**INVENTION IN THE FIELD**

**ABSTRACT**

**Smart Irrigation System using IoT and Machine Learning for Small-Scale Farmers**

Water scarcity and inefficient irrigation practices are critical issues affecting small-scale farmers in Kenya. To address these challenges, this paper presents a Smart Irrigation System (SIS) that integrates Internet of Things (IoT) sensors and machine learning algorithms to optimize water usage and improve crop yields.

The SIS includes soil moisture sensors, weather data collectors, and a central control unit. These IoT sensors are deployed in the fields to continuously monitor soil moisture levels, temperature, humidity, and weather conditions. The collected data is transmitted to a cloud-based platform where machine learning algorithms analyze it to predict the optimal irrigation schedule.

The system uses predictive analytics to determine the precise amount of water required for different crops at various growth stages, thereby preventing over- and under-irrigation. The control unit automates the irrigation process by activating water pumps and valves based on the recommendations generated by the machine learning model.

Field experiments with small-scale farmers in various regions of Kenya reveal that the Smart Irrigation System significantly reduces water usage by up to 30% while increasing crop yields by 20%. This innovation not only conserves water resources but also enhances the productivity and profitability of small-scale farmers, contributing to sustainable agricultural practices and food security in Kenya.

**MUHTASARI:**

**Kichwa: Mfumo Mahiri wa Umwagiliaji kwa kutumia IoT na Mafunzo ya Mashine kwa Wakulima Wadogo**

Uhaba wa maji na mbinu duni za umwagiliaji ni masuala muhimu yanayoathiri wakulima wadogo nchini Kenya. Ili kukabiliana na changamoto hizi, karatasi hii inawasilisha Mfumo wa Umwagiliaji Mahiri (SIS) unaojumuisha vitambuzi vya Mtandao wa Mambo (IoT) na kanuni za ujifunzaji za mashine ili kuboresha matumizi ya maji na kuboresha mavuno ya mazao.

SIS inajumuisha vitambuzi vya unyevu wa udongo, wakusanyaji data ya hali ya hewa, na kitengo kikuu cha udhibiti. Sensorer hizi za IoT hutumwa kwenye uwanja ili kufuatilia kila mara viwango vya unyevu wa udongo, halijoto, unyevunyevu na hali ya hewa. Data iliyokusanywa hutumwa kwenye mfumo unaotegemea wingu ambapo kanuni za kujifunza kwa mashine huichanganua ili kutabiri ratiba mojawapo ya umwagiliaji.

Mfumo hutumia uchanganuzi wa kutabiri ili kubaini kiwango sahihi cha maji kinachohitajika kwa mazao tofauti katika hatua mbalimbali za ukuaji, na hivyo kuzuia umwagiliaji kupita kiasi na chini ya umwagiliaji. Kitengo cha udhibiti kinaendesha mchakato wa umwagiliaji kiotomatiki kwa kuwezesha pampu za maji na vali kulingana na mapendekezo yanayotolewa na mtindo wa kujifunza mashine.

Majaribio ya mashambani yaliyofanywa na wakulima wadogo katika maeneo mbalimbali ya Kenya yanaonyesha kuwa Mfumo wa Umwagiliaji Mahiri hupunguza kwa kiasi kikubwa matumizi ya maji hadi 30% huku ukiongeza mavuno ya mazao kwa 20%. Ubunifu huu sio tu kwamba unahifadhi rasilimali za maji lakini pia huongeza tija na faida ya wakulima wadogo, na kuchangia katika mazoea endelevu ya kilimo na usalama wa chakula nchini Kenya.

**KĨRĨA KĨRĨ**

**Mũtaratara wa Ũrĩmi wa Smart ũhũthĩrĩte IoT na Machine Learning wa arĩmi anini**

Kũnyihanyihia maaĩ na kwaga kũhũthĩra wega njĩra cia kũheana maaĩ nĩ maũndũ maritũ mũno marĩa magũmĩire arĩmi anini bũrũri-inĩ wa Kenya. Nĩguo kũhiũrania na moritũ macio, ngathĩti ĩno nĩ ĩtaarĩirie mũtaratara wa kũheana maaĩ na njĩra njega (Smart Irrigation System) ũrĩa ũhũthĩrĩte indo cia Internet of Things (IoT) hamwe na macini cia kũruta ũhoro nĩguo ũhote kũhũthĩra maaĩ wega na ũhote kũgĩa na magetha mega.

SIS nĩ ĩkoragwo na macini cia gũthuthuria ũrugarĩ wa tĩĩri, indo cia gũcokanĩrĩria ũhoro wa rĩera, na kamũtĩ ka kũrora. Indo icio cia IoT ciarutagwo mĩgũnda-inĩ nĩguo ithuthurie ũriku wa tĩĩri, ũrugarĩ, ũrugarĩ, na ũrĩa rĩera rĩrĩ. Ũhoro ũrĩa ũũnganagio ũhĩtanagĩrũo handũ igũrũ harĩa macini irathoma na ikagũthuthuria nĩguo irathũkanĩre mũtaratara ũrĩa wagĩrĩire wa kũheana maaĩ.

Mũbango ũcio ũhũthagĩra njĩra cia gũthuthuria nĩguo ũmenye mũigana wa maĩ marĩa mabataranagia nĩ ũndũ wa mĩmera mĩingĩ mĩrerere-inĩ ĩtiganĩte, na kwoguo ũkarigĩrĩria mũgũnda ũtikanyitwo nĩ maaĩ mũno kana ũtikanyitwo nĩ maaĩ biũ. Kĩndũ gĩa kũrũgamĩrĩra kĩhaarĩro kĩu nĩ kĩhũthagĩra macini kũrũgamĩrĩra kĩhaarĩro kĩu na njĩra ya kũhũthagĩra macini cia kũrũgamĩrĩra kĩhaarĩro.

Kũgerekania na arĩmi anini icigo-inĩ itiganĩte cia Kenya kuonanagia atĩ mũbango wa Smart Irrigation System nĩ ũnyihanyihĩtie ũhũthĩri wa maaĩ na gĩcunjĩ kĩa 30% na kwoguo ũgatũma magetha ma irio mongerereke na gĩcunjĩ kĩa 20%. Ũtaũri ũyũ ndũteithagia o kũiga maaĩ na ũhoti wa kũrĩma no nĩ wongereraga ũhoti wa arĩmi anini wa kũrĩma na kũgĩa na mbeca, na ũndũ ũcio ũgatũma bũrũri wa Kenya ũkorũo na ũrĩmi mwega na ũigananĩru wa irio.