# SUN-POWERED INTELLIGENT IRRIGATION: ENHANCING EFFICIENCY WITH SOLAR TECHNOLOGY

**Jitendra Suthar, Rakhi Maroo, Varsha Rathore, Aditya Paliwal, Suraj Singh Jhala, Monika Vardia, Raunak Jangid**

**E-Mail Id: raunak.ee85@gmail.com**

**Department of Electrical Engineering, Geetanjali Institute of Technical Studies, Udaipur, Rajasthan, India**

**Abstract**- This study was conducted with few objectives of design a microcontroller based solar powered automatic irrigation system (AIS) model. To quantify the paddy field water content of and as well to provide adequate water supply in the right paddy field areas. In agricultural areas this may help for the production of crops as well can prevent the wastage of energy. To provide an efficient design to the farmers is the main objective of this paper.

## 1. INTRODUCTION

Modern world is facing a crisis of energy resources. To resolve the issue renewable energy source may be the best option. The conventional energy resources are almost at the verge of end. The most abundant energy resources are mostly renewable energy. Among all the renewable sources solar-energy is the most ecofriendly and reliable source of energy. In the field of irrigation use of solar energy may be a great achievement. Farmers of agriculture field are really facing various issues approaches to pouring water into paddy field to provide crops a healthy and green environment especially in summer seasons. The lack of power supply is one of the major tribulations of the farmers. To operate water pump sufficient power and technology is required. So, if the system automation is done, it may help the economically weaker people a lot.

Automation helps in reducing the need for human work in the production of goods and services. Automated teller machine (ATM) is one of the solutions for complete automatic process which achieves highest benefit using automation that saves time and labor too. This type of machine saves energy, rectify the accuracy and precision and improve the quality. Agriculture plays an important role for the development of the food production. For the continuously increasing population in India, it is important to improve the production of food in every way possible. Irrigation particularly is one of the most important steps for optimum production in the agricultural sector. Irrigation is defined as applying sufficient amount of water to the plants at regular interval, or the water which is supplied to land or crops that helps the crop growth, typically using separate channels.

Irrigation and cultivation are related to each other and can be used for the agricultural crops during the span of inadequate rainfall and for maintaining landscapes. In India, smart irrigation systems are not widely used. According to a survey which was done by the bureau of electrical energy in India in 2011 it has been observed that the number of agricultural pumps installed is 18 million and new connections for each year was approximately 0.5 million with an average capacity of 5 hp. If the total annual consumption is calculated then it can be seen in agriculture sector 131.96 billion kWh is in use which is cited in paper solar power smart irrigation technique. Due to such big amount of energy consumption, in future for the agriculture sector electricity may not be available to use. So, the proposed system is solar powered system we are using techniques analyzed. In the research paper during the operation of inverters PWM technique has been those results in a very less harmonics which promotes the augmentation of the overall efficiency of the system, the rating of the system was calculated corresponding to the pump specifications referred.

In a system of rain gun irrigation which is automated by microcontroller is shown. Irrigation is required only when it becomes necessary to water the fields, which in real meaning saves a large quantity of water. Many researchers are working on the topic, viz. smart irrigation system, which includes autonomous monitoring and controlling of water pump by using photovoltaic energy. The power supply for whole system is taken from renewable photovoltaic cells energy; it reduces the cost of power consumption. The supply water quantity, temperature as well as pH level of the soil are supervised autonomously using the proposed design.

## 2. COMPONENTS DESCRIPTION:

- Arduino Uno,
- Solar panel,
- Soil moisture sensor,
- Lcd module,
- Relay Module
- Jumper wires.

## 3. MODEL DESCRIPTION


All Right Reserved @ IJTRS

In this proposed design of solar energy-based AIS, photo voltaic cells are generating electricity, the excess amount of generated energy may be stored, for the storing rechargeable batteries may be used. In case of stored energy which is produced from the battery cells can be used during the system operation. A water pump may be used to pump the water from a bore well or natural water resources like river, pond, and lake to a water storage tank. Here a proposal has been given for the automatic irrigation using a PV cell that can drive water from various natural resources to the tank. The outlet valve of the tank is automatically regulated by the controller, to control the level of moisture a moisture sensor may be attached to keep the record of flow rate of water to the irrigation field. The sensor and actuator optimize the required amount of water.

