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## NamMTI ILMIY-TEXNIKA JURNALI TAHRIR HAY'ATI A'ZOLARI

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# DEVELOPMENT OF A CONTROL ALGORITHM FOR A SMART IRRIGATION SYSTEM BASED ON SOIL MOISTURE AND METEOROLOGICAL DATA

**ROKHMUNOV DURBEK**

Associate Professor, Namangan State Technical University, Namangan, Uzbekistan

Phone.: (0591) 177-0370, e-mail.: [durbekrahmonov@gmail.com](mailto:durbekrahmonov@gmail.com)

\*Corresponding author

**SULAYMONOV JASURBEK**

Postdoctoral fellow, Namangan State Technical University, Namangan, Uzbekistan

Phone.: (0591) 670-2429, e-mail.: [jasur1996.07.09@gmail.com](mailto:jasur1996.07.09@gmail.com)

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**Abstract:** This article proposes an intelligent control algorithm based on soil moisture and weather (meteorological) data to develop an effective irrigation regime for agricultural lands. The system collects and analyzes data in real time through IoT devices, and irrigation is carried out automatically or semi-automatically. The proposed approach serves to increase water use efficiency, reduce energy consumption, and improve crop yield.

**Keywords:** Smart irrigation system, IoT, soil moisture sensor, meteorological data, automatic control, Arduino, ESP32, water resource efficiency, agrotechnology, real-time monitoring, irrigation algorithm.

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**Introduction.** Water scarcity is one of the pressing problems in agriculture. Traditional irrigation methods lead to excessive water consumption, soil salinization, and reduced productivity. Therefore, optimizing resources through modern technologies, in particular, smart irrigation systems, is of great importance. Developing a control algorithm based on sensor data and meteorological forecasts using IoT technologies is one of the important scientific and practical issues.

## Methodology.

### 1. Main components:

- - Soil moisture sensor (YL-69 or DHT22)
- - Air temperature and humidity sensor (DHT22, BMP280)
- - Arduino or ESP32 microcontroller
- - Internet connection (Thingspeak or MQTT via WiFi)
- - Irrigation actuators (relay and solenoid valve)

### 2. Algorithm working principle:

- - Sensors read data (T, H, soil moisture)
- - If soil moisture < specified threshold:
- - Air temperature and wind speed are taken into account
- - Irrigation duration is automatically determined
- - The valve opens.
- - If the weather forecast calls for rain:
- - Irrigation is stopped or delayed
- - When watering is complete, the status is transmitted to the server

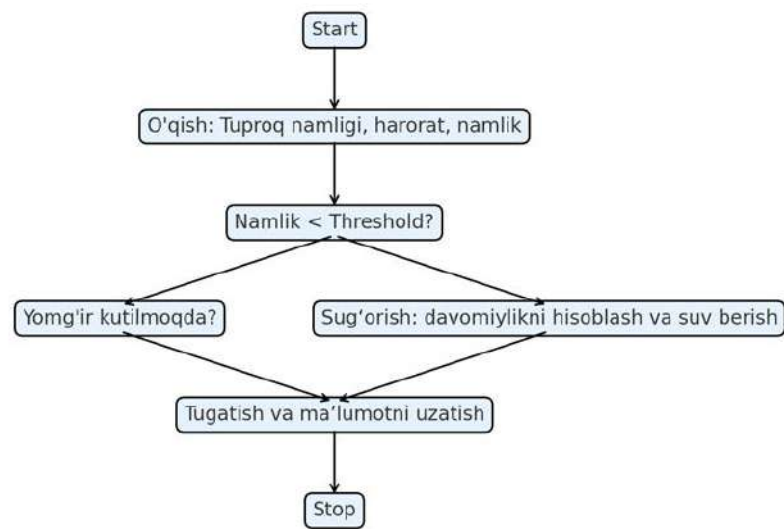
### 3. Formula for calculating irrigation duration:

$$T_s = k \cdot (M_{opt} - M_{act}) \cdot \frac{E}{R}$$

Here:

