International Journal on Emerging Technologies **11**(1): 358-363(2020)

ISSN No. (Print): 0975-8364
ISSN No. (Online): 2249-3255

An Investigation on Bore-well Rescue Robot–Present Devices and Techniques

Sriramireddy K.[1], D. Satyanarayana[2] and Ravikumar Mandava[3]
[1]Research Scholar, Department of Mechanical Engineering, VFSTR (Andhra Pradesh), India.
[2]Professor, Department of Mechanical Engineering, VFSTR (Andhra Pradesh), India.
[3]Associate Professor, Department of Mechanical Engineering, VFSTR (Andhra Pradesh), India.

(Corresponding author: Sriramireddy K.)
(Received 14 October 2019, Revised 17 December 2019, Accepted 24 December 2019)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: In India, we get some news like a child has struck up in a bore well, and it takes more than16 to 24 hours save a child. Borewell accidents are common because of uncovered openings of bore well at farms and home surroundings. Dragging the child out from the narrow hole of bore well is not easy. It is difficult to protect children who fell into a bore well by using exhausting methods, because a child who falls into a borehole has no gaps between the walls of the bore well. In this study paper, we analyze the problems associated with the bore well rescue operations. We also present details of various existing robot systems available. Along with this, we discuss how robotics and automation could be a possible solution for this entire problem.

Keywords: Bore Well, Narrow Holes, Rescue Operations, Robotic Systems.

I. INTRODUCTION

In India, we saw many incidents about falling in bore well, those are almost hopeless to save the children. Because of lack of knowledge on uncovered openings of the bore well. Most of these accidental falls happen in bigger diameter bore well. The fact in these accidents is that 90% of victims are under the age of 10 years. After falling in narrow holes, the children death caused due to lack of oxygen before the rescue team reach them. The borewell accident became highlighted in 2006, where a 5 years old child fell into 200 foot deep open borewell.

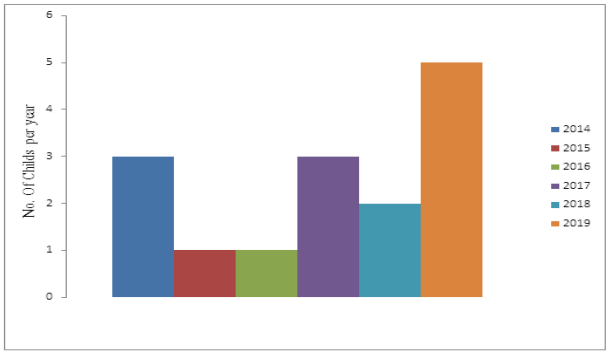
History of childs who fallen in borewell across india.

A manual rescue operation is the traditional form of bore well-lifting child. Due to the deep depth and deathly atmosphere pumping oxygen, lifting the child is a challenging job — this kind of rescue operation done by only professionals. People are not interested in traditional ways because they do not want to put their lives in the holes. Nowadays, there are so many ways to save the child using a robot instead of manual work.

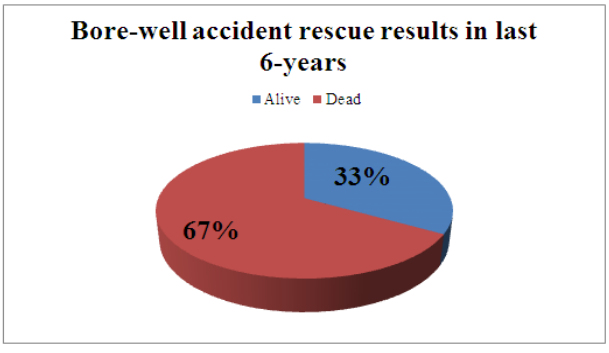
Rajesha *et al.*, are proposing a design to bring back the child with two levels of safety achieved by using robotic arms at the top and safety airbag at the bottom [14]. The airbag does not fallback to the child, and it gives extra support while performing a rescue operation. The robotic arms movement will operate in the personal computer, and we can observe the child position in the CCTV camera, which is attached to the robot. Raj *et al.*, (2014) purpose a new robot design used to lift a child. The robotic design will attach a harness to the child using pneumatic arms to picking up. A CCTV camera is fixed to pneumatic arms to observe the child [13]. Pandian and Sundarsamy (2018) design a stabilizing mechanism for picking up the child. In this mechanism, proximity-vision sensors are used for detecting the child conditions like detecting the human condition, depth from the ground, the surrounding temperature, pressure and existence of any smoke gas [11]. The position and condition of the child in the hole where he is stuck up at the bottom or middle. Then the Prosthetic Bore Well Rescue System [PBRS] will bring back the child [15]. Implemented lightweight servo motors for the machine operation. CCTV camera was fixed to communicate the child. A safety balloon was introduced into the hole to provide extra safety [6]. Fixed Temperature Sensor and Smoke Sensor to the robot. These will find out the temperature and gaseous concentration near the child. This robot design constructed to move simply by using wheels on three sides. When the robot reached the target, the three arms hold the child and picking up the target. Prakash and Devi (2017) design a remotely controlled robot [12]. This robot moves do bore well and perform a rescue operation. This contains a balloon to give extra support to the target and wireless camera. We can operate a robot on PC with wireless remote. Kurukuti *et al.*, (2016) propose a novel design of a rescue robot. The Robot changes its shape according to the diameter of the hole by enlarging its wheels size. This robot contains four wheels which help to move down in bore well. This robot is useful to all sizes of holes. it also contains a camera and also aid in the survival of the child [8].