A solar powered automated irrigation system refers to the operation of the system with no or just a minimum of manual involvement beside the surveillance. An automatic irrigation system does the operation of a system with minimum requirement of manual involvement of labor with the help of electronic devices. It makes the irrigation system more efficient and workers can concentrate more on other farming task. Irrigation system such as drip irrigation, sprinkler system and surface irrigation get automated with the help of electronic appliances and detectors such as computers, timers, sensors and other mechanical devices. Almost every irrigation system can be automated. A well-controlled irrigation system is the one which adjusts the special and time -distribution of water to maximize the efficiency of crop production. It makes in every region of the world as it times and water.
The main intention of this project is to develop a solar powered automatic irrigation system. The entire system is controlled by a programmable microcontroller. A wireless application of irrigation in automation is supported by soil moisture sensors. Intelligent automatic plant irrigation concentrates watering plants regularly without human monitoring using a moisture sensor. The system hardware components that are used may be replaced with the availability and environmental conditions. The newly added feature in this work is water level sensor module. The water level sensor YL-69 manufactured by Sun Robotics is used to check the level of water of surrounding. For water level increment or decrement from the reference value is required for good growth of a crop, the arrangement is done with the help of which will maintain the water supply to the paddy field, which results in controlled irrigation that may provide healthy growth to the crops. The use of solar panel makes the whole system less costly in long run. Using power supply from solar energy the total power consumption of the circuit is reduced. The renewable energy source is acting as a major resource for the AIS. This system has an additional arrangement of power supply from regular domestic mains too. A solar photovoltaic panel contains the following components of Fig. 1 which converts solar energy to electrical energy with the help of semiconducting material properties. In this Fig. 1 the equivalent circuit of PV panel is presented, where a current source of Iph, diode of D, shunt resistance Rsh, series resistance Rs is shown. The theoretical equation to find amount of current from panel is given in e

**code:** : // Define the pins for the relays
*define RELAY-PIN-1 2 *define RELAY-PIN-2 3 int levell. leve12; void setup() // Set the serial monitor baudrate to 9600
Senal.begin(9600);
// Set the relay pins as output pinMode (RELAY-PlN-1. OUTPUT); pinMode (RELAY-PlN-2.
OUTPUT); HIGH); digitalWrite(RELAY-PlN-2, HIGH); void loop()
// Variables to store ADC values (O to 1023)
// analogRead function returns the integer 10 bit integer (O to 1023) levell = analogRead(AO); leve12 = analogRead(A1
// Print text in senal monitor Serial.pnntCAnalog value 1: •y. // Print analog value 1 in serial monitor
Serial.println(levell); delay(100);
// Print text in serial monitor Serial.printCAnalog value 2: // Print analog value 2 in serial FIG HARDWARE IMPLEMENTATAION monitor
Serial.println(leve12); delay(100);
// Check if analog value 1 is less than 500 if (levell 500 leve12 500 ) // Turn on relay 1
HIGH); Serial.printlnCRelay 1 OFF); delay(100); digitalWrite(RELAY-PlN-2. LOW); Serial.printlnCRelay 2 ON•); delay(100); else if (levell 500 leve12
500 )
// Turn on relay 1 digitalWrite(RELAY-PlN-1. LOW); Serial.DrintlnCRelav 1 ON •y.
Serial.printlnCRelay 1 ON'); delay(100); LOW); Serial.printlnCRelay 2 ON); delay (100); else
// Turn off relay 1
HIGH); Serial.printlnCRelay 1 OFF); delay(100);
HIGH); Serial.printlnCRelay 2 OFF•, delay(100);
// Delay for stability delay(100);

## 4. METHODOLOGY

The solar powered AIS is sustainable and draws attention to utilization to the renewable sources. This approaches the AIS more efficient and techno-economical also. The circuits are mostly classified by two parts one is (a) solar power supply to the water pump and the other is (b) monitoring the automation. The motor pump arrangement


All Right Reserved @ IJTRS

requires a specific or exact rated solar panel which will be mounted nearby the pump and should face the sunlight directly.

