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INTELLIGENT SOLAR COLLECTOR CONTROL SYSTEM

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Abstract

The article discusses solar collector control systems using intelligent control methods. The article presents key concepts, problem statement, description of the solution and conclusions about the advantages of the approach. The use of intelligent control in solar energy systems can optimize the performance of solar collectors and increase their efficiency.

Keywords. Solar collectors, intelligent control, optimization, energy efficiency.

Introduction. Solar energy is one of the most promising sources of renewable energy. Solar collectors are used to convert solar radiation into electrical or thermal energy (Fig. 1).

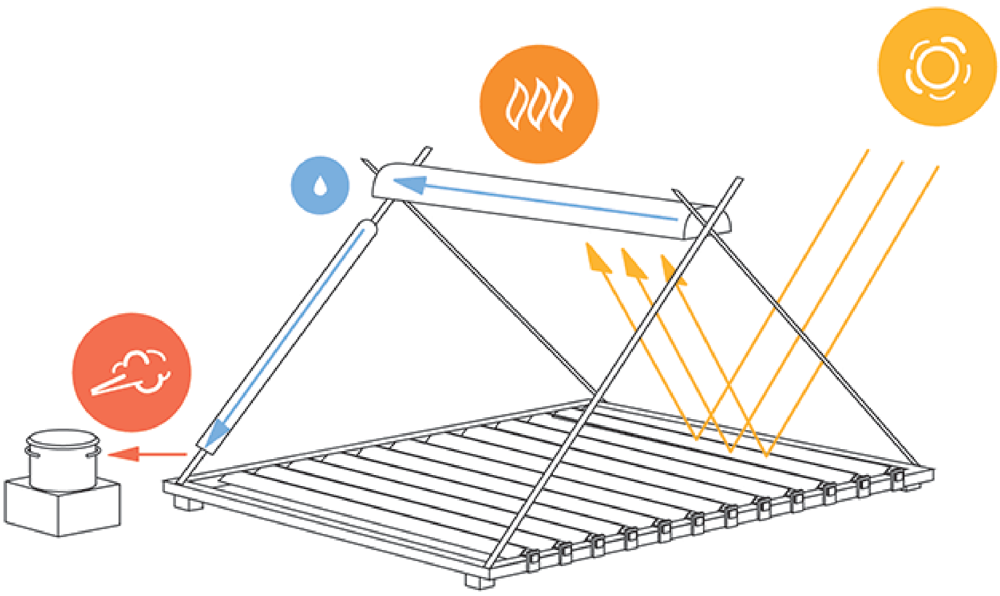

Fig.1. Technological diagram of a solar collector.

However, the efficiency of solar collectors can depend significantly on many factors, such as angle of inclination, orientation and weather conditions. This article discusses a system that uses intelligent control techniques to optimize the performance of solar collectors.

Setting goals. The purpose of this work is to develop a solar collector training system using intelligent control.

