International Journal of Multidisciplinary Research and Growth Evaluation.

Developing A Cylinder Pump with Self-Cleaning Anti-Clog Pulse Flow, Finding Optimum Purity for Anti-Clog Pulse Based On Mosquito Swarm Optimization

Wasantha Samarathunga [1*], Yuji Kurimoto [2], Risindu Ransen [3]
[1-2] Department of Electrical and Electronic Engineering, National Institute of Technology, Kisarazu College, Kisarazu city, Chiba Prefecture, Japan
[3] Thurstan College, Colombo 07, Sri Lanka

* Corresponding Author: **Wasantha Samarathunga**

Article Info
ISSN (online): 2582-7138
Volume: 06
Issue: 02
March-April 2025
Received: 09-02-2025
Accepted: 09-03-2025
Page No: 915-918

Abstract
This paper describes the expansion of a silent wastewater suction cylinder pump that can handle highly viscous wastewater of varying density over time as an environmental engineering solution. This cylinder pump is a scaled-up full-fledged version of a low-noise, fully dry-running cylinder pump originally developed for indoor use. When clogging is detected or has been programed to run periodically, an anti-clog self-cleaning pulse flow is sent to clean the suction inlet. This contributes to lower maintenance costs and longer pump life. When the inlet is properly submerged, the pump operates in the same manner, but a separate check valve and piping allows the flow to operate in the reverse direction for a short time to clean the inlet filter. If additional clean water is not available, the previously pumped low-concentration liquid can be reused after an appropriate settling period. In this case it can be considered that self-cleaning pulse use wastewater debris is settled unevenly. Further assume that inlet for self-cleaning should be moved with minimum possible angle as it is placed in wastewater. Another factor is movable at minimum possible height due to high viscosity. Now with two minimizing factors this objective can be considered as minimizing problem of two-dimensional optimization. Since this is a two-dimensional optimization problem of finding minimum values of both dimensions a particle swarm optimization method of mosquito swarm optimization is considered here as the candidate and simulations were performed. Simulation results show a fast convergence proving the feasibility for further research to obtain cleaner pulse flow. Applying cleaner pulses contributes to lower maintenance costs and longer pump life.

DOI: https://doi.org/10.54660/.IJMRGE.2025.6.2.915-918

Keywords: Mosquito Swarm Optimization, dry-running cylinder pump, anti-clog self-cleaning pulse flow

1. Introduction

Regular pumps often get clogged when pumping dirty water. When pumps get clogged, the service person has to fix them, which costs time and money. How about when it comes pump liquid which viscosity changes with time. In other words, at certain moments, it is denser, another moment is air, then it will be water and so on. A normal pump will soon break when this occurs. Research [3, 4, 5, 6] address this issue in an indoor application. When it comes to debris separation preprocess is often required as in [2]. Readers may be familiar with the macerator pumps [9] used in basement toilet which uses grinder for this separation before actual pumping. Examples of completely dry runnable pumps are often displacement type such as Peristaltic-pumps, cylinder pumps. In this case a slow-moving cylinder pump with rack and pinion mechanism is used.

The proposed solution is that pump with ability to clean itself. When it detects that something might be clogging it up, it does something clever.

It briefly runs in reverse (like when you're drinking from a straw and blow back into it) this reverse flow helps push out anything that might be stuck. This reverse flow is manually programmable such that after a period sucking wastewater it can send the reverse flow so that suction inlet will be clean for the next run of operation. This feature is explained in patent application [1]. When the pump runs with auto detected reverse pulse, the interval of reverse pulse and accumulated information on reverse pulse is indeed plays as an asset for maintenance planning. Properly databased information can combine with artificial intelligence for predictive maintenance.
The cylinder pump used in this research does not depend on additional clean water for reverse pulse. In can reuse the waste water that it pumped before for this pulse with certain cleanness. The research object of this paper is how to minimize the inlet pipe movement to get the cleaner pulse based on sensor data.
Assume that the environmental application does not allow additional clean water for reverse pulse, then both output pipe of pump and reverse pulse inlet pipe are connected to wastewater tank as in figure1.

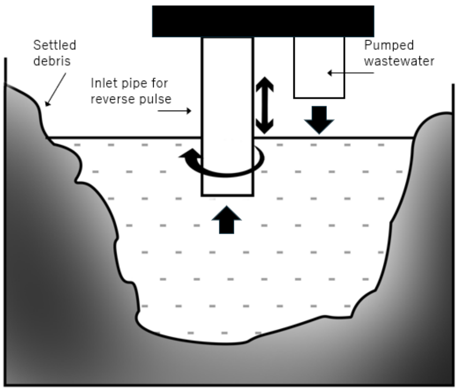

Fig 1: output pipe of pump and reverse pulse inlet pipe are connected to wastewater tank

Since we pump wastewater with debris, we can expect a wastewater tank with uneven settled debris. Further it can be treated as a high viscosity waste tank which inlet pipe for reverse pulse is expected to be with minimum possible movements. Two types of movements are possible such as one is vertical movement, and the other is slightly bending the inlet pipe such a small angle for cleaner pulse as shown in figure 2.