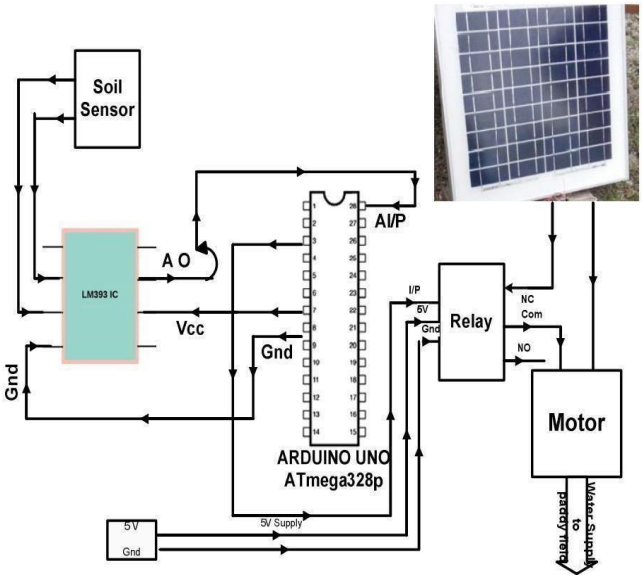


**Fig. 4.1 Circuit Diagram**

The operation of solar panel and water pump are required for 5-6 hrs of day time, except the operation of pump solar energy may be stored in some batteries for the alternate power supply resources. Charging circuit of battery using diode and resistor of proper rating is required which may provide power in absence of sunlight. The essential part of the circuit is to operate the water pump and constructing an automated circuit for that. Now-a-days using electronic chip many high rated appliances also can be controlled. In this paper such type of controller is designed using ARDIUNO UNO. The main circuit diagram is shown in Fig 2 and a prototype of the proposed design is shown in Fig. 3. Microcontrollers may work parallel and store several commands in its memory. Here using ARDUINO the automation is done where four level performances is analyzed. LM 383 is used to control the analog output of the main microcontroller circuit.

**4.1 Working Model**

The YL-69 sensor can observe the level of water present in the soil. With the help of probes current is passed to the circuit of the sensor and it activates the resistance to measure the water level from the working area. When the water level is higher it comes in contact with higher soil conductivity which helps the soil current to resist from the flow of higher current to the receiver of the relay. Now due to the higher level of water the motor current becomes zero and water will not flow through the hosepipe.

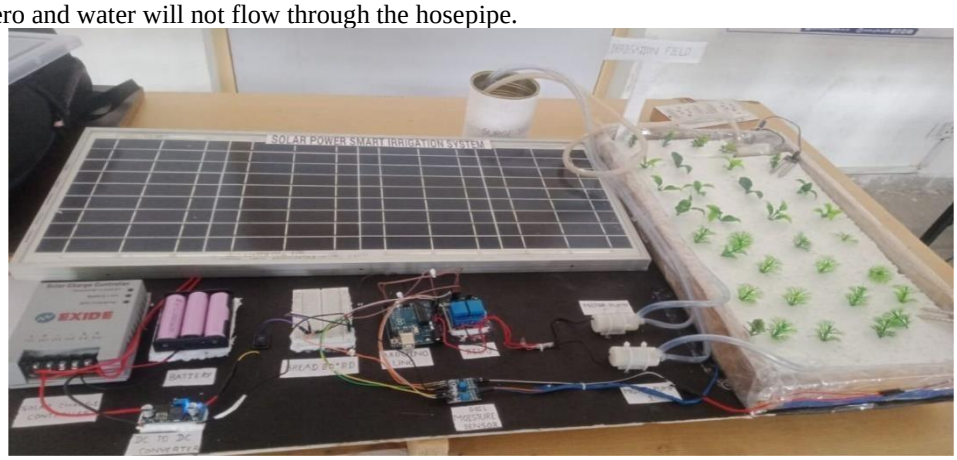


**Fig. 4.2 Prototype of the System**

The optimum moisture level is kept at 45%, if the soil moisture level shows more than 45% the pump is off hence no water will be supplied to the soil and if the moisture level is 45%, the pump is automatically ON as it is below the threshold level and water will be supplied till it reaches the moisture level of more than 45%. A massive number of water sources are used every year in for irrigation and crop production in all over the world, the number of figures is very high, and the amount used for water supply is also very high. The renewable source may reduce this gigantic amount of energy and that energy may be preserved for other electrical applications.

After installing this solar powered AIS, the payback period of the total project will be very less, almost 2 and a half year. The initial cost may be high to the lower economical county people, but installing such project where


All Right Reserved @ IJTRS

the payback period is less is profitable only. Now the excess amount of solar powered AIS may be used for domestic lighting purpose too. Low wattage lights may be used in domestic area, or streetlights to illuminate streets at nighttime. The major investment will be provided in water pump only, but this kind of automation circuits can be used for parallel controlling of water pumps. So using only one AIS circuit more than two water pumps can be controlled.