A baby (Mokshita - 3 years) fallen in borewell in Nellore district, A.P, India on 24th June 2019. The government has made a move on this issue and the salvage group battled a great deal to spare this youngster however shockingly the kid was dead inside 3hours after felt. In 28th January 2019, the kid (Tejpratap – 2 Years old, from Bhopal Madhya Pradesh, India) fallen into the borewell. The Rescue Team has been taken a battle to spare the youngster following 70 hours by the god elegance the kid was alive. 110 hours taken by the Punjab government to save a child (Fatehveer -2 years) from bore well but shockingly the kid was dead. In11th April 2019, in Uttar Pradesh, India. Seema's age was 6 years, she has fallen into bore-well, the Rescue Team is battle a great deal to spare the kid, yet the kid was

dead. 2 years old Shiva from Nagputtinum city situated in Tamilnadu India. He has fallen in bore well on 23rd September 2018. The government Rescue Team has been taken a battle to spare the kid following 12 hours by the god elegance the kid was alive. And also another kid Roshan (4 years) from Dewas, Uttar Pradesh, India. on March 2018 he has fallen in bore well following 12 hours battle the infant was taken out from the drag well and the youngster was alive. Two kids from the Hyderabad was fallen in borewell at a different location. One kid was Chinnari 2 years and Rakesh three years old. Following 60 hours of the salvage group battle, the infant was taken out from the drag well however the Chinnari was dead and following 27 hours of the Rescue Team battled to spare however lamentably the kid Rakesh also dead. In 18th February 2017, Chandrasekhar Bhai (1-year) from Bhopal Madhya Pradesh. He has fallen in bore well quickly the legislature has made a move on this issue and following 17 hours the youngster was taken from bore-well and he is alive. A 6 years of age baby fallen into bore-well on 27 April 2017. Following 24 hours of safeguarded the youngster was dead. Kamal 6 years of age from Rajasthan fallen in bore well after quite a while battle that is 168 hours the youngster was dead. Tamanna 6 years of age living in Bagalkot situated in Karnataka at 10th August 2014, the youngster was fallen in bore-well following 150 hours of the salvage the kid was dead.
The following column chart: 1 and pie chart: 1 explains how many children fallen in the bore-well year by year and results of the rescue operations (dead/alive) respectively.



Column chart: 1 Number of bore-well accidents year by year in last 6-years.



Pie chart: 1 Bore-well accident rescue results in last 6-years.