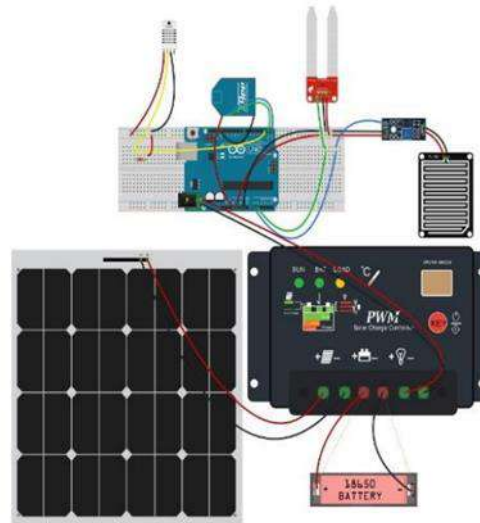
- $T_s$  — sug'orish vaqti (sekund),
- $M_{opt}$  — optimal namlik darajasi,
- $M_{act}$  — hozirgi namlik darajasi,
- $E$  — bug'lanish koeffitsienti,
- $R$  — suv oqimi tezligi (l/min),
- $k$  — kalibrlash koeffitsienti.

4. Irrigation system block diagram:



**Figure 1.** Irrigation system block diagram.

5. Practical project part:



**Figure 2.** Project connection diagram.

**I. Result .** During the research, an effective control algorithm for a smart irrigation system based on soil moisture, air temperature, and meteorological changes was developed. Initially, the stability and accuracy of the data obtained through the sensors were tested, and their real-time transmission was successfully ensured.

**II. Conclusion.** Smart irrigation systems controlled based on soil and meteorological parameters allow for efficient use of resources in agriculture. The proposed control algorithm works with simple microcontrollers and sensors, is inexpensive and easy to use. In the future, it is planned to develop advanced, self-learning irrigation systems by combining this algorithm with artificial intelligence (machine learning).

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## C O N T E N T S

---

### TECHNICAL SCIENCES: COTTON, TEXTILE AND LIGHT INDUSTRY

---

<b>Saloxiddinova M.</b>	<b>3</b>
Improving the separator design to prevent cotton fiber loss.	
<b>Juraeva G.</b>	<b>9</b>
Optimizing cotton fiber quality during the production process.	
<b>Mamadaliyev F.</b>	<b>16</b>
Analysis of problem in the aerodynamic system of cottonseed linting equipment in cotton processing plants.	
<b>Kozokov S.</b>	<b>23</b>
Conducting experiments with newly designed saw gin ribs in the cotton cleaning process for different cotton varieties.	
<b>Usmonov I., Abdullajonov S.</b>	<b>30</b>
Methods and results for determining the parameters and operating modes of irradiating watermelon seeds with ultraviolet rays.	
<b>Majidov A.</b>	<b>36</b>
Theoretical foundations of the technological parameters of a straight-flow fiber separation device.	
<b>Rahmatova S.</b>	<b>44</b>
Scientific approach to considering properties in the design of garments made from knitted fabrics.	
<b>Rahmatova S.</b>	<b>48</b>
Technology for obtaining knitted fabrics from various raw materials.	
<b>Turaboyev G.</b>	<b>54</b>
Methodology for determining the tribotechnical properties of structural materials interacting with raw cotton.	

---

### TECHNICAL SCIENCES: AGRICULTURE AND FOOD TECHNOLOGIES

---

<b>Khurmamatov A., Boyturayev S.</b>	<b>58</b>
Results of industrial water treatment from mechanical impurities.	
<b>Khurmamatov A., Alimardonov Kh., Akhmedova K.</b>	<b>65</b>
Two-stage installation for deep air purification from fine-dispersed solid particles.	
<b>Mamatusmonova D., Mamatov Sh.</b>	<b>73</b>
Technical characteristics of the use of vibrating conveyors for drying rosa caninas.	
<b>Toshboyeva S., Dadamirzayev M.</b>	<b>79</b>
Physicochemical properties of a functional sauce for fish canned products.	

---

<b>Saribayeva D., Maxmudova D.</b>	
Study of protein–lipid composition in food products.	<b>83</b>
<b>Gulomkhojaeva N., Zokirova M.</b>	
Study of polyphenolic compounds in jujube ( <i>Ziziphus jujuba</i> mill.) grown in Uzbekistan.	<b>88</b>
<b>Gulomkhojaeva N., Zokirova M.</b>	
Investigation of the amino acid composition in black and white mulberry ( <i>Morus nigra</i> L. and <i>Morus multicaulis</i> Perr.) varieties.	<b>94</b>
<b>Kadirov A., Vokosov Z.</b>	
New technology for growing microorganisms of the <i>Bacillus</i> sp, <i>Rhizobium</i> sp, <i>Azotobacter</i> sp.	<b>101</b>
<b>Rakhimova G.</b>	
Development of an effective technology for producing soy milk from local soy raw materials, studying its composition and physical and chemical properties	<b>107</b>