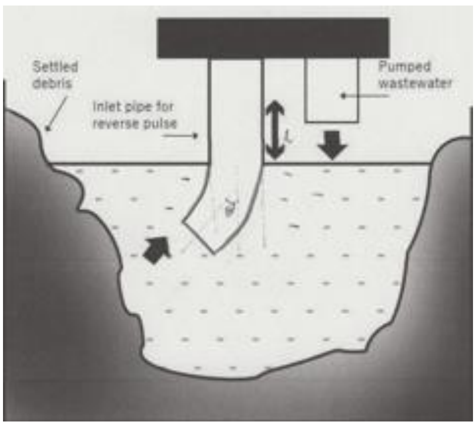

Fig 2: output pipe of pump and reverse pulse inlet pipe with bent are connected to wastewater tank

Now we can decompose the research problem into the optimization problem of these two parameters, i.e. minimizing vertical movement and minimizing bending angle at the same time for a cleaner pulse. For a system implementation problem this can be seen as a software layer on optimization followed by hardware selection and implementation. In this paper we address this optimization problem and check the feasibility.

2. Method

Among optimization algorithms we select the mosquito swarm algorithm or in broader terms mosquito swarm optimization (MSO), which has quite few known real-world implementations. It should be mentioned that it is Praveen kumar's wonderful contribution [7] to academic society we motivated us to consider this algorithm as a candidate for this optimization problem with slight modifications on visualization and initial conditions. In other terms, Appling MSA here is an off the beaten track approach as an optimization problem perspective but a contributive step. Following is the theoretical background mosquito swarm optimization and MSA.
Ruiz-Vanoye and Díaz-Parra (2012) [8] introduce the Mosquito Swarm Algorithm (MSA), an innovative metaheuristic that harnesses the principles of nature. This algorithm is a bio-inspired, parallel, and distributed approach grounded in the fascinating social behavior of mosquito swarms. This distributed approach makes it suitable for a range of decentralized applications.
Mosquitoes utilize sophisticated sensors to locate their prey effectively. Mosquito chemical sensors enable them to detect carbon dioxide and lactic acid from distances known up to 36 meters. These gases are naturally emitted by mammals and birds during respiration, while specific compounds in sweat can further entice them. This is the case when excessive perspiration is caused by spicy food. In addition to that mosquitoes possess heat sensors that help them identify warm-blooded animals, making it easy for them to converge on their targets when they are in proximity. Furthermore, it is also a fact that mosquito swarms in areas close to standing water, a crucial habitat for their survival.
By studying the behavior of mosquito swarming, Ruiz-Vanoye and Díaz-Parra have crafted the Mosquito Swarm Algorithm [8], a powerful contribution capable of problem solving that operates as follows,

Input: number of mosquitoes (n)

- Initialize a Mosquito Population with Chemical Sensors (CS) and Heat Sensors (HS).
- Generating the initial locations (x) of the mosquitoes (n).
- Initialize the temperature (t) and Maximum Temperature (T).
- Repeat (total of mosquitoes) //by parallel and/or distributed processing
- Repeat (maximum temperature)
- Generate new solutions by adjusting the Heats (HS) and updating the locations (x).
- Verify and assign the feasibility of the solution by the Chemical Sensor (CS).
- Select the best solution (S).
- While t < T // (Maximum Temperature)
- While (n total of mosquitoes)
- Report the best solutions.

With theoretical concepts above on how algorithm works we will proceed to simulations in the next section.

3. Results and Discussion

The following figures illustrate simulation results obtained using mosquito swarm optimization. One dimension is vertical length, and another is the angle that inlet pipe has to be bent.