II. PROBLEM STATEMENT

Borewell is a narrow pipe bored vertically or horizontally in the ground. The purpose of the borewell dug is extraction water or oil (such as petroleum, kerosene…natural gases). Most of the bore well accidents happen in rural areas. Lesser diameter Borewells are used for domestic purposes in the cities. So it seems bigger diameter holes are a problem. In the villages, the borewells are dug for two reasons. Those are domestic and agriculture purposes. When underground sources are drained, the pipes are pulled out, and they forgot filling mud in the holes because of lack of knowledge. Someday a child goes there and falls in uncovered bore well. Sometimes a small mistake can charge death. The child may go completely bottom are stuck somewhere else. Bore-well depths are commonly from 100 feet to 500 feet. Saving the child in high depth and deathly holes are not easy. Most of the rescue operations are failed to save the child because they know where the child stuck. In the previous incidents, people use to move into the hole by using thread to save the child. These rescue operations may cost rescue person life also and not useful because the child hands may be stuck in the hole. It is time that we look for an alternate solution in which we can save the child without human resources.
Robotics and Automation systems could be a possible solution. We have to solve several issues like how the robots find out the child in high depth hole, pumping oxygen, lifting the child, how much time durable, etc. the structure of the hole is also an important parameter to be considered. Borewelldiameter may vary in bore well from top to bottom. Depth of the bore-well, which places a significant role in this accident. This paper deals with different possibilities and mechanisms for Borewell Rescue.

III. EXISTING METHODOLOGIES

Bore-well rescue methods are two methods. Those used to bring up the children from the bore-well. The first method is a manual rescue operation, and the second method is robot rescue operations. In manual rescue operation threads are used to save a child's life, but this method was useless because we do not know where the child was in the bore well. In the robot rescue operations, we sent the robots into a bore well. We can operate the robot on a personal computer. By using CCTV camera and proximity non-vision sensors, we can observe the child and detect the child conditions. Nowadays, there are several robot rescue operation technologies available. We discuss some of them here.

A. Bore-well accidents rescue robot-pneumatic arms, oxygen tube, and CCTV camera:
Giridharan *et al.*, (2016) did a work on Design and Fabrication of Child rescue system from Bore wells Rack and pinion mechanism. In this, a CCTV camera and oxygen tubes are attached to this robot, as shown in Fig. 1. When a robot sent into the bore well, we can observe the child position on PC. If the oxygen level is low, oxygen will be supplied through an oxygen tube. When child location trace out the pneumatic arms hold the child's body or head. We can observe the child movement on the PC [5].

Fig. 1. A robot with arms and oxygen cylinder.

B. Bore-well Rescue Robot-Balloon type Rescue System

The rope is connected to the top of the robot, and the control unit chip is connected to the motors electric wires. The oxygen hose is attached to the upper plate of the robot along with the roof. The gas hose from the compressor is connected to the gas box fixed on the lower plate through the hole in the upper plate. The gas box is an intermediate gas transmitter. CCTV camera also used in this rescue system to observe the baby position. At the particular position, the fork will fix into the bore-well wall using the motor connected to the bevel gear setup on the upper plate. If the baby is at the middle of bore well, The robot hands will hold child then the lower plate is rotated in such a way to find a gap to safety balloon gas tube between bore well and the child. The safety balloon will fill by using the air compressor through the gas box after a safety balloon moves down to the child. Then the safety balloon is moved up a word using the motor. The child will come up on the safety balloon. The below Fig. 2 and 3 explains the Borewell Rescue Robot-Balloon type Rescue System [11].

Fig. 2. Safety balloon.

Fig. 3. Balloon type rescue system.

C. Robot for Bore-Well Rescue Operations- chest mount harness

This robot system Consists of two round plates. The mechanical system is fixed to the upper plate, which will hold the robot in a particular position. Gear system also attached to the upper plate, which will rotate the lower plate to get the child position. The two hands attached to the lower plate will hold the child. The camera also fixed to the lower plate, as shown in Fig. 4. We can observe the child and surroundings. A chest mount harness will be attached to the robot, which will be highly essential in picking up the child. The Fig. 5 explains the rescue process of a robot for Bore-Well Rescue Operations- chest mount harness [13].

Fig. 4. Illustrated hardware module.

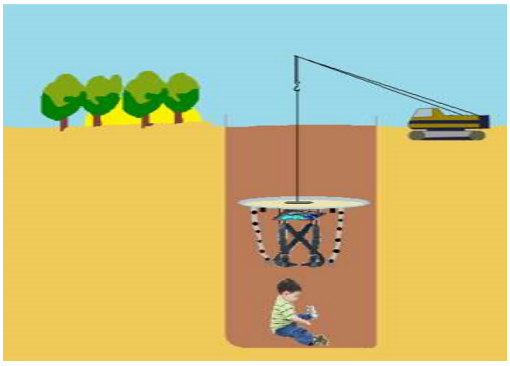


Fig. 5. Illustrate the image of the proposed rescue task.

