REPORT OF RESEARCH RESULTS

(a) Title

Development of an Intelligent Advisory System for Safe and Active Aging

(b) Primary Researcher:

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(c) Summary: Include the outline and conclusions of the research

The increase in life expectancy and emphasis on self-reliance for older adults are global phenomena. As such, living healthily in the community is considered a viable means of promoting successful and active aging. Self-management abilities (internal resources) are needed to manage external resources in such a way that physical and social wellbeing are maintained or restored when lost. Therefore, it is evident that application of technology could help older adults to enhance their self-management capabilities.

This study developed an Intelligent Advisory System for safe and active aging, which monitor vital signs and physical activity of the individual older adult continuously; analyse usual range of vital signs, pace of walking, stability; advise older adults on the range of safe or active activities that the body is capable of; and create awareness for the older adults on their physical capability, enhance functional status, and promote healthy aging.

This project makes a positive impact on the older adults' physical and psychological well-being. Those impacts encourage older adults living an active life and maximize their social capital. Therefore, the project promotes health and wellbeing of the older adults, and reduces geriatric related conditions.

(d) Aim of Research

This study aimed to develop an Intelligent Advisory System for safe and active aging which

1. monitor the vital signs and physical activity of the individual older adult continuously
2. analyse the usual range of vital signs, and other parameter, such as, pace of walking, stability
3. advise older adults on the range of safe or active activities that the body is capable of.
4. create awareness for the older adults on their physical capability and enhance functional status.

(e) Method of Research & Progression

Research Design

The research consisted of 3 phases:

Phase 1: develop an Intelligent Advisory System (**IAS**) which includes hardware and software, camera system, wearable sensors, advisory system for safe activity

Phase 2: collect ongoing data on activity to determine the variation from the older adult's usual range of vital signs, other parameter, such as, pace of walking, stability, and physical health, self-management abilities, and level of well-being.

Phase 3: evaluate the effectiveness of the **IAS** to advise the older adults on the range of safe or active activities that the body is capable of.

Setting

We have worked with Lion Befrienders Senior Activity Centre to develop and evaluate the IAS.

Technical development of the System

Working Mechanism of the System

The system uses an inexpensive consumer IP-camera to track the location of joints. Image processing is done by a processor connected to the same network as the IP-camera. The joint positions and angles are tracked to determine if the subject is sitting, standing or walking. A local network generated by a 4G model creates a private secure network for the video data to be transmitted. An optional micro-SD card in the camera stores the data for verification.

The processor is running a data processing script that accesses the video and then plots of various landmarks on the body. The landmarks are used to calculate the knee and arm angles to determine position and location. The time to accomplish sit-to-stand and stand-to-walk is logged to a spreadsheet.

The system uses a generic machine learning-based pose detection library, which is designed to work on low power computational devices including mobile phones. A script is then fed footage either directly from a camera or from a pre-recorded video. It uses the media pose library to input the coordinates of the ankle, knee and thigh as three Cartesian points. It then calculates the angle these 3 points will form using trigonometry to determine the posture and then uses a timer to detect how long the posture takes to change. That data is logged in a CSV file.

Further data collection is aided by a wearable that is given to an individual which monitors heart rate data and transmits that automatically when it connects to the WIFI network, which the script is able to graph and store the data from.

The flowchart is depicted in Figure 1.