## 5. RESULT AND FUTURE SCOPE

The solar powered AIS is designed to sense the moisture level of the soil continuously and transmit the response to the main circuit. The system responds appropriately by using the electronic circuit design. The sensor invention is a great achievement to the electronic society which helps the day to day life with all smart appliances.

This soil moisture sensor is also a wonder in the field of smart irrigation system. The sensor is monitored electronically in normal environment and can share the information to the circuit to set the desired values of actuators. The actuators are connected with the water pump controlling circuit and help to transmit the signal through proper channel. This paper mainly emphasizes on how irrigation is atomized in various electronic devices with the development of solar power. The experimental results are shown in Fig 4 and 5, where two levels have been measured. First level 1 is examined and found that when the soil is very dry and no water content the current from the sensor is passing through the motor and hence water flows. Now in Fig. 5 water level is very high where the flow of the current is barred by the resistance of the circuit and water supply is paused. This is the most rigorous effect of the circuit that an optimization may be done for energy savings using solar powered AIS.

This paper consists of an economical plan of automation work for the application in agricultural fields using different levels of water content in the paddy. This automation is activated by switching arrangements of ON/OFF for the water pump. These components are less costly with high accuracy. It is a programmed technology in a microcontroller which cost very less amount and easily available.

Now the system operation is distributed into four levels as shown in Table 3, Level 1 consists of higher power output and Level 4 consists of low power output; in between these levels two more levels are given as option to operate, when less water or medium water will be sensed. The sensor YL-69 current will be provided to the microcontroller with the help of analog input circuit and then the logical circuit will be operated to control the current flow at the output side of the motor. A low rating motor has been used for the operation of the hardware design which may be changed into high rating motor for future use.This automation circuit is designed for a higher rated motor circuit also.

**Table-5.1 Operational model for AIS**

| Operation | Water Level | Motor Rating (kW) | Torque |
|---|---|---|---|
| Level 1 | No | 22 | Max |
| Level 2 | Low | 20 | Medium |
| Level 3 | Medium | 18 | Low |
| Level 4 | High | 00 | Nil |

## CONCLUSION

From one survey it can be seen that over a nine hundred thousand are used almost all states of India, which cost a huge amount of money for the use of energy. This irrigation costs much using the conventional system. This uncontrolled fund may be used for electricity generation for the cause of electrifying in un-electrified villages. A huge amount of energy may be spared using renewable energy source. Investment also may be systematic and controlled using non-conventional resources. Using non-conventional energy for automation of AIS gives a huge liberty to save energy per year. The excess energy from solar may be fed back to the grid after modification and may cause advantage while payback cost assumption. Automation of the solar powered AIS may be a better solution for the farmers of different regions of India. In any climatic condition this model may be installed and can be making operational. Like the cost effectiveness power consumption of the circuit is also very less.

## REFERENCES

[1] T. K. Gannavaram V, R. Bejgam, S. B. Keshipeddi, S. Sunkari and V. K. Aluvala, "Conversion of Sound Energy into Electrical Energy in Highly Populated Areas," 2021 6th International Conference on Communication and Electronics Systems (ICCES),2021, pp.32-36, doi:10.1109/ICCES51350.2021.9489219.

[2] T. K. Gannavaram V and R. Bejgam, "Brief Study and Review on the Next Revolutionary Autonomous Vehicle Technology," 2021 International Conference on Advance Computing and Innovative Technologies in Engineering (ICACITE), 2021, pp. 34-37, doi: 10.1109/ICACITE51222.2021.9404763.

[3] T. K. Gannavaram V, R. Bejgam, S. B. Keshipeddi, A. Banda and G. Bollu, "Study of Automobile Safety Technology Development using Vehicular Safety Device (VSD)," 2021 6th International Conference on


All Right Reserved @ IJTRS

Inventive Computation Technologies (ICICT), 2021, pp.240-244, doi: 10.1109/ICICT50816.2021.9358670.