D. Bore-well child rescue-robot with wheels, wireless sensors, and pneumatic arms

This robot made up with the wheels which will give support to move along the wall. These wheels can adjust according to wall size. Wired sensors are not feasible in the rescue operation. Wireless Camera and sensors (temperature and pressure sensors) are attached to the robot which will send the child position temperature range and pressure data to PC. After collecting the data, the pneumatic arms hold the child, and the balloon sent below to the child. We observe the child movement on the PC. The below Fig. 6 and 7 explains the Bore well-child rescue-robot with wheels, wireless sensors, and pneumatic arms [6].

Fig. 6. Wheeled leg mechanism for robot.

Fig. 7. Gripper used for a robotic arm.

E. Pipeline inspection and bore well rescue robot system

This robot was made with three-finger mechanism to go inside the pipe. The robot has adaptive, and it is used to adjusting the three-finger mechanism according to the pipeline lengths and widths. Moreover, also this design consists LM-35 temperature sensor interfaced with at mega 16 microcontrollers to detect the temperature in the pipeline, and it displays in the laptop. The robot has an arm, it picks the child from the pipeline, and this all process was shown in a display Fig. 8 [17].

Fig. 8. Method of rescue.

F. Child detection and rescue system for bore well accidents

This robot interfaced with an automatic computerized pulley system, and it is used to control the up and down motion, which is working based on a DC motor. The temperature sensor, gas sensors are interfaced with design and UDM sensor also interfaced with the design it is used for detecting the obstacles which also gives the distances to the child, these all are shown in the display Fig. 9 which was connected to the PC [4].

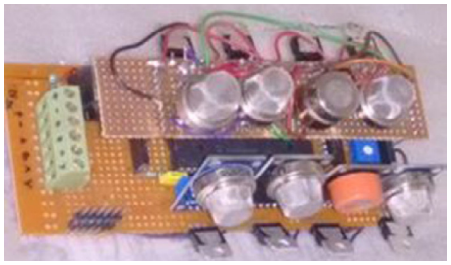


Fig. 9. Wireless sensor fusion systems.

G. Smart and safe child reserve system

Sumathy and Monika (2018) are used clippers which were picked and hold the child by using a remote controller and also sensors were used like the temperature sensor and gas sensor. The process of rescuing a child is the clipper is tied to the rope and sent to the borehole by using rope and pick the child with the help of clipper using the remote controller as shown in Fig. 10 [20].

Fig. 10. Clipper used in a smart and safe child rescue system.

H. A multifunctional system based rescue robot adapted for borehole accidents controlled using Arduino

The secure robotic system using diameter to enlarge the borehole as per the dimensions and also contains the artificial arms to hold the child who was struck in the bore well and all this process is visualized in the camera.

I. Bore-well rescue robot using motors

All the methods are spent too much money to rescue the child who was fell into the bore manhole. In this method the researcher to design and fabricate the portable robot using simple mechanical components like a mechanical limit switch, rack, and pinion to hold and lift the child as shown in Fig. 11. The design of the motor is fixed with gripper, and it rotates the rack and pinion setup. When the gripper is passed to the child the motor switch is on, and gripper touches the child's head, and motor switch is off when the gripper is in a specific position on the child and slowly dragged the child with the help of motor, gripper [10].

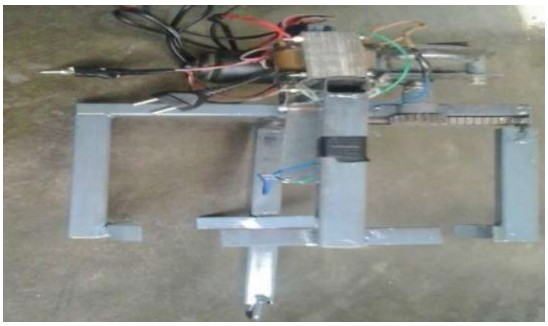


Fig. 11. Experimental robots with gripper arms and clippers.

J. Comparative study of design and analysis of gripper systems for bore well rescue operation:

Arunkumar *et al.,* (2015) performed work on Mechatronics and Automobile Engineering Borewell Rescue Robot. Three types of robotic arms that is rectangular, square, and cylindrical. The rectangular and square arm gripping system is used in real rescue incidents and causes the injuries to the child, so researcher implements a cylindrical arm gripping system, and it performs well compared to rectangular and square gripping arm system and the bellow Fig. 12. Shows Photograph of cylindrical robotic arm based gripper system [1].

