The arrangement of the logic gates is a deliberate design to pump water to the metal container whenever water in the container fall below to a set safety level and to cut off water supply when the water reaches the desired safety level.

A. *Pumping Water to the drinking Container*

When the steel rods (probes) are not immersed into water the input pins 1 and 2 of IC1A NOR gate will be high and its output pin 3 will be low. The output of pin 3 will serve as one of the input of IC1B pin 6 due to the deliberate design any signal at the second input (pin 5 of IC1B) will not have effect on the output pin 4, hence pin 4 which remain high. The low signal of pin 4 will serve as one of the input terminal of IC1C pin 8, while the second input pin 9 of the same IC1C will be high since the longest probe is not in the water and so the output pin 10 of the gate will be low. Pin 10 will be connected to the input terminals (pin 12 and 13) of IC1D, this holds the output of IC1D pin 11 high and hence saturate the transistor, which in turn energies the relay to switch - ON the water pump and fill the container to the required safer level.

B. Stop Refilling Water to the drinking Container

When the two probes are both immersed in the water (container fills up to required level) the input terminals of IC1A will be tied low and the output terminal pin 3 will be high. Pin 3 is connected to pin 6 as one of the new input of IC1B will assume the feedback high signal from pin 10 of IC1C, hence the output of pin 4 will be low. Pin 4 is connected to one of the input of IC1C pin 8, since both probes are immersed in water pin 9 will be low and this results in making pin 10 high. Pin 10 is tied to both inputs of IC1D (pin 12 and 13) hence, the output pin 11 will be low. The low signal from pin 11 is fed to the base of transistor QB, which cut off the transistor and results in de-energizing of the relay RLB. Therefore, the water pump stops pumping water to the drinking container [3]

C. Design of the water Refilling Control Circuit

From data sheet, the specifications of the transistor Q_B are β is 220 , V_{BE} is 0.7 V and I_B is 1.36 mA.Using equation (1) [4] the value of resistor R_F is obtained as:

$$R_F = \frac{V_{CC} - V_{BE}}{I_B} \quad (1)$$

R_F is 8.3 kΩ

where V_{CC} is 12 V. A standard value of 10kΩ±20% tolerance is used.

R_G is a current limiting resistor to the LED D_B,which is designed using equation (2) as [5]:

$$R_G = \frac{V_{CC} - V_d}{I_d} \quad (2)$$

From data sheet, it was found that voltage drop across D_B is $V_d = 2.2$ V, it can also take current $'I_d'$ ranging from10 mA to 15 mA. In this design, a minimum I_d of 10 mA was selected for safety.

Using equation (2) R_G was calculated as:

R_G is 0.92 kΩ.

A standard value of 10kΩ±20% tolerance was used.

Quad 2 input NOR gate CMOS IC CD4001 can operate on the current I_{in} ranging from 0.5mA to 1mA. In this design a current of 0.8 mA was used since it falls within the accepted range.

The two input limiting resistors are selected to be of equal value(R_D is R_E) R_D and R_E are calculated using equation (3) as [6]:

$$R_D = \frac{V_{CC}}{I_{in}} \quad (3)$$

$R_D = R_E$ is 15 kΩ.

A germanium diodeD_C (IN4148) was used as the freewheeling diode to prevent a reverse emf, which may be generated in the relay's coil. Relay 'RL_B' is SPDT with 2A at 220V switch, coil voltage 12 V, coil resistance of 200Ω to 300 Ω was used for safety.

Two steel rods (probes) of same length are used as sensors to switch ON/OFF the water pump to provide water in the drinking container when empty/full respectively. A summary of the components required and used is as shown in Table I.