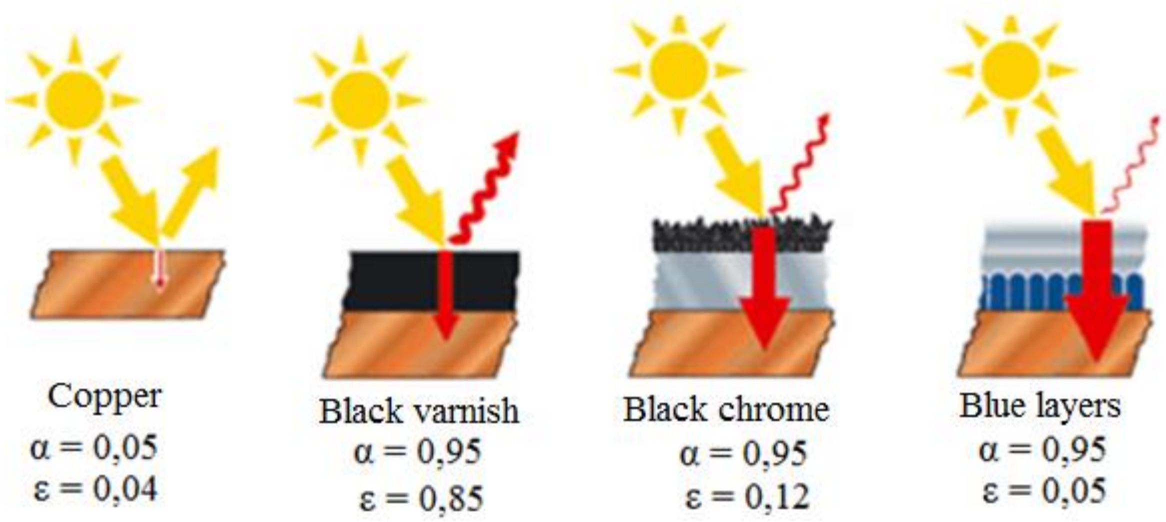

Fig.2. Dependence of thermal reflection on the surface of the material.

Tasks include determining optimal collector operating parameters, predicting energy performance depending on external conditions (Fig. 2), and automatically adjusting parameters to maximize energy output.

Problem solving. To solve the problems, an approach based on intelligent control is used. To begin with, data is collected about the operation of the solar collector, such as angle of inclination, orientation, intensity of solar radiation, temperature and other parameters. This data is then used to train an intelligent control model that can predict reservoir performance under different conditions (Figure 3). Optimization techniques such as genetic algorithms or gradient descent optimization techniques are used to optimize reservoir performance.

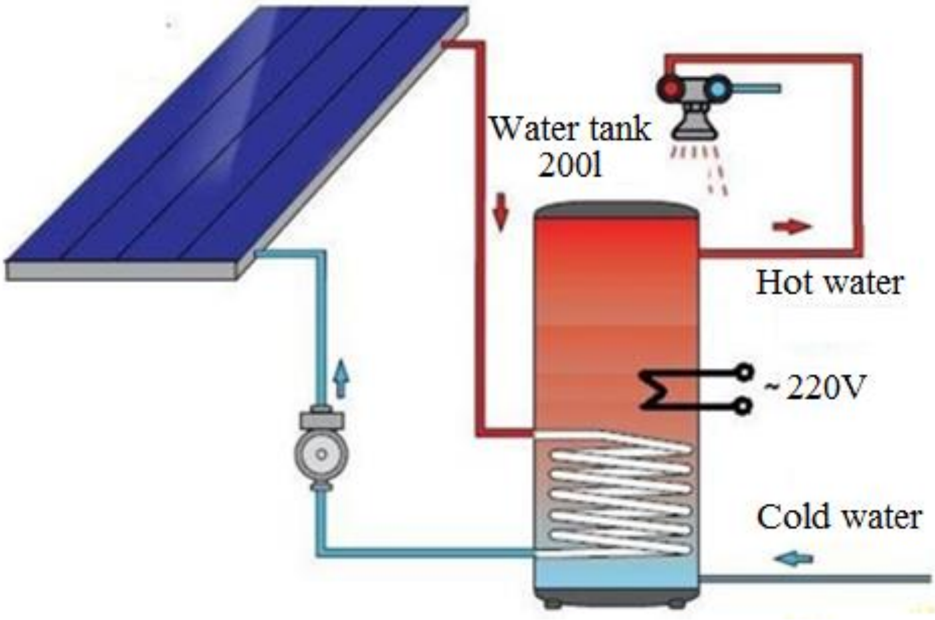

Fig.3. Functional and technological diagram of a solar collector.