[4] T. K. Gannavaram V, U. Maheshwar Kandhikonda, R. Bejgam, S. B. Keshipeddi and S. Sunkari, "A Brief Review on Internet of Things (IoT)," 2021 International Conference on Computer Communication and Informatics (ICCCI), 2021, pp. 1-6, doi: 10.1109/ICCCI50826.2021.9457009.

[5] T. K. Gannavaram V, U. M. Kandhikonda, R. Bejgam, S. B. Keshipeddi and S. Sunkari, "A Brief Review on Internet of Things (IoT)," 2021 International Conference on Computer Communication and Informatics (ICCCI), 2021, pp. 1-6, doi: 10.1109/ICCCI50826.2021.9451163.

[6] Tummanapally, Shraddha Shree and Sunkari, Saideep, Smart Vehicle Tracking System using GPS and GSM Technologies (July 12, 2021). Available at SSRN: https://ssrn.com/abstract=3884903 or http://dx.doi.org/10.2139/ssrn.3884903.

[7] Gannavaram V, Tulasi Krishna & Singh, Akhilesh & Gannavaram, Venkat Praveen & Gannavaram, Venkat Chinmai Sai & Ohene-Akoto, Justice & Keshipeddi, Sai & Chandel, Garima & Sangem, Raviteja & Koul, Sumit & A., Sabarivani & Deo, Rajesh & A., Ambikapathy. (2021). IoT and Machine Learningbased Headlight Intensity Changing device for Electrical Vehicles.

[8] Gannavaram V, Tulasi Krishna & Gannavaram, Venkat Praveen & Gannavaram, Venkat Chinmai Sai & Reddy, G. & Prabhakar, Girija & Kama, Ramudu & Budda, Jagadish & Rao, Vadithala & Vuppu, Shankar & Laxman, Srinivas & Bushan, Phridviraj & Pratapagiri, Sreenivas & Kolluri, Johnson. (2021).

[9] SOLAR PARK MONITORING AND FAULT DETECTION SYSTEM USING IOT AND MACHINE LEARNING.

[10] Vyas, M., Yadav, V.K., Vyas, S., Swami, R.K. (2022). An Intelligent Control Strategy for Power Quality Improvement of DFIG-Based Wind Energy Conversion System. In: Kumar, J., Tripathy, M., Jena, P. (eds) Control Applications in Modern Power Systems. Lecture Notes in Electrical Engineering, vol 870. Springer, Singapore. https://doi.org/10.1007/978-981-19-0193-5_21.

[11] Vyas, M., Yadav, V.K., Vyas, S., Joshi, R.R. and Tirole, R. (2022). A Review of Algorithms for Control and Optimization for Energy Management of Hybrid Renewable Energy Systems. In Intelligent Renewable Energy Systems (eds N. Priyadarshi, A.K. Bhoi, S. Padmanaban, S. Balamurugan and J.B. Holm-Nielsen). https://doi.org/10.1002/9781119786306.ch5.

[12] Sasanka Sekhor Sharma, RR Joshi, Raunak Jangid, Shripati Vyas, Bheru Das Vairagi, Megha Vyas., 2020, MITIGATION OF TRANSIENT OVER-VOLTAGES AND VFTO EFFECTS ON GAS INSULATED SUBSTATION. Solid State Technology, Volume 63, Issue 5/

[13] Sujit Kumar et al 2021. Strategies to Enhance Solar Energy Utility in Agricultural Area of Rajasthan State, India. J. Phys.: Conf. Ser. 1854 012013. DOI 10.1088/1742-6596/1854/1/012013.

[14] M. Aarif; D. Joshi; R. Jangid and S.S. Sharma, "Grid Power Smoothing Management for Direct Drive PMSG Variable Speed Wind Energy Conversion System with Multilevel Converter", IEEE 7th International Conference on ICT for Sustainable Development, Organized by Global Knowledge Foundation during 29-30, July 2022 at Goa, India.

[15] Y. Joshi; J.k Maherchandani; V.K Yadav; R. Jangid; S. Vyas and S.S Sharma, "Performance Improvement of Standalone Battery Integrated Hybrid System" IEEE 7th International Conference on Electrical Energy Systems (ICEES), Organized by Sri Sivasubramaniya Nadar College of Engineering during 11-13 Feb. 2021at Chennai, India.

[16] R. Jangid; J.k Maherchandani; R.R. Joshi and B.D Vairagi, "Development of Advance Energy Management Strategy for Standalone Hybrid Wind & PV System Considering Rural Application", IEEE 2nd International Conference on Smart Systems and Inventive Technology, Organized by Francis Xavier Engineering College during November 27-29, 2019 at Tirunelveli, India.