## CHEMICAL SCIENCES

<b>Khabibullaev J., Shomurotov Sh.</b>	
Oxidation of various cellulose containing materials using the $\text{HNO}_3/\text{H}_3\text{PO}_4\text{-NaNO}_2$ system.	<b>112</b>
<b>Nuritdinov A., Abdullaev O.</b>	
Technical parameters and energy efficiency of an oil sludge processing unit	<b>122</b>
<b>Okhundadaev A.</b>	
Study of the effect of various factors on the synthesis of vinyl esters of wine acids	<b>127</b>
<b>Usmonova Z.</b>	
Effectiveness analysis of thermally and steam activated plum seed adsorbents	<b>133</b>
<b>Kaxarova M.</b>	
Technological scheme for extracting naphthalene from pyrolysis oil by the extraction (phase separation) method	<b>139</b>
<b>Oribzhonov M., Bektemirov A., Arislanov A., Azizov V.</b>	
Method for producing biosuperphosphate fertilizers containing humic compounds	<b>143</b>
<b>Erkinov R., Soliyev M., Arislanov A.</b>	
Synthesis of sulfur containing organic compounds by reaction of thiol-en and thiol-in	<b>151</b>
<b>Yusupov M., Nuritdinov A.</b>	
Elemental analysis of carboxyl-modified copper phthalocyanine pigment	<b>156</b>

---

<b>Nuritdinov A.</b>	
Thermal analysis of carboxyl-modified cobalt and calcium metal phthalocyanine pigments	<b>162</b>

---

<b>Isakov B.</b>	
Development and study of an anti-caking additive to improve the physico-mechanical properties of ammonium nitrate	<b>168</b>

---

### TECHNICAL SCIENCES: MECHANICS AND MECHANICAL ENGINEERING

---

<b>Gulamova D., Bobokulov S., Eshonkulov E.</b>	
Resistance and voltage anomalies above 200k bscco synthesized by solar technology	<b>173</b>

---

<b>Kutbidinov O., Abdullabekov D., Usmonov D., Xushbakov M.</b>	
Analytical and experimental model for assessing the depreciation rate of transformer oil based on physicochemical factors	<b>182</b>

---

<b>Obidov A., Abdurasulov A.</b>	
Basis of implementation of resource-effective shaft production	<b>188</b>

---

<b>Utaev S.</b>	
Calculation of oil change intervals in diesel-based gas engines	<b>193</b>

---

<b>Isomiddinov A.</b>	
Derivation of differential equations for spindle oscillation in a system of rectangular coordinates	<b>200</b>

---

<b>Dedakhanov A.</b>	
Determination of fuel consumption for drying cotton raw materials	<b>209</b>

---

<b>Atambaev D.</b>	
Difference of the individual yarns in the composition of a wrapped yar on the quality of the yar and determination of acceptable values of the main factors affecting their production	<b>215</b>

---

<b>Rokhmonov D., Sulaymonov J.</b>	
Development of a control algorithm for a smart irrigation system based on soil moisture and meteorological data	<b>224</b>

---

<b>Mamakhonov A., Khikmatillaev I.</b>	
Modeling of a vibratory cleaning device with cosinoidal and sinusoidal shapes in matching the longitudinal and transverse cutting surface	<b>227</b>

---

<b>Soliyev A.</b>	
Theoretical study and characteristics of yarns in the production of circular knit fabrics	<b>239</b>

---

---

**Nomanov M.**

With improved blade mixer results of research work on the development of the 5lp linter **246**

---

**Lastochkin P.**

The influence of carding parameters optimization on the useful time coefficient of a rotor spinning machine **259**

---

**Mirzaakbarov A.**

Improving the efficiency of the ginning process to enhance fiber quality **260**

---

## ADVANCED PEDAGOGICAL TECHNOLOGIES IN EDUCATION

---

**Abdumanonov A.**

Enhancing the methodology for applying intelligent control systems in the teaching of technical sciences **265**

---

**Makhmudov Z.**

Increasing students' activity and knowledge level using test assignments **271**

---

## ECONOMICAL SCIENCES

---

**Sarimsakov B., Mirzabdullayev R.**

The role of contemporary HR technologies in improving business performance **275**

---