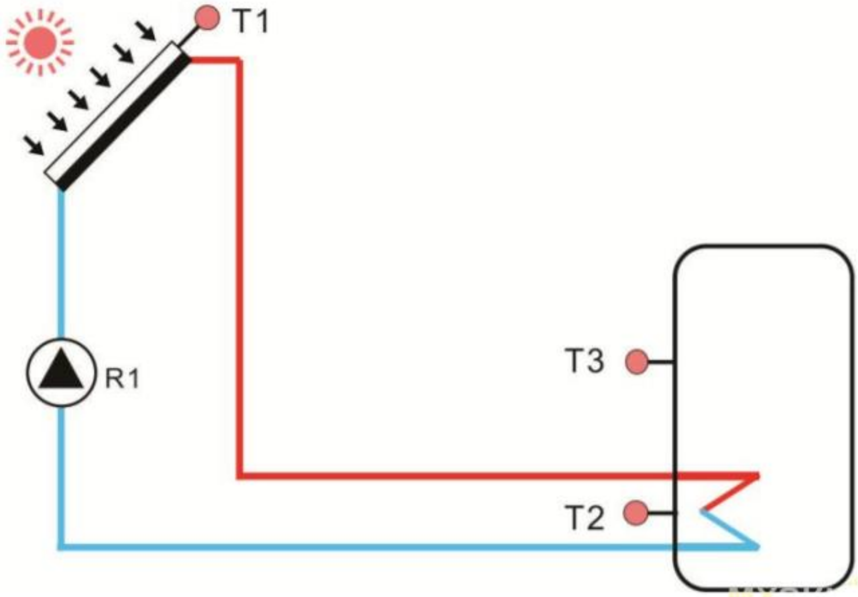

Fig.4. Block diagram of a solar collector.

These techniques allow collector parameters to be automatically adjusted to maximize energy output under changing conditions (Figure 4).

T1 – solar collector temperature sensor, T2 – cold water temperature sensor, T3 – hot water temperature sensor.

Resistance value PT1000

^0C	0	10	20	30	40	50	60	70	80	90	100	110	120
Ω	1000	1039	1077	1116	1155	1194	1232	1270	1309	1347	1385	1422	1460

NTC 10K B = 3950 resistance value

^0C	0	10	20	30	40	50	60	70	80	90	100	110	120
Ω	33620	20174	12535	8037	5301	3588	2486	1759	1270	933	697	529	407

A photoresistor is a sensor whose electrical resistance varies depending on the intensity of light incident on it [1]. LDRs are mainly used to provide analog input to Arduino. Control device - it was decided to use the Arduino UNO hardware platform as a microcontroller. This choice is based on functionality, availability, price and ease of operation. The purpose of the microcontroller is to control the position of the servomotor [2]. Drive unit - servo drives were chosen as electric drives. These drives will allow you to control the position of solar panels with high precision. One of the motors is responsible for changing the position of the stands around the X-axis, and the other is responsible for changing the position of the stands around the Y-axis. The servo motor can rotate up to a maximum angle of 180 degrees. Our proposed design uses a 4.8V motor. The servo motors are powered by the PWM output received from the Arduino. A solar battery is a combination of photoelectric converters—semiconductor devices that directly convert solar energy into direct electric current [3]. 4. Implementation The operating principle of the solar tracking system is made by light dependent resistor (LDR) (Fig. 5). The four LDRs are connected to the Arduino AO analog pin - A4, which serves as the input to the system (Table 1). The built-in A/D converter converts the LDR analog value and converts it to digital.

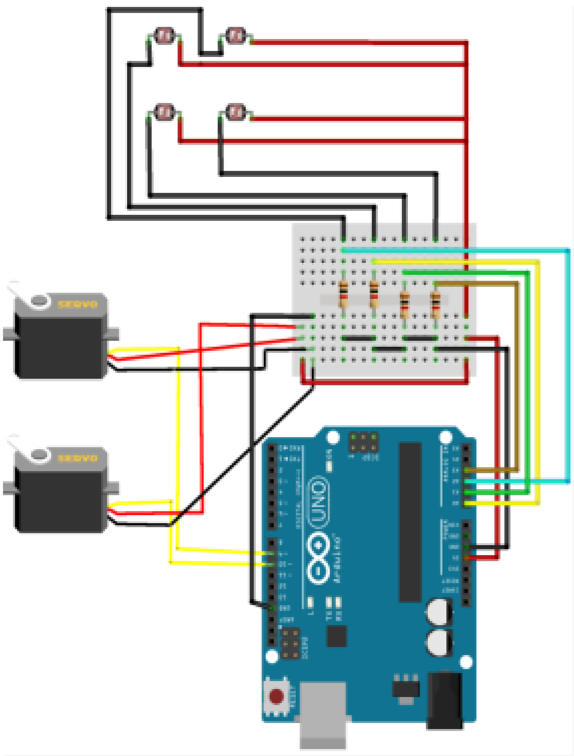

Fig.5. Connection diagram of the technological process with Arduino.