[17] R. Jangid; K. Parikh and P. Anjana, "Reducing the Voltage Sag and Swell Problem in Distribution System Using Dynamic Voltage Restorer with PI Controller", International Journal of Soft Computing and Engineering, ISSN: 2231-2307, Vol.-3, Issue-6, January 2014.

[18] R. Jangid; J.k Maherchandani; V.K Yadav and R.K Swami, "Energy Management of Standalone Hybrid Wind-PV System", Journal of Intelligent Renewable Energy Systems (John Wiley & Sons, Inc.) Pages 179-198, 2022.

[19] H. Kumawat and R. Jangid, "Using AI Techniques to Improve the Power Quality of Standalone Hybrid Renewable Energy Systems", Crafting a Sustainable Future Through Education and Sustainable Development, IGI Global, Pages 219-228, 2023.

[20] H. Kumawat; R. Jangid, "Performance and Investigation of Two Drive Train Interfaced Permanent Magnet Synchronous Generator for Wind Energy Conversion System", Journal of Emerging Technologies and Innovative Research, ISSN:2349-5162, Volume 7, Issue 1, January 2020.

[21] R. Jangid et. al., "Smart Household Demand Response Scheduling with Renewable Energy Resources", IEEE Third International Conference on Intelligent Computing and Control System, Organized by Vaigai College of Engineering during May 15-17, 2019 at Madurai, India.


All Right Reserved @ IJTRS

[22] S. Kumar; R. Jangid and K. Parikh "Comparative Performance Analysis of Adaptive Neuro-Fuzzy Inference System (ANFIS) & ANN Algorithms Based MPPT Energy Harvesting in Solar PV System." International Journal of Technical Research and Science, vol. 8, Issue 3, March 2023.
[23] S. Sharma; R. Jangid and K. Parikh "Development of Intelligent Control Strategy for Power Quality Improvement of Hybrid RES Using AI Technique" International Journal of Technical Research and Science, vol. VIII, Issue II, Feb. 2023.
[24] L. Jhala et al., "Development of Control Strategy for Power Management in Hybrid Renewable Energy System" International Journal of Technical Research and Science, vol. VI, Issue XII, Dec. 2021.
[25] P. S. Rajpurohit, et al., "Design of DE Optimized PI and PID Controller for Speed Control of DC Drives" International Journal of Research in Engineering, Science and Management, Volume-2, Issue-6, June-2019.
[26] N. Dhakre, et al., "Optimal Synchronization of PSS and Statcom Based Controller Using De Algorithm" International Journal for Research in Applied Science & Engineering Technology, Volume-5, Issue-XI, Nov.-2017.
[27] P. Megha, et al., "Flow Analysis of Transmission System Incorporating STATCOM" International Journal of Inventive Engineering and Sciences, Volume-3, Issue-1, Dec.-2014.
[28] D. Trivedi, et al., "Optimization of Voltage Stability of Transmission line using UPQC" International Journal of Engineering Research & Technology, Volume-4, Issue-2, Feb.-2015.
[29] Vyas, Megha & Yadav, Vinod & Vyas, Shripati & Joshi, R.. (2021). Voltage Sag Mitigation Using Distribution Static Compensator. 10.1007/978-981-15-8586-9_24.
[30] Tirole, R., Joshi, R.R., Yadav, V.K., Maherchandani, J.K. and Vyas, S. (2022). Intelligent Control Technique for Reduction of Converter Generated EMI in DG Environment. In Intelligent Renewable Energy Systems (eds N. Priyadarshi, A.K. Bhoi, S. Padmanaban, S. Balamurugan and J.B. Holm-Nielsen). https://doi.org/10.1002/9781119786306.ch4.
[31] Gannavaram V, Tulasi Krishna & Gannavaram, Venkat Praveen & Gannavaram, Venkat Chinmai Sai & Rao, Vadithala & Reddy, G. & Polala, Niranjan & Pakala, Shireesha & Madugula, Sujatha & Madupu, Ram & Rangu, Seshu & Saideep, Sunkari & Kandhikonda, Uma & Gannavaram, Srivani. (2021). AI and IoT enabled Smart Medicine Box.


All Right Reserved @ IJTRS