Table I. Water Refilling System Components

COMPONENT	CALCULATED VALUE (kΩ)	STANDARD VALUE (kΩ)
R_D	15	15
R_E	15	15
R_F	8.3	10
F_G	0.92	1

V. RESULTS

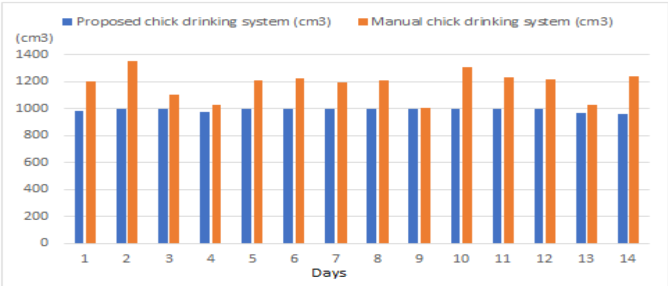
The automatic drinking water system was compared with the traditional method of pouring water in a container for 120 chicks. A reservoir of water was provided were the automatic chick drinking system gets its supply from. Same volume of reservoir was provided for the traditional practice of pouring the water for the chicks manually. The two methods were compared for a period of two weeks. Table II shows the comparison when a preset safer volume of 1000 cm^3 was set.

Table II. Results Comparison

Days	Proposed chick drinking system (cm^3)	Manual chick drinking system (cm^3)
1	984	1202
2	999	1350
3	1000	1104
4	978	1026
5	1000	1207
6	1000	1224
7	1000	1193
8	996	1211
9	997	1009
10	998	1312
11	998	1233

12	1000	1215
13	970	1032
14	960	1239
Average Total	991.428571	1182.64286

From Table II a significant variation was recorded from the desire level in day 1, 4, 13 and 14 with a shortest set value of 984 cm^3, 978 cm^3, 970 cm^3 and 960cm^3. These fall in the chicks drinking water level may lead to uneven growth of the chicks though it may prevent them from falling in the drinking water and die [1]. The traditional method shows that excess of water was supply to the chick throughout the weeks, which may result drinking excess water by the chicks. Taking excess water will make the chick plumb and eventually die [1]. Similarly, supplying excess water to the drinking pan in the traditional method as shown in Figure II do lead to the chicks fall in to the container and die. As a result of the excess water supply, three chicks were death in two weeks and this number of mortalities may rise when the traditional method is adopted.



VI. CONCLUSION

From the above fact, the proposed design has an efficiency of about 79% because it only malfunction in four days out of the 14 weeks of testing. However, the traditional method is discouraged to be applicable to chick drinking water due to the excess supply of water throughout the fourteen days of testing. It can now be concluded that the proposed method of using logic gave in implementing the chick drinking water is encourage to the used by poultry farmers than the traditional method.

REFERENCES

1) A. Mohammad, M. J. Musa; K. Ahmad, S. Garba and M.D. Almustapha "Design and Performance of HEFINC840 Micro-controller Based Incubator" NIAE International Conference, Uyo 2013 University of Uyo, Nigeria. October 21-24, 2013, p. 685-692, 2013
2) K. Ahmad, M. J. Musa; Y. A. Shaaban, A.M.S Tekanyi, A. Muhhamad "Design and Development of Automatic Drip Irrigation System" NIAE International Conference, Uyo 2013 University of Uyo, Nigeria. October 21-24, 2013, p. 712-719, 2013.
3) K. Ahmad, M. J. Musa, M. J. Saidu, A. J. Abubakar and I. Rilwanu "Development of Micro-Controller Based Home-Garden Watering System with GSM Remote Control" (NIAE) International Conference, Minna 2016, Federal University of Technology, Minna, Niger State, Nigeria. October 4-7th, Vol. 27, 2016, Pp. 521-527, 2016.
4) U. F. Abdu-Aguye, S. Garba, M. J. Musa, K. Ahmad, and A.M.S. Tekanyi "Development of an Embedded Light Activated Remote for fan Regulator" Proceedings of Academia Industry Conference. Faculty of Engineering, Bayero University Kano 9th-11th December 2014.
5) M. J. Musa, K. Ahmad, I. Umar, M. A. Aminu; A. Ahmed (2013) "Control and Monitoring of Green House Environment Microcontroller-Based Approach" NIAE International Conference, Uyo 2013 University of Uyo, Nigeria. October 21-24, 2013, Pp. 757-773
6) K. Ahmed, Y. A. Sha'aba, M. J. Musa, A. S. Musa and A. M. S. Tekanyi "Design, Development and Reliability Assessment of four-in-one Electronics Security Assistant" 46TH Annual Conference of Science Association of Nigeria. ZAZZAU 2011