Inputs from analog value LDR, Arduino as controller and servo motor will be output. LDR1 and LDR2, LDR3 and LDR4 are taken as a pair.

Program code in C++ Table 1.

#include <Servo.h>	digitalWrite(RELAY_PIN, HIGH);
#define RELAY_PIN 7	}
#define TEMPERATURE_PIN A0	else
#define SERVO_PIN_1 9	{
#define SERVO_PIN_2 10	digitalWrite(RELAY_PIN, LOW);
Servo servo1;	}
Servo servo2;	int servoPosition1 = map(temperature, 20, 40, 0, 180);
void setup() {	int servoPosition2 = map(temperature, 20, 40, 180, 0);
pinMode(RELAY_PIN, OUTPUT);	servo1.write(servoPosition1);
pinMode(TEMPERATURE_PIN,	servo2.write(servoPosition2);
INPUT);	delay(1000);
servo1.attach(SERVO_PIN_1);	}
servo2.attach(SERVO_PIN_2);	int readTemperature() {
}	int sensorValue = analogRead(TEMPERATURE_PIN);
void loop() {	float temperature = sensorValue * (5.0 / 1023.0) * 100.0;

int temperature = readTemperature(); if (temperature > 30) {	return (int)temperature; }

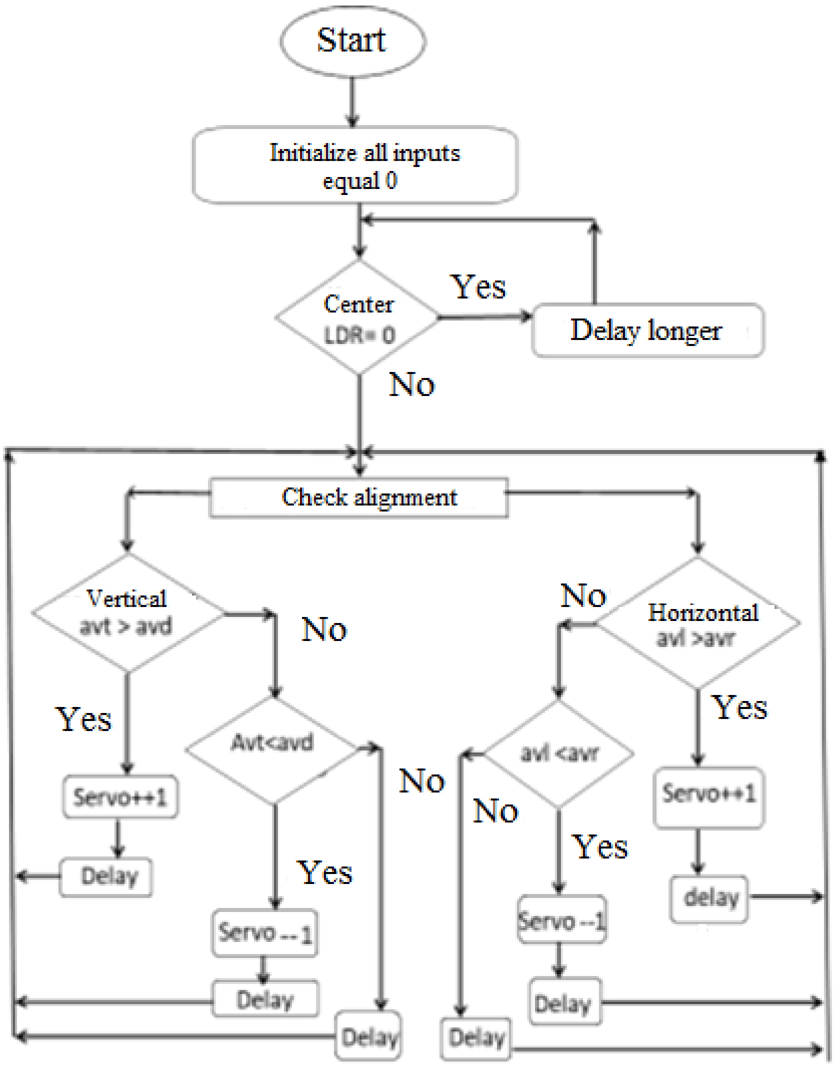

Fig.6. Solar collector control algorithm.