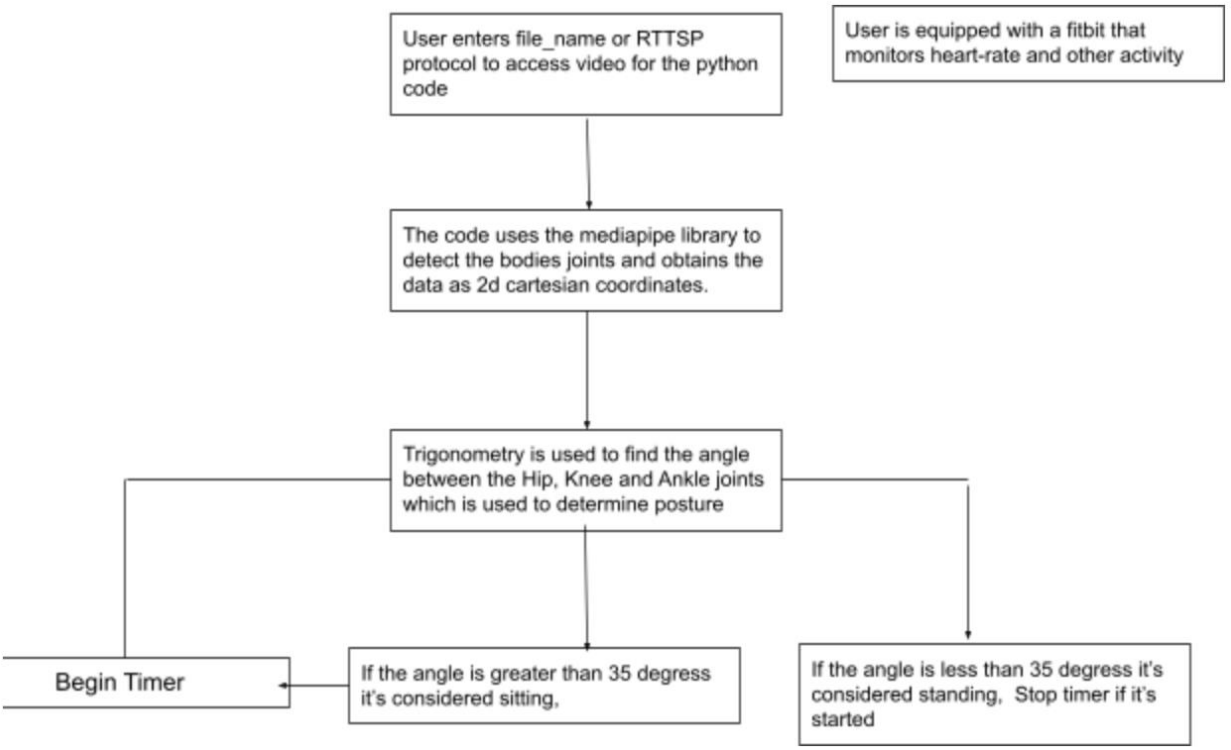

Figure 1. Flowchart of the system

(f) Results of Research

Data Collection and Analysis

The setup of the system in a living room is presented in Figure 2. The camera was set up in a room where a table was set-up. The camera was mounted on a table facing a chair. A subject was asked to sit on the chair as the initial position. The subject was then asked to stand up from the sitting position and to walk forward with the IP-camera. The sit-to-stand and stand-to-walk time were recorded.

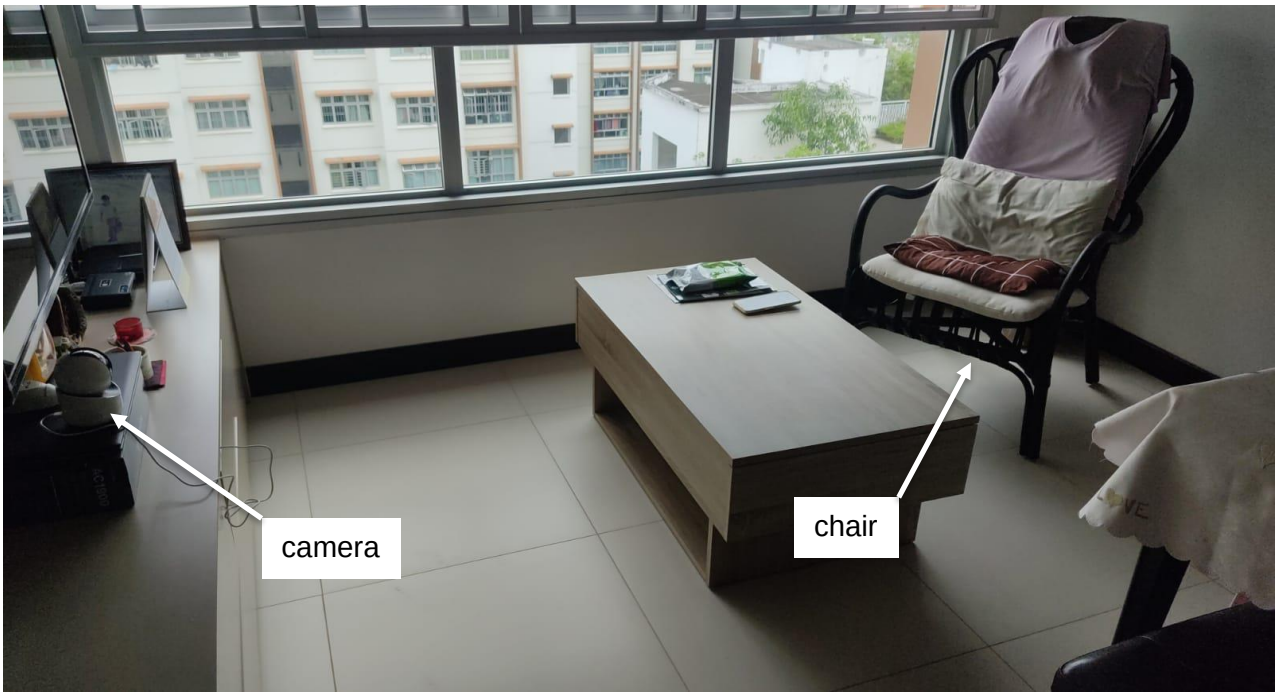

Figure 2. The setup of the system in a living room

A GUI was created for the purpose of recording the data to allow an operator without coding experience to run the code and the time-stamped data was written to a spreadsheet file.

The sit-to-stand time for 26 subjects during trials are presented in Figure 3 and Table 1.