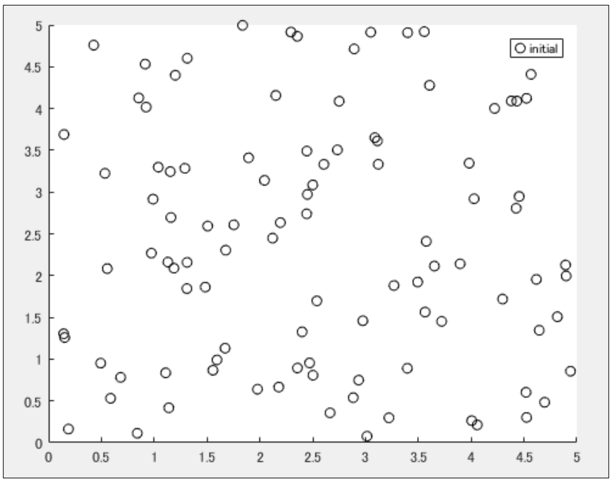

Fig 3: Initial positions of mosquitoes

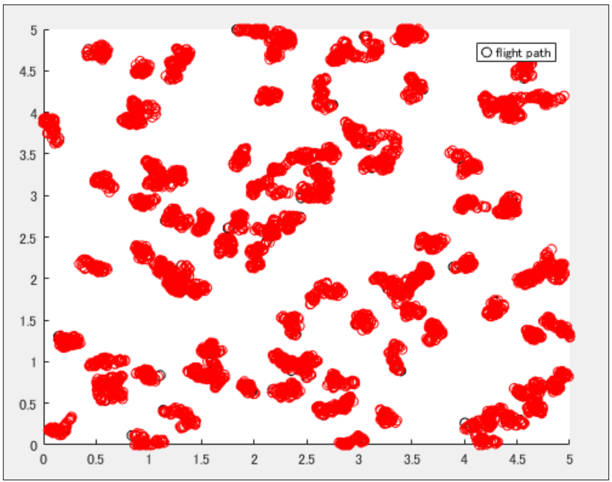

Fig 4: Mosquito flight path proceeds

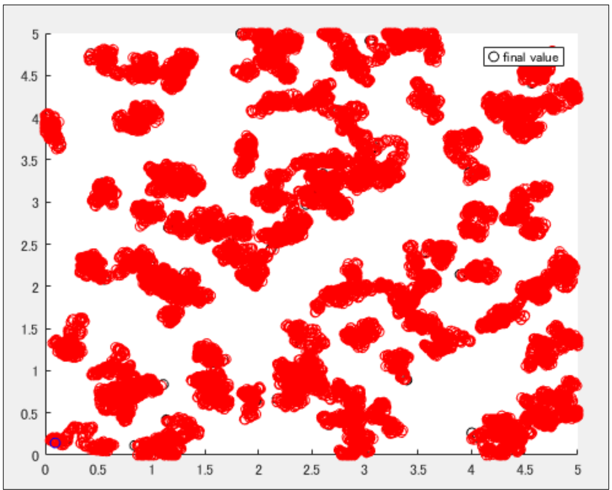

Fig 5: Converged to identify where both dimensions are minimum

Figure 3 illustrates the initial positions of mosquitos, figure 2 illustrates at certain midpoint mosquito flight proceeds and figure 5 illustrates the results of the mosquito swarm optimization simulations.

num_mosquitoes = 100
max_iterations = 200
Best Solution: 0.093409 0.14378

The algorithm converged to minimums in both dimensions.

4. Conclusion

From simulation results it can be stated that for finding optimum purity for clef-cleaning pulse, mosquito swarm optimization proved to be suitable.

Small prototype of proposed pump for initial testing has already developed and basic feasibility on self-cleaning pulse is achieved.

For future expansions sensor selection, stepping motor selection for bending the inlet pipe and linear actuator for extending the inlet pipe are due.

5. Acknowledgements

The authors would like to thank the research scholar Praveen Kumar [7] for uploading the code in MATLAB central which became a motivating factor for considering this algorithm as a candidate among other optimization methods. Special thanks to Risindu Ransen's family for financial and technical assistance for actual development of a pump prototype for academic use.

6. Reference

1. Samarathunga W, Sato R, Isono H, Izumi M, Arakawa K. Japan Patent Application no 2025-34910. Title of invention: Drainage system. Application date: March 5, 2025.
2. Vogelsang GmbH & Co. KG. Active separation of heavy material for maximum protection: Debris Catcher [Internet]. Available from: https://www.vogelsang.info/int/products/debris-management-systems/debriscatcher/. Accessed 2024 Nov 21.
3. Samarathunga W, *et al*. Automatic excrement disposal device. Japan Patent filing no: 2020-217853. Filed 2020 Dec 25.
4. Samarathunga W, *et al*. Automatic excrement disposal device, method, and disposable diaper. Japan Patent filing no: 2022-001413. Filed 2022 Jan 7.
5. Automatic excrement disposal apparatus [Internet]. International Filing Date: 2009 Sep 10. Publication Date: 2010 Mar 18. Available from: https://patentscope2.wipo.int/search/en/detail.jsf?docId=WO2010030122.
6. Samarathunga W. Automated toilet for bedridden patients, design modifications for Japanese residential care homes. International Research Journal of Modernization in Engineering Technology and Science. 2023 Jun;5(6):2426-2432.
7. Kumar P. Mosquito Swarm Optimization (MSO) [Internet]. MATLAB Central File Exchange; 2025 Mar 27. Available from: https://www.mathworks.com/matlabcentral/fileexchange/162196-mosquito-swarm-optimization-mso.
8. Ruiz-Vanoye JA, Díaz-Parra O, Cocón F, Soto A,

Buenabad Arias MA, Verduzco-Reyes G, Alberto-Lira R. Meta-heuristics algorithms based on the grouping of animals by social behavior for the traveling salesman problem. International Journal of Combinatorial Optimization Problems and Informatics. 2012 Sep-Dec;3(3):104-123.
9. What is a macerating pump system and how does it work? [Internet]. Available from: https://www.sfasaniflo.com/en/blog/what-is-a-macerating-pump-system-and-how-does-it-work. Accessed 2025 Mar 30