If one of the LDRs in a pair receives more light intensity than the other, there will be a difference in the node voltages sent to the corresponding Arduino channel to take the necessary actions (Figure 6). The servo motor will move the solar panel to the high intensity LDR position that was when programmed.

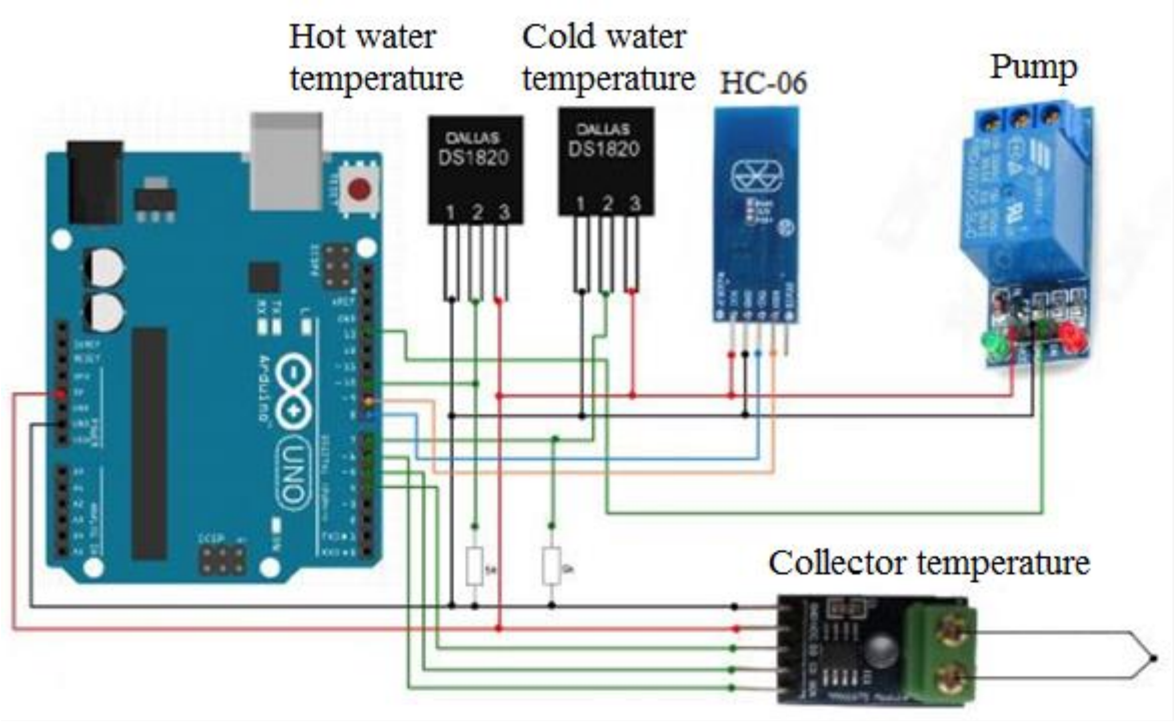

Fig.7. Solar collector temperature control circuit.

Conclusion. The use of intelligent control techniques in solar energy systems can significantly improve their efficiency and performance. The solar training system presented in this article demonstrates the potential for optimizing solar installation performance and improving energy efficiency.

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2. Yang, H., Wang, H., Shao, H., Liu, B. (2019). A review of machine learning approaches for prediction and optimization in building energy consumption. Sustainable Cities and Society, 45, 486-505.

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