The table shows the Existing system of rescue operation.

Fig. 12. Photograph of cylindrical robotic arm based gripper system.

Table 1: The existing system of the rescue operation.

S. No.	Author Name	The system used for the rescue operation
1.	Rajesha [14]	DC motor and two servo meters and CCTV camera system
2.	Chitra *et al.*, (2018) [22]	Child detection and rescue system for bore well accidents using sensors and DC motors, robotic arm systems
3.	Sumathy and Monika (2018) [20]	Smart and safe child reserve system using clippers and rescue system
4.	Monisha *et al.*, (2018) [10]	A multifunctional system based rescue robot adapted for borehole accidents controlled using Arduino system
5.	Sridhar *et al.*, (2018) [18]	Borewell rescue robot with the help of the gripper system
6.	Suji *et al.*, (2018) [19]	Smart bore well-rescuing robot system using Adriano UNO and ultrasonic sensor
7.	Thangaraj and Gavaskar *et al.,* (2018) [16]	Borewell rescue to the child by using IOT techniques and LCD, GSM, Microcontrollers, robotic arm system
8.	Channabasavaraj (2017) *et al.*, [2]	PC based child rescue system from bore well by using a computer-controlled motor and robotic system
9.	Danieal and Ruhan (2017) [3]	Design of a robotic system using robotic arms and fail-safe system
10.	Prakash and Devi (2017) [12]	Borewell child rescue robot with wheels, wireless sensors, and pneumatic arms
11.	Manonmani (2018) [9]	Borewell rescue system using Morphological chart system
12.	Venmathi *et al.*, (2015) [21]	Borewell Rescue Robot-Balloon type Rescue system
13.	Arunkumar *et al.,* (2015) [1]	Borewell rescue robot using motors and rack and pinion system
14.	Kaur *et al.*, (2014) [7]	Rescue robot using LM-35 temperature sensor and PIC 16F877A microcontroller
15.	Raj *et al.*, (2014) [13]	A Robot for Bore-Well Rescue operations- chest mount harness system

IV. CONCLUSION

Many child deaths are appeared in the past due to bore well accidents. Borewell rescue robots are saved many children's life with a high success rate. Borewell accidents mainly happen in rural areas because of lack of knowledge of people. In this context, we presented the study of various Borewell Rescue Robots, which are the existing robotic models available in nowadays, how robots find out the child location in bore well and the way of rescuing the child's life.

V. FUTURE SCOPE

There is a considerable range to develop the mechanical models to save the child who slipped into the borewell, and we discussed above the methods. Research can go into this area of making it an automated one which would not be so easy and soon but can be of great help if achieved. Moreover, the development of robotics design and automation can be useful to achieve the task and can go to the next level to save the child with alive. This next-level design robotics can get some of restrictions and risks due to the mechanical design. If the robot can damage after reaching the specific level to the child, then it will face severe problems like a child cannot breathe due to the damage of the oxygen tube which was fixed to the robot to supply the oxygen to the child because in boreholes oxygen levels are low. In the future, we can use the above projects in many applications by adding additional components to the existing.

A. Using suction cups

Previous robots consist the camera, temperature sensor to save the child from the bore wells, and also we can add the suction cups to the robot, and it can help to grab the children from bore well. Also, we can maintain the pressure level of the suction cups.

B. Using ultrasonic and gas sensor

By using the ultrasonic sensor we can find the child in that borehole then we can see how much length between the child and borehole it will help to save the child quickly and if any harmful gases are there(bore well) gas sensor will detect that dangerous gases so then we can easily find a solution to save the child from bore wells.

REFERENCES

[1]. Arunkumar, K., Selvakumar, K. S., Sriguna, K., & Subash, K. (2015). Bore well Rescue Robot. *International Journal of Research in Mechanical Mechatronics and Automobile Engineering, 1*(2), 76–82.

[2]. Channabasavaraj, B. D., R, B. P. H., Amar, Y. N., & Varghese, B. P. (2017). Pc Based Child Rescue System from Bore-Well 2017 IJLERA – All Right Reserved, 104–112.