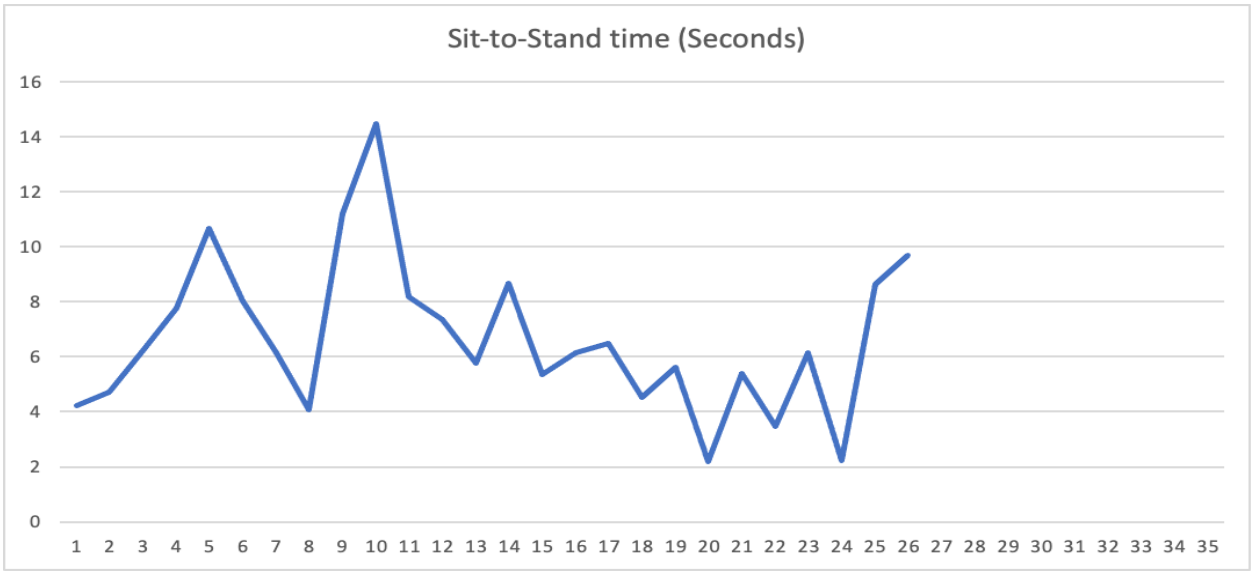

Figure 3. Sit-to-stand for 26 subjects

Outlying data points and a broad range of results are observed, with values ranging from 0.3 seconds up to 11.0 seconds.

The stand to walk time has a much lower measurement but more distinct outliers. The average is 0.2 seconds.

The start of data-recording was set up manually and hence is a variable in the data collection.

Table 1. Sit-to-stand and stand-to-walk time for 26 subjects

Trial	Sit-to-Stand Time (seconds)	Stand to Walk Time (seconds)
1	2.18	0.00
2	2.21	0.00
3	3.48	0.12
4	4.06	0.26
5	4.24	4.12
6	4.53	0.08
7	4.71	0.44
8	5.37	0.54
9	5.38	0.00
10	5.63	0.22
11	5.77	0.51
12	6.14	0.48
13	6.14	0.12
14	6.17	0.80
15	6.24	0.21
16	6.49	0.00
17	7.37	0.43
18	7.78	0.60
19	8.02	0.00
20	8.20	0.07
21	8.63	1.08
22	8.67	0.43
23	9.70	7.81
24	10.68	1.08
25	11.20	0.45
26	14.46	0.30

(g) Future Areas to Take Note of, and Going Forward

Life expectancy has improved globally and active ageing is increasingly promoted by policy-makers. Increased longevity has social consequences such as increased healthcare costs. Healthy living in communities is considered as a viable means of promoting independent and active aging.

This research contributes to building capabilities in population health research and foster collaboration with the goal of translating evidence into action. Singapore's elderly population has rapidly grown and their experience and knowledge would be valuable resources to our families, communities and societies. This research offers important insights into the need for utilising digital technology to enhance the health and well-being of older adults, and also empower older adults to manage own conditions. Therefore, this project promotes health and wellbeing of the older adults, and reduces the potential complications of geriatric related conditions, for instance, frailty.

Developing partnerships between researchers, communities, and healthcare organisations is critical to the successful adoption and implementation of health promotion programs. The partnership with the senior activity centres represents an unprecedented opportunity to inform practice and policy at community and national levels to promote healthy and active lifestyles among older adults, and therefore contribute to health and well-being of the elderly population in Singapore, and prevent deterioration to the unhealthy stage.

In summary, this project makes a positive impact on the older adults' physical, cognitive, social and psychological well-being. Those impacts encourage older adults living an active life and maximize their social capital. Therefore, this project promotes health and wellbeing of the older adults, and reduces geriatric-related conditions. Our program will set a good foundation for translational research in future. The preliminary findings pave the way to improve clinical service in long-term community-based elder care, focusing on safe and active activities and self-management. The research team plans to extend the evidence-based Intelligent Advisory System to promote larger-scale implementation in the community-living environment in Singapore.

(h) Means of Official Announcement of Research Results

We plan to publish this project work at an academic journal, and present the results of the study at international and regional conferences to disseminate the findings, and look for opportunities for potential collaboration.