[3]. Danieal, L., & Ruhan, R. V. R. (2017). Design of Robotic System to Rescue a child under constrained, *116*(5), 31–36.

[4]. Sridhar, K. P., Hema, C. R., & Deepa, S. (2017). Design of a wireless sensor fusion system to analyze conditions inside bore wells. *Wireless Personal Communications*, *94*(4), 1951-1962.

[5]. Giridharan, M., Franklin, R., Bhuvaneswaran, R., & Vinothan, M. (2018). Design and Fabrication of Child rescue system from Borewells Rack and pinion mechanism. *EPH-International Journal of Science And Engineering*, *1*(1), 436-438.

[6]. Kaur, P. (2014). Hardware and software implementation of a robot for bore-well rescue operations. *International Journal of Emerging Technology and Advanced Engineering*, *4*(8), 645-648.

[7]. Kaur, P., Kaur, R., & Singh, G. (2014). Pipeline inspection and borewell rescue robot. *International Journal of Research in Engineering and Technology*, *3*(4), 726-729.

[8]. Kurukuti, N. M., Jinkala, M., Tanjeri, P., Dantla, S. R., & Korrapati, M. (2016). A novel design of robotic system for rescue in bore well accidents. In *2016 International Conference on Robotics and Automation for Humanitarian Applications (RAHA)* (pp. 1-5).

[9]. Manonmani, K. (2018). Design of Bore Well Rescue System using Morphological Chart.

[10]. Monisha, K., Mythilid, C., Priya, S. M., & P., A. P. (2018). A Multifunctional System Based Rescue Robot Adapted For Borehole Accidents Controlled Using Arduino. 7–13.

[11]. Pandian, S. S., & Sundarsamy, K. (2018). Multi-Purpose Prosthetic Bore Well Rescue Robot System. *Journal for Advanced Research in Applied Sciences, 5*(3), 1-9

[12]. Prakash, S., & Devi, K. N. (2017). Smart Bore Well Child Rescue System. *International Research Journal of Engineering and Technology (IRJET)*, *4*(3), 358–362.

[13]. Raj, M., Chakraborty, P., & Nandi, G. C. (2014). Rescue robotics in bore well Environment. 1-5

[14]. Rajesha, C. (n.d.). Design And Implementation of Borewell Rescue Robot using Lab View Project Reference No . 38S1474.

[15]. Saran, K., Vignesh, S., & Louis, M. J. (2014). *International Journal of Research In Aeronautical Bore-Well Rescue Robot Abstract,* 2(4), 61–80.

[16]. Thangaraj, P., Gavaskar, S. (2018). Borewell Rescue to Child Using IOT Techniques : A Survey, *6*(10), 2744–2752.

[17]. Shruthi, H. O., Divyashree, G., & Thomas, B. A. (2017). Open Borewell Rescue Robot. *International Journal of Recent Trends in Engineering & Research (IJRTER),* 3(12), 85–88.

[18]. Sridhar, K. P., Hema, C. R., & Deepa, S. (2018). Comparative study of design and analysis of gripper systems for bore well rescue operation. *International Journal of Computer Aided Engineering and Technology*, *10*(3), 266-273.

[19]. Suji, M. P., Farhin, M. B. S., Sheikh, M. N., Ramijha, C., & Jayaraman, G. (2018). Smart Bore well Rescuing Robot. *Indo-Iranian Journal of Scientific Research (IIJSR), 2*(2), 59–66.

[20]. Sumathy, P., & Monika, A. (2018). Smart and Safe Child Rescue System. *International Journal of Pure and Applied Mathematics, 119*(15), 861–865.

[21]. Venmathi, V., Poorniya, E., & Sumathi, S. (2015). Borewell Rescue Robot. *International Journal of Computer Applications, 113*(14), 22–25.

[22]. Chaitra, C., Kavyashree, K., Athulya, A., Aswanth, Nambiar., & Guruprasad, U. (2018). Child Detection and Rescue System for Borewell Accidents. *International Journal of Computer Engineering and Applications*, 2321-3469.

How to cite this article: Sriramireddy K., Satyanarayana, D. and Mandava, Ravikumar (2020). An Investigation on Bore-well Rescue Robot –Present Devices and Techniques. *International Journal on Emerging Technologies*, *11*(1